**3GPP TSG-RAN WG4 Meeting # 110 R4-2400753**

**Athens, Greece, 26 February ‒ 01 March, 2024**

**Agenda item:** 8.14.4

**Source:** Moderator (Ericsson)

**Title:** Topic summary for [110][217] NR\_pos\_enh2\_part1

**Document for:** Information

# Introduction

The document contains discussion related to the positioning core and performance requirements for the following 6 main topics:

* Topic#1: General aspects relevant tdocs (AI 8.14.2.1)
* Topic#2: RedCap positioning core requirements (AI 8.14.2.4)
* Topic#3: PRS/SRS bandwidth aggregation core requirements (AI 8.14.2.5)
* Topic#4: Work plan for performance requirements (AI 8.14.3)
* Topic#5: RedCap positioning performance requirements (AI 8.14.3.3)
* Topic#6: PRS/SRS bandwidth aggregation performance requirements (AI 8.14.3.4)

Recommendations for the online discussion in order of decreasing priority:

* Topic#2: RedCap positioning core requirements (AI 8.14.2.4)
	+ Issue 2-1-1: Number of hops within a single MG occasion
	+ Issue 2-1-3: How to use Rel. 17 core requirement as baseline
	+ Issue 2-1-4: Minimum PRS bandwidth for Rx FH
* Topic#3: PRS/SRS bandwidth aggregation core requirements (AI 8.14.2.5)
	+ Issue 3-1-4: Impact of PRS collision with other signals on PRS bandwidth aggregation requirement
	+ Issue 3-3-2: Interruption due to guard period for SRS aggregation
* Topic#4: Work plan for performance requirements (AI 8.14.3)
	+ Issue 3-1: Rapporteur input to work plan for completion of performance requirement
* Topic#5: RedCap positioning performance requirements (AI 8.14.3.3)
	+ Issue 5-1-1: Side conditions and channel models for RSTD and UE Rx-Tx measurements for 1Rx UE without Rx FH
	+ Issue 5-1-2: Side conditions and channel models for RSRP measurements for 1Rx UE without Rx FH
	+ Issue 5-1-3: Side conditions and channel models for RSRPP measurements for 1Rx UE without Rx FH
* Topic#6: PRS/SRS bandwidth aggregation performance requirements (AI 8.14.3.4)
	+ Issue 6-2-3: Bandwidth configuration to define accuracy requirements for positioning measurements based on bandwidth aggregation
	+ Issue 6-2-4: Separate accuracy requirement for positioning measurements based on bandwidth aggregation depending on the number of PFLs

# Topic #1: General aspects

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2401869**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401869.zip) | **Nokia, Nokia Shanghai Bell** | **Proposal 1: RAN4 to send another LS to RAN2 and RAN3 correcting the minimum reporting quantities for Differential RSTD, k=-6, Additional path for UE Rx-Tx, k=-3, Additional path for UL-RTOA, k=-3 and Additional path for gNB Rx-Tx, k=-3.** **Proposal 2: RAN4 to discuss the need for new performance requirements for the measurement types indicated by RAN1 when frequency hopping is in use for RedCap positioning.****Proposal 3: RAN4 to inquire from RAN1 the condition(s) for applying the two-time window configuration at UE side for CPP.** **Proposal 4: RAN4 to share our understanding with RAN1 that PRS/SRS bandwidth aggregation is only specified for RRC\_INACTIVE and RRC\_CONNECTED states.****Proposal 5: RAN4 to evaluate whether the configuration with 2 PFL combinations and a shared PFL with split aggregation is to be considered in the measurement period requirements.****Proposal 6: RAN4 to specify the aggregated reference RSTD reporting requirement in the WI performance part.** **Proposal 7: RAN4 to inquire from RAN1 what the term “additional” UE Rx-Tx time difference / RSTD / UL RTOA / gNB Rx-Tx time difference measurement means in case of CP measurements (DL RSCP / RSCPD / UL RSCP) and whether this is related to additional path reporting.** |

## Open issues summary

### Sub-topic 1-1: General

**Issue 1-1-1: New k values for measurement report mapping.**

* Proposals
	+ Option 1: Nokia
		- RAN4 to send another LS to RAN2 and RAN3 correcting the minimum reporting quantities for Differential RSTD, k=-6, Additional path for UE Rx-Tx, k=-3, Additional path for UL-RTOA, k=-3 and Additional path for gNB Rx-Tx, k=-3.
* Recommended WF
	+ Discuss this issue under Issue 6-1-1.

**Issue 1-1-2: Aspects related to performance requirement for RedCap positioning with Rx FH.**

* Proposals
	+ Option 1: Nokia
		- RAN4 to discuss the need for new performance requirements for the measurement types indicated by RAN1 when frequency hopping is in use for RedCap positioning.
* Recommended WF
	+ Discuss this issue under Issue 5-1-4.

**Issue 1-1-3: Time window for CPP measurement.**

* Proposals
	+ Option 1: Nokia
		- RAN4 to inquire from RAN1 the condition(s) for applying the two-time window configuration at UE side for CPP.
* Recommended WF
	+ Issues related to CPP will be discussed in thread [110][218] NR\_pos\_enh2\_part2.

**Issue 1-1-4: LS to RAN1 on PRS/SRS aggregation.**

* Proposals
	+ Option 1: Nokia
		- RAN4 to share our understanding with RAN1 that PRS/SRS bandwidth aggregation is only specified for RRC\_INACTIVE and RRC\_CONNECTED states.
* Recommended WF
	+ Discuss the option(s).

**Issue 1-1-5: Impact of shared PFL on BW aggregation core requirement**

* Proposals
	+ Option 1: Nokia
		- RAN4 to evaluate whether the configuration with 2 PFL combinations and a shared PFL with split aggregation is to be considered in the measurement period requirements.
* Recommended WF
	+ This issue will be discussed as a part of Topic #3 of this thread.

**Issue 1-1-6: Aggregated reference RSTD measurement**

* Proposals
	+ Option 1: Nokia
		- RAN4 to specify the aggregated reference RSTD reporting requirement in the WI performance part.
* Recommended WF
	+ This issue will be discussed as a part of Topic #6 of this thread.

**Issue 1-1-7: Clarification on measurement reporting when carrier phase measurements are reported together with “additional” timing measurements**

* Proposals
	+ Option 1: Nokia
		- RAN4 to inquire from RAN1 what the term “additional” UE Rx-Tx time difference / RSTD / UL RTOA / gNB Rx-Tx time difference measurement means in case of CP measurements (DL RSCP / RSCPD / UL RSCP) and whether this is related to additional path reporting..
* Recommended WF
	+ Issues related to CPP will be discussed in thread [110][218] NR\_pos\_enh2\_part2.

## Draft CRs

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2402676**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402676.zip) | **Ericsson** | **DraftCR to 38.133 to implement measurement gap patterns for RedCap positioning** |

# Topic #2: RedCap positioning core requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2401869**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401869.zip) | **Nokia, Nokia Shanghai Bell** | **Proposal 2: RAN4 to discuss the need for new performance requirements for the measurement types indicated by RAN1 when frequency hopping is in use for RedCap positioning.** |
| [**R4-2400081**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2400081.zip) | **CATT** | **Proposal 1: Based on Option 1, the following modified solution that accommodates the cases where multiple hops are performed in one slot can be used to derive the number of hops in a single MG occasion for fast RF switching, i.e.,** $K^{'}=1$**:**  **Step1: Check the value of** $K^{'}$**.** **- If** $K^{'}=1$**, calculate the possible number of hops in one slot** $N\_{hop}^{slot}$**,**$$N\_{hop}^{slot}=min\left(\left⌊\frac{14}{N\_{CombSize}+N\_{RFswiching}}\right⌋,\left⌈\frac{N\_{PRS\\_OFDM}^{slot}}{N\_{CombSize}+N\_{RFswiching}}\right⌉\right)$$**Where**$N\_{PRS\\_OFDM}^{slot}$ **is the number of OFDM symbols for PRS resources in one slot.** $N\_{CombSize}$ **is the PRS comb size.** $N\_{RFswiching}$ **is the number of OFDM symbols for RF switching time.** **Note1: The flooring operation is used to limit the time for receiving the last hop and RF switching to the same slot.** **Note2: The ceiling operation is used because no RF switching time is considered for the last hop in a slot.****- If** $K^{'}=2$**, go to Step3.** **Step2: Check the value of** $N\_{hop}^{slot}$**.** **- If it is equal to or larger than 1, the number of hops in a single MG occasion is** $$N\_{hop}=N\_{hop}^{slot}\*min\left(N,N\_{hop,max}\right)$$**And the Step3 is skipped.****- If it equals to 0, then change** $K^{'}$ **to 2 and go to Step3.** **Step3: Apply the mechanism in Option 1, i.e., calculate** $K=max\left(K^{'},M\right)$ **and follow the test of rules.** **A CR (R4-2400082) that captures the above solution for all three RRC states is submitted.** **Proposal 2: The legacy measurement period requirements are used as baseline, the modifications include:** **- Applicable Nsample is {2, 4}.****- The time duration of available PRS is derived by** $$L\_{available\\_PRS,i}=N\_{hop}\*L\_{per\\_hop}$$**Where,**$N\_{hop}$ **is the number of hops in a single MG occasion.** $L\_{per\\_hop}$ **is the time duration of available PRS per hop.** **- Other parameters are reused.** **Proposal 3: In RRC\_IDLE or RRC\_INACTIVE state, the number of hops can be derived by**$$N\_{hop}=min\left(6, \left⌊\frac{BW\_{PRS}-N\_{RB\\_overlap}}{N\_{RB\\_hop}-N\_{RB\\_overlap}}\right⌋\right)$$**Where** $N\_{hop}$ **is the number of hops,** $BW\_{PRS}$ **is the configured BW for PRS resources,** $N\_{RB\\_hop}$ **is the number of RBs per hop and** $N\_{RB\\_overlap}$ **is the number of overlapping RBs between adjacent hops.****And the time duration of available PRS is derived by** $$L\_{available\\_PRS,i}=N\_{hop}\*L\_{per\\_hop}$$**Where** $L\_{per\\_hop}$ **is the time duration of available PRS per hop.**  |
| [**R4-2401224**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401224.zip) | **Qualcomm Inc.** | **Proposal 1: RAN4 to first discuss requirements for PRS measurements with FH in RRC\_CONNECTED and leverage agreements to the extent possible to define the corresponding requirements in RRC\_IDLE/RRC\_INACTIVE.****Proposal 2: Assume up to 50% overhead from Rx hopping when defining the measurement period requirement and the number of Rx hops measured per MG occasion. i.e. the fraction of time within each measurement gap spent retuning between hops is at most 50%. RAN4 may not need to capture this assumption in the specifications.****Proposal 3: Define the number of Rx hops per slot** $\left(N\_{hops}^{slot}\right)$ **as follows**

|  |  |  |
| --- | --- | --- |
| **Retuning time between Rx hops** $\left(RRT\_{FH}\right)$ | **(comb size, Number of PRS symbols)** | **Applicable number of hops per slot** $\left(N\_{hops}^{slot}\right)$ |
| $$RRT\_{FH}\leq 2 symbols$$ | **(≤ 4, 12)** | **2** |
| **All others** | **1** |
| $$2 symbols <RRT\_{FH}\leq 6 symbols$$ | **(≤ 6, any)** | **1** |
| **(12, 12)** | **½** |
| $$RRT\_{FH}>6 symbols$$ | **Any combination** | **½** |

**Proposal 4: The number of Rx hops measured by the UE in a MG instance is given by**$$N\_{hops}=min\left(N\_{hops,effect}, N\_{hops, max}\right)$$**where*** $N\_{hops, max}$ **is the maximum number of Rx hops signaled in the UE capability (FG 41-5-1)**
* $N\_{hops, effect}$ **is the effective number of Rx hops within a MG instance**
* $N\_{hops, effect}=\left⌊N\_{hops}^{slot}∙N\_{rep}^{PRS}\right⌋$ **if** $M\_{rep}^{PRS}=1$ **or** $N\_{hops}^{slot}\geq 1$**, otherwise** $N\_{hops}=1+\left⌊{\left(N\_{rep}^{PRS}-1\right)}/{\left⌈{1}/{\left(M\_{rep}^{PRS}∙N\_{hops}^{slot}\right)}\right⌉}\right⌋$
* $N\_{rep}^{PRS}$ **is the number of PRS inter-slot repetitions within a single MG instance, excluding the gap retuning times**
* $M\_{rep}^{PRS}$ **is the stride of PRS inter-slot repetitions (*dl-PRS-ResourceTimeGap*)**
* $N\_{hops}^{slot}$ **is the number of Rx hops per slot**

**Proposal 5: The minimum PRS BW expected to be measured with Rx hopping is given by**$$min\left(BW\_{PRS},N\_{hops}∙BW\_{hop}-BW\_{overlap}∙\left(N\_{hops}-1\right)\right)$$**where*** $BW\_{PRS}$ **is the configured PRS BW**
* $BW\_{hop}$ **is the BW per hop signaled in the UE capability**
* $BW\_{overlap}$ **is the minimum hop overlap signaled in the UE capability**
* $N\_{hops}$ **is the number of Rx hops measured by the UE within a MG instance**

**Proposal 6: Add a scaling factor** $k\_{FH,i}$ **to the measurement period formula to account for Rx hopping overhead for PRS measurements with Rx hopping:**$$T\_{xxx,i}=\left(k\_{FH,i}\*k\_{multiTEG,i}\*CSSF\_{PRS,i}\*ceil( K\_{p,PRS,i})\*N\_{RxBeam,i}\*\left⌈\frac{N\_{PRS,i}^{slot}}{N^{'}}\right⌉\left⌈\frac{L\_{available\\_PRS,i}}{N}\right⌉\*N\_{sample}-1\right)\*T\_{effect,i}+T\_{last,i}$$**where*** $k\_{FH,i}=\left⌈\frac{2∙N\_{hops}}{N\_{rep}^{PRS}}\right⌉$ **for** $N\_{hops}^{slot}\leq 1$**,**
* $k\_{FH,i}=2$ **for** $N\_{hops}^{slot}=2$**,**

**and*** $N\_{rep}^{PRS}$ **is the number of PRS inter-slot repetitions within a single MG instance, excluding the gap retuning times,**
* $N\_{hops}$ **is the number of Rx hops measured by the UE in a MG instance.**

**Proposal 7: The measurement period requirement with FH (multiple hops) applies provided all PRS resources in a PFL have the same number of inter-slot repetitions within an MG instance and the same spacing between inter-slot repetitions. If these conditions do not apply the measurement period can be longer.****Proposal 8: Measurement requirements with FH apply to PRS resources that have a duration (including RSTD uncertainty) not larger that the UE PRS processing capability N.****Proposal 9: RAN4 to discuss additional applicability conditions for PRS measurements with Rx hopping and/or measurement period extensions to address large differences in expected RSTD between PRS resources in the assistance data.****Proposal 10: If a RedCap UE reports PRS measurements with single Rx hop when Rx hopping is requested, the requirements for measurements without Rx hopping apply.** |
| [**R4-2401820**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401820.zip) | **ZTE Corporation** | **Observation 1: The measurement is within one measurement gap (if confirmed) and for positioning for RedCap UEs with DL PRS Rx Hopping, the UE hops within a DL PRS resource.****Proposal 1: RAN4 shall consider and study the measurement period requirements for both of two cases the RAN1 proposed and the measurement period requirements are similar to two cases.** |
| [**R4-2402180**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402180.zip) | **Huawei, HiSilicon** | **Proposal 1: The number of hops within a single MG occasion** $N\_{hop}$ **is defined as**$$N\_{hop}=min\left(\left⌊\frac{\left(N-1\right)\*M}{K}\right⌋+1,N\_{hop,max}\right)$$**where** * $N$ **is the number of PRS repetitions within the MG occasion**
* $M$ **is the PRS repetition interval (given by *dl-PRS-ResourceTimeGap*)**
* $K$ **is the number of slots per hop and** $K=max\left(K^{'},M\right)$
* $K^{'}=1$ **if the RF switching time is ≤ 7 symbols and** $K^{'}=2$ **otherwise**
* $N\_{hop,max}$ **is the maximum number of hops indicated as UE capability**

**Proposal 2: For Case 1, RAN4 to define the overall BW with FH** $$BW\_{multi-hop}=min\left(BW\_{PRS},N\_{hop}\*BW\_{per-hop}-\left(N\_{hop}-1\right)\*BW\_{overlap}\right)$$**where** * $BW\_{PRS}$ **is determined by the min. among 1) the configured PRS BW, 2) UE capability (Component 1 of FG 41-5-1), and 3) total BW of all hops requested by LMF**
* $N\_{hop}$ **is number of hops UE can perform within a single MG occasion as in Proposal 1.**
* $BW\_{per-hop}$ **is the supported BW per hop which is UE capability (Component 1 of FG 13-1)**
* $BW\_{overlap}$ **is the BW of the overlapping RB which is UE capability (Component 6 of FG 41-5-1)**

**Proposal 3: Existing requirements for MG-based measurement are re-used as baseline, and the following adaptations are considered:*** **Lprs = Nhop \* Lper\_hop, where Nhop is the number of hops that UE can do in an MG occasion, and Lper\_hop is the PRS duration per hop;**
* **The requirements are applicable only to PRS resource in the sampling duration in each hop.**

**Proposal 4: RAN4 not to further discuss enlarged soft buffer for FH given the RAN1 feature list.** |
| [**R4-2402679**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402679.zip) | **Ericsson** | **Proposal 1: Lavailable for PRS measurement period requirement with FH is calculated as:Lavailable= Lavailable per hop × Nhops + RFretuning time × (Nhops -1),where*** **Lavailable per hop is the time duration of PRS resource UE can measure in each hop and depends on the UE capability,**
* **RFretuning time is the RF retuning time based on UE reported capability,**
* **Nhops is calculated based on the DL PRS bandwidth UE can measure across all hops, PRS bandwidth UE can measure per hop and overlapping between hops supported by the UE. Nhops =** $\left⌈\frac{BW\_{max}}{BW\_{per hop}- PRB\_{overlapping}}\right⌉$**. BWmax is the DL PRS bandwidth across all hops. BWper hop is the DL PRS BW UE can measurement in each hop. And PRBoverlapping is the number of overlapping PRBs between hops.**
 |
| [**R4-2402734**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402734.zip) | **Nokia, Nokia Shanghai Bell** | **Proposal 1: The upper bound of the number of hops in an MG occasion is determined based on the configured PRS BW and/or the maximum size of PRS BW.** **Proposal 2: The number of hops should be defined as a function of factors such as PRS symbols, PRS comb size, switching time, total PRS BW size, and maximum BW size supported by UE.** |
| [**R4-2402902**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402902.zip) | **MediaTek inc.** | **Proposal 1: When the number of hops within a single MG occasion is equal to the total number of hops required to cover the entire BW of PRS resources, measurement delay requirements for RedCap positioning with FH can reuse R17 positioning measurement delay with gap. Otherwise, when only some of the total hops are received within a single MG occasion, the requirements shall not apply.** |

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1: Core requirements for Rx FH.

**Issue 2-1-1: Number of hops within a single MG occasion.**

* *Background*:
	+ *Agreement from RAN4#109 relating to this issue:*
		- *Number of hops within a single MG occasion is defined as a requirement. The details are FFS*.
* Proposals
	+ Option 1: CATT

# Number of hops in RRC\_CONNECTED mode

Based on Option 1 (i.e., HW’s proposal in this meeting, Option 4), the following modified solution that accommodates the cases where multiple hops are performed in one slot can be used to derive the number of hops in a single MG occasion for fast RF switching, i.e., $K^{'}=1$:

**Step1**: Check the value of $K^{'}$.

* + - If $K^{'}=1$, calculate the possible number of hops in one slot $N\_{hop}^{slot}$,
		- $N\_{hop}^{slot}=min\left(\left⌊\frac{14}{N\_{CombSize}+N\_{RFswiching}}\right⌋,\left⌈\frac{N\_{PRS\\_OFDM}^{slot}}{N\_{CombSize}+N\_{RFswiching}}\right⌉\right)$

Where

* + - $N\_{PRS\\_OFDM}^{slot}$ is the number of OFDM symbols for PRS resources in one slot.
		- $N\_{CombSize}$ is the PRS comb size.
		- $N\_{RFswiching}$ is the number of OFDM symbols for RF switching time.
		- Note1: The flooring operation is used to limit the time for receiving the last hop and RF switching to the same slot.
		- Note2: The ceiling operation is used because no RF switching time is considered for the last hop in a slot.
		- If $K^{'}=2$, go to Step3.

**Step2**: Check the value of $N\_{hop}^{slot}$.

* + - If it is equal to or larger than 1, the number of hops in a single MG occasion is
		- $N\_{hop}=N\_{hop}^{slot}\*min\left(N,N\_{hop,max}\right)$
		- And the Step3 is skipped.
		- If it equals to 0, then change $K^{'}$ to 2 and go to Step3.

**Step3**: Apply the mechanism in Option 1 (i.e., HW’s proposal in this meeting, Option 4), i.e., calculate $K=max\left(K^{'},M\right)$ and follow the rest of rules.

* + Option 2: CATT

# Number of hops in RRC\_INACTIVE/IDLE mode

In RRC\_IDLE or RRC\_INACTIVE state, the number of hops can be derived by

* + - $N\_{hop}=min\left(6, \left⌊\frac{BW\_{PRS}-N\_{RB\\_overlap}}{N\_{RB\\_hop}-N\_{RB\\_overlap}}\right⌋\right)$
		- Where $N\_{hop}$ is the number of hops, $BW\_{PRS}$ is the configured BW for PRS resources, $N\_{RB\\_hop}$ is the number of RBs per hop and $N\_{RB\\_overlap}$ is the number of overlapping RBs between adjacent hops.
	+ Option 3: Qualcomm Inc.
		- Define the number of Rx hops per slot $\left(N\_{hops}^{slot}\right)$ as follows

|  |  |  |
| --- | --- | --- |
| Retuning time between Rx hops $\left(RRT\_{FH}\right)$ | (comb size, Number of PRS symbols) | Applicable number of hops per slot $\left(N\_{hops}^{slot}\right)$ |
| $$RRT\_{FH}\leq 2 symbols$$ | (≤ 4, 12) | 2 |
| All others | 1 |
| $$2 symbols <RRT\_{FH}\leq 6 symbols$$ | (≤ 6, any) | 1 |
| (12, 12) | ½ |
| $$RRT\_{FH}>6 symbols$$ | Any combination | ½ |

* + - The number of Rx hops measured by the UE in a MG instance is given by
			* $N\_{hops}=min\left(N\_{hops,effect}, N\_{hops, max}\right)$
			* where
				+ $N\_{hops, max}$ is the maximum number of Rx hops signaled in the UE capability (FG 41-5-1)
				+ $N\_{hops, effect}$ is the effective number of Rx hops within a MG instance
				+ $N\_{hops, effect}=\left⌊N\_{hops}^{slot}∙N\_{rep}^{PRS}\right⌋$ if $M\_{rep}^{PRS}=1$ or $N\_{hops}^{slot}\geq 1$, otherwise $N\_{hops}=1+\left⌊{\left(N\_{rep}^{PRS}-1\right)}/{\left⌈{1}/{\left(M\_{rep}^{PRS}∙N\_{hops}^{slot}\right)}\right⌉}\right⌋$
				+ $N\_{rep}^{PRS}$ is the number of PRS inter-slot repetitions within a single MG instance, excluding the gap retuning times.
				+ $M\_{rep}^{PRS}$ is the stride of PRS inter-slot repetitions (dl-PRS-ResourceTimeGap).
				+ $N\_{hops}^{slot}$ is the number of Rx hops per slot.
	+ Option 4: HW
		- The number of hops within a single MG occasion $N\_{hop}$ is defined as
			* $N\_{hop}=min\left(\left⌊\frac{\left(N-1\right)\*M}{K}\right⌋+1,N\_{hop,max}\right)$

where

* + - * + $N$ is the number of PRS repetitions within the MG occasion
				+ $M$ is the PRS repetition interval (given by dl-PRS-ResourceTimeGap)
				+ $K$ is the number of slots per hop and $K=max\left(K^{'},M\right)$
				+ $K^{'}=1$ if the RF switching time is ≤ 7 symbols and $K^{'}=2$ otherwise
				+ $N\_{hop,max}$ is the maximum number of hops indicated as UE capability
	+ Option 5: Nokia
		- The upper bound of the number of hops in an MG occasion is determined based on the configured PRS BW and/or the maximum size of PRS BW.
		- The number of hops should be defined as a function of factors such as PRS symbols, PRS comb size, switching time, total PRS BW size, and maximum BW size supported by UE.
* Recommended WF
	+ Discuss the option(s).

**Issue 2-1-2: Priority of RRC state for core requirement definition**

* Proposals
	+ Option 1: QC.
		- RAN4 to first discuss requirements for PRS measurements with FH in RRC\_CONNECTED and leverage agreements to the extent possible to define the corresponding requirements in RRC\_IDLE/RRC\_INACTIVE.
* Recommended WF
	+ Discuss the option(s).

**Issue 2-1-3: How to use Rel. 17 core requirement as baseline**

* Proposals
	+ Option 1: CATT
		- The legacy measurement period requirements are used as baseline, the modifications include:
			* Applicable Nsample is {2, 4}.
			* The time duration of available PRS is derived by:
				+ $L\_{available\\_PRS,i}=N\_{hop}\*L\_{per\\_hop}$
				+ Where,

$N\_{hop}$ is the number of hops in a single MG occasion.

$L\_{per\\_hop}$ is the time duration of available PRS per hop.

* + - * Other parameters are reused.

* + Option 2: QC
		- Add a scaling factor $k\_{FH,i}$ to the measurement period formula to account for Rx hopping overhead for PRS measurements with Rx hopping:
			* $T\_{xxx,i}=\left(k\_{FH,i}\*k\_{multiTEG,i}\*CSSF\_{PRS,i}\*ceil( K\_{p,PRS,i})\*N\_{RxBeam,i}\*\left⌈\frac{N\_{PRS,i}^{slot}}{N^{'}}\right⌉\left⌈\frac{L\_{available\\_PRS,i}}{N}\right⌉\*N\_{sample}-1\right)\*T\_{effect,i}+T\_{last,i}$

where

$k\_{FH,i}=\left⌈\frac{2∙N\_{hops}}{N\_{rep}^{PRS}}\right⌉$ for $N\_{hops}^{slot}\leq 1$,

$k\_{FH,i}=2$ for $N\_{hops}^{slot}=2$,

and

$N\_{rep}^{PRS}$ is the number of PRS inter-slot repetitions within a single MG instance, excluding the gap retuning times,

$N\_{hops}$ is the number of Rx hops measured by the UE in a MG instance.

* + Option 3: HW
		- Existing requirements for MG-based measurement are re-used as baseline, and the following adaptations are considered:
			* Lprs = Nhop \* Lper\_hop, where Nhop is the number of hops that UE can do in an MG occasion, and Lper\_hop is the PRS duration per hop;
			* The requirements are applicable only to PRS resource in the sampling duration in each hop.
	+ Option 4: E///
		- Lavailable for PRS measurement period requirement with FH is calculated as:

			* Lavailable= Lavailable per hop × Nhops + RFretuning time × (Nhops -1),

where

* + - * + Lavailable per hop is the time duration of PRS resource UE can measure in each hop and depends on the UE capability,
				+ RFretuning time is the RF retuning time based on UE reported capability,
				+ Nhops is calculated based on the DL PRS bandwidth UE can measure across all hops, PRS bandwidth UE can measure per hop and overlapping between hops supported by the UE. Nhops = $\left⌈\frac{BW\_{max}}{BW\_{per hop}- PRB\_{overlapping}}\right⌉$. BWmax is the DL PRS bandwidth across all hops. BWper hop is the DL PRS BW UE can measurement in each hop. And PRBoverlapping is the number of overlapping PRBs between hops.
	+ Option 5: MTK
		- When the number of hops within a single MG occasion is equal to the total number of hops required to cover the entire BW of PRS resources, measurement delay requirements for RedCap positioning with FH can reuse R17 positioning measurement delay with gap. Otherwise, when only some of the total hops are received within a single MG occasion, the requirements shall not apply.
* Recommended WF
	+ Discuss the option(s).

**Issue 2-1-4: Minimum PRS bandwidth for Rx FH**

* Proposals
	+ Option 1: QC
		- The minimum PRS BW expected to be measured with Rx hopping is given by

$$min\left(BW\_{PRS},N\_{hops}∙BW\_{hop}-BW\_{overlap}∙\left(N\_{hops}-1\right)\right)$$

where

* + - * $BW\_{PRS}$ is the configured PRS BW
			* $BW\_{hop}$ is the BW per hop signaled in the UE capability
			* $BW\_{overlap}$ is the minimum hop overlap signaled in the UE capability
			* $N\_{hops}$ is the number of Rx hops measured by the UE within a MG instance
	+ Option 2: HW

		- For Case 1, RAN4 to define the overall BW with FH
			* $BW\_{multi-hop}=min\left(BW\_{PRS},N\_{hop}\*BW\_{per-hop}-\left(N\_{hop}-1\right)\*BW\_{overlap}\right)$

where

* + - * + $BW\_{PRS}$ is determined by the min. among 1) the configured PRS BW, 2) UE capability (Component 1 of FG 41-5-1), and 3) total BW of all hops requested by LMF
				+ $N\_{hop}$ is number of hops UE can perform within a single MG occasion as in Proposal 1.
				+ $BW\_{per-hop}$ is the supported BW per hop which is UE capability (Component 1 of FG 13-1)
				+ $BW\_{overlap}$ is the BW of the overlapping RB which is UE capability (Component 6 of FG 41-5-1)
* Recommended WF
	+ Discuss the option(s).

**Issue 2-1-5: Overhead due to Rx FH**

* Proposals
	+ Option 1: QC
		- Assume up to 50% overhead from Rx hopping when defining the measurement period requirement and the number of Rx hops measured per MG occasion. i.e. the fraction of time within each measurement gap spent retuning between hops is at most 50%. RAN4 may not need to capture this assumption in the specifications
* Recommended WF
	+ Discuss the option(s).

**Issue 2-1-6: Applicability of core requirement for Rx FH**

* Proposals
	+ Option 1: QC
		- The measurement period requirement with FH (multiple hops) applies provided all PRS resources in a PFL have the same number of inter-slot repetitions within an MG instance and the same spacing between inter-slot repetitions. If these conditions do not apply the measurement period can be longer.
		- Measurement requirements with FH apply to PRS resources that have a duration (including RSTD uncertainty) not larger that the UE PRS processing capability N.
		- RAN4 to discuss additional applicability conditions for PRS measurements with Rx hopping and/or measurement period extensions to address large differences in expected RSTD between PRS resources in the assistance data.
		- If a RedCap UE reports PRS measurements with single Rx hop when Rx hopping is requested, the requirements for measurements without Rx hopping apply.
* Recommended WF
	+ Discuss the option(s).

**Issue 2-1-7: Types of core requirements**

* *Background:*
	+ *Agreement from RAN4#109 relating to this issue:*
		- *RAN4 to define requirements for positioning measurement based on multiple hops.*
* Proposals
	+ Option 1: ZTE
		- RAN4 shall consider and study the measurement period requirements for both of two cases the RAN1 proposed and the measurement period requirements are similar to two cases.
* Recommended WF
	+ It is moderator’s understanding that this issue has already been resolved in RAN4#109.
	+ No further discussion on this issue.

**Issue 2-1-8: Buffer size for Rx FH**

* Proposals
	+ Option 1: HW
		- RAN4 not to further discuss enlarged soft buffer for FH given the RAN1 feature list.
* Recommended WF
	+ Discuss the option(s).

## Draft CRs

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Title** |
| [**R4-2400082**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2400082.zip) | **CATT** | **(NR\_pos\_enh2-Core) CR on correction of measurement period requirements for RedCap UE with FH** |
| [**R4-2401201**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401201.zip) | **Xiaomi** | **Draft CR # 16:PRS measurement requirements for RedCap positioning in RRC INACTIVE state (PRS-RSRPP requirements)** |
| [**R4-2401231**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401231.zip) | **Qualcomm Inc.** | **Correction to CSSF for SSB when PRS measurements are configured for RedCap UE** |
| [**R4-2402181**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402181.zip) | **Huawei, HiSilicon** | **draftCR on RRM requirements for RedCap positioning** |
| [**R4-2402680**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402680.zip) | **Ericsson** | **DraftCR to 38.133 Corrections to core requirements for RedCap positioning** |
| [**R4-2402903**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402903.zip) | **MediaTek inc.** | **Draft CR on correction for Rel-18 RSTD and PRS-RSRP requirements for RedCap in RRC connected state** |

# Topic #3: PRS/SRS bandwidth aggregation core requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2400083**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2400083.zip) | **CATT** | **Proposal 1: The definition for** $K\_{carrier,agg}$ **in measurements without bandwidth aggregation can be reused and the symbols are updated as following:****-** $K\_{carrier, aggr}$ **is a scaling factor for PRS-based NR positioning measurements in RRC\_INACTIVE. If the UE supports parallelPRS-MeasRRC-Inactive-r17, Kcarrier,agg = 1; otherwise,** **- If Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ,** $K\_{carrier, aggr}=K\_{carrier}+1$**, where** $K\_{carrier}$ **is defined in clause 4.2.2.4****- If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ,** $K\_{carrier, aggr}=N\_{layers}+1$**, where** $N\_{layers}$ **is defined in clause 4.2.2.7.****Proposal 2: For** $N\_{Rx, TEG, aggr, m}$**, the definition in measurements without bandwidth aggregation can be reused and the symbol is updated as following:****-** $N\_{Rx,TEG,aggr,m}$ **is the Rx TEG specific scaling factor:****-** $N\_{Rx,TEG,aggr,m}$ **= 1 if the UE is not configured by the LMF to measure a PRS resource with multiple Rx TEGs via measureSameDL-PRS-ResourceWithDifferentRxTEGs-r17 [34].****-** $N\_{Rx,TEG,aggr,m}$**is defined as follows if the UE is configured by the LMF with measureSameDL-PRS-ResourceWithDifferentRxTEGs-r17 [34] to perform measurement on same DL PRS resource of a TRP using different Rx TEGs in NR-DL-TDOA-RequestLocationInformation [34]:****-** $N\_{Rx,TEG,aggr,m}$ **= P, if the UE is not capable of receiving same DL PRS resource simultaneously from multiple Rx TEGs, where P is the number of UE Rx TEGs that the UE is requested by LMF to measure the same DL-PRS Resource of a TRP indicated by measureSameDL-PRS-ResourceWithDifferentRxTEGs-r17, and in case ‘n0’ is indicated, P is the maximum number of Rx TEGs with which UE can support to measure the same PRS resource as reported in NR-UE-TEG-Capability.****-** $N\_{Rx,TEG,aggr,m}$ **= ⌈P/Q⌉, if the UE is capable of receiving the same DL PRS resource simultaneously from multiple Rx TEGs, where Q is the number of UE Rx TEGs for measuring the same DL-PRS Resource simultaneously indicated by measureSameDL-PRS-ResourceWithDifferentRxTEGsSimul-r17 in [34].****Proposal 3: When PRS resources collide with other signals/channels and are dropped, if the rest of PRS resources are on one PFL or two contiguous PFLs, UE shall continue the on-going measurements with bandwidth aggregation and longer measurement period may be expected. Otherwise, it depends on UE implementation whether to perform positioning measurements based on two non-contiguous PFLs.**  |
| [**R4-2401198**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401198.zip) | **xiaomi** | **PRS bandwidth aggregation****Observation 1: The optimized UE implementations when the PRS collided with other signals in the aggregated PFLs are feasible and beneficial to improve all PRS resource utilization.** **Observation 2: At least when there is colliding on PRS with other signal, UE can fallback to the measurement with non-aggregated bandwidth aggregation PRS measurement indeed.** **Proposal 1: When the PRS collision with other signals on PRS bandwidth aggregation requirement, UE’s measurement can rely on the PRS of the PFL which is not collided.** **SRS bandwidth aggregation****Proposal 2: RAN4 can further discuss the impacts due to SRS bandwidth aggregation for UE Rx-Tx time difference requirements in RRC\_CONNECT state.****Observation 3: For UE Rx-Tx time difference measurements with SRS aggregation, if SRS in one of aggregated PFL is dropped in a symbol, UE can restart new measurements.** **Proposal 3: The requirements of UE Rx-Tx time difference measurements with SRS aggregation is applicable only when there is no any dropped aggregated SRSs.** **Proposal 4: RAN4 to define interruption requirements for SRS transmission for BW aggregation on CC without PUSCH/PUCCH based on conclusions from RAN1 and RF session. Requirements for SRS carrier switching or antenna switching can be re-used as baseline.** |
| [**R4-2401227**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401227.zip) | **Qualcomm Incorporated** | **Proposal 1: RAN4 to clarify in the specifications that requirements for PRS BW aggregation apply when the channel spacing between adjacent PFLs does not exceed the nominal channel spacing for intra-band contiguous CA defined in 38.101-1, clause 5.4A.1 for FR1 and in 38.101-2, clause 5.4A.1 for FR2-1.****Observation1: The LMF can configure up to two PFL groups for measurements with PRS BW aggregation subject to UE capability FG 41-4-2.****Proposal 2: Measurement requirements with PRS BW aggregation apply provided the number of PFL combinations for aggregation in the location request does not exceed UE capability (FG 41-4-2).****Proposal 3: RAN4 not to discuss further UE behavior when some PRS resources linked for aggregation are dropped due to collisions with higher priority DL signals/channels.****Proposal 4: Define interruption requirements for SRS transmission for BW aggregation on CC without PUSCH/PUCCH based on conclusions from RAN1 and RAN4 RF session. Requirements for SRS carrier switching or antenna switching can be re-used as baseline.****Proposal 5: Update the simulation assumptions for PRS BW aggregation to include the gap between adjacent intra-band contiguous PFLs.**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| **SCS, RB num, Repetition** | **SCS (kHz)** | **RB num** | **Gap between PFLs (num subcarriers)** | **Repetition (Note)** | **Sample rate (Tc)**  |
| **15** | **104** | **84** | **1** | **64** |
| **30** | **132** | **82** | **1** | **32** |
| **272** | **68** | **1** | **16** |
| **60, FR1** | **64** | **65** | **1** | **32** |
| **132** | **82** | **1** | **16** |
| **60, FR2** | **64** | **64** | **1** | **32** |
| **132** | **82** | **1** | **16** |
| **120** | **64** | **65** | **1** | **16** |
| **128** | **82** | **1** | **8** |
| **PRS comb size** | **4** |
| **PRS symbol size** | **4** |
| **Number of samples** | **2, 4** |
| **PRS periodicity** | **40ms, 200ms** |
| **TOA estimation**  | **Realistic** |
| **Path #** | **First path** |

 |
| [**R4-2401824**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401824.zip) | **ZTE Corporation** | **Proposal 1: RAN4 shall consider that the UE shall perform the measurement on the non-colliding PFLs which is the basic situation.****Proposal 2: When 2PFLs have been considered and one of the PFLs collides with the high DL signal, the UE is configured to perform the PRS measurement on the non-colliding PFL and the legacy measurement requirements can be considered.****Observation 1: RAN4 only study the PRS bandwidth aggregation up to three intra-band contiguous carriers.****Observation 2: PFLs to be configured are non-contiguous and this is not the corner case.****Observation 3: In previous meetings, RAN4 has already defined measurement period requirements with bandwidth aggregation across all PFLs.** **Proposal 3: When 3PFLs have been considered and one of the PFLs collides with the high DL signal, the UE is configured to perform the PRS measurement on the other 2 contiguous PFLs and the measurement requirements can be considered by aggregating 2PFL:****Tmeasure,total = Taggregate + Tnon-aggregate+**$T\_{margin}$**Where,****Taggregate is the total measurement period for aggregate measurements (i.e. measurements with bandwidth aggregation) across all PFLs**$T\_{margin}=\max\_{ }\left(T\_{effect, i}\right) $ **between where Teffect,i is the Teffect from aggregated PFLs which are configured for positioning measurement.** **Tnon-aggregate is equal to 0.****Proposal 4: RAN4 shall also consider the non-contiguous PFLs when one of PFLs collides with high priority DL signals:****Tmeasure,total = Taggregate + Tnon-aggregate+**$T\_{margin}$**Where,****Taggregate is equal to 0**$T\_{margin}=\max\_{ }\left(T\_{effect, i}\right) $ **between where Teffect,i is the Teffect from non-aggregated PFLs which are configured for positioning measurement.** **Tnon-aggregate is the total measurement period for non-aggregate measurements (i.e. measurements without bandwidth aggregation) across all PFLs.****Observation 4: In RRC\_CONNECTED state, for positioning SRS aggregation across CCs, if SRS in one of aggregated carriers is dropped in a symbol, stop SRS transmission in all aggregated carriers in the same symbol.****Proposal 5: In RRC\_CONNECTED state, for positioning PRS aggregation across CCs, if PRS in one of aggregated carriers is dropped in a symbol, stop PRS transmission in all aggregated carriers in the same symbol.** |
| [**R4-2401871**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401871.zip) | **Nokia, Nokia Shanghai Bell** | **Proposal 1: In case of PRS collision with other signals on one or more PFLs, the following requirements applicability is proposed.** * **For the case when UE is configured to perform positioning measurements on 2 aggregated PFLs and one of the PFLs is dropped due to collision with other high priority DL signal, such as SSB, the legacy measurement period requirement applies.**
* **For the case when UE is configured to perform positioning measurements on 3 aggregated PFLs in RRC\_CONNECTED state and one of the PFLs is dropped due to collision with other high priority DL signal such as SSB, and non-colliding PFLs are contiguous then UE shall meet measurement period requirement for positioning measurements by aggregating 2 PFLs.**
* **For the case when UE is configured to perform positioning measurements on 3 aggregated PFLs in RRC\_CONNECTED state and one of the PFLs is dropped due to collision with other high priority DL signal such as SSB, and non-colliding PFLs are non-contiguous then UE determines PFL, among the non-colliding ones, to perform positioning measurements on. In this case legacy measurement period requirement applies.**
* **In case of PRS resource dropping due to collision with signals on one or more PFLs, the UE indicates to LMF the number of PFLs the aggregated PRS measurement is based on (1 or 2).**

**Proposal 2: RAN4 not to define requirements for collision between SRS CA (outside initial BWP) with other UL/DL channels in RRC\_CONNECTED.****Proposal 3: RAN4 to specify in TS 38.133 that,** **• in case of aggregated PFLs for RSTD and UE Rx-Tx time difference, PRS-RSRP and PRS-RSRPP need to be measured and reported over aggregated PFLs, too, and** **• in case of aggregated PFLs for UL-RTOA and gNB Rx-Tx time difference measurements, SRS-RSRP and SRS-RSRPP need to be measured and reported over aggregated PFLs, too.** **Proposal 4: RAN4 to specify this for PRS-RSRP in the new subclause 9.9.3.9 and for PRS-RSRPP in the new subclause 9.9.6.9, whilst for SRS-RSRP in the existing subclause 13.3.1 for report mapping and for SRS-RSRPP in the existing subclause 13.6.1 for report mapping.** |
| [**R4-2401869**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401869.zip) | **Nokia, Nokia Shanghai Bell** | **Proposal 5: RAN4 to evaluate whether the configuration with 2 PFL combinations and a shared PFL with split aggregation is to be considered in the measurement period requirements.** |
| [**R4-2402182**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402182.zip) | **Huawei, HiSilicon** | **Proposal 1: Requirements for aggregate measurement are applicable to PRS resources in the resource sets that are indicated to be linked, provided that the alignment conditions defined by RAN1 are met.****Proposal 2: RAN4 not to define UE behaviour when there is no PRS resource dropping on any of the aggregated PFLs.****Proposal 3: For aggregated measurements, when PRS-RSRP(P) is requested with TOA measurement, TOA and PRS-RSRP(P) measurements are performed over the same measurement period.** **Proposal 4: RAN4 not to define interruption requirements for SRS transmission for BW aggregation on CC without PUSCH/PUCCH, assuming that collision between the SRS and other channels/signals as well as the guard period are to be defined in RAN1.****Proposal 5: RAN4 not to define new applicability rule for UE Rx-Tx requirements related to SRS dropping in case of SRS CA.**  |
| [**R4-2402681**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402681.zip) | **Ericsson** | **Proposal 1: RAN4 to clarify that the requirement for UE Rx-Tx measurements with bandwidth aggregation for RRC\_INACTIVE state applies provided that the SRS resources for bandwidth aggregation are not dropped due to the collision with other signal.****Observation 1: 0µs is one of the guard period values defined by the RF group.****Proposal 2: No interruption length is defined for the UEs supporting guard period of 0µs for SRS aggregation.****Proposal 3: For UEs supporting guard period values {30µs, 100µs, 140µs, 200µs} interruption lengths are defined by reusing values in 8.2.2.2.9 of 38.133.** **Observation 2: UE can report a single PRS-RSRP measurement based on aggregated PRS resources across aggregated PFLs/carriers together with aggregated timing measurements.****Observation 3: UE can report a single PRS-RSRPP measurement based on aggregated PRS resources across aggregated PFLs/carriers together with aggregated timing measurements.****Proposal 4: Core requirement for timing measurements (RSTD or UE Rx-Tx) based on aggregated carriers/PFLs apply to PRS-RSRP/RSRPP, when UE reports PRS-RSRP/RSRPP together with the timing measurements (RSTD or UE Rx-Tx) based on the aggregated carriers/PFLs.** |

## Open issues summary

### Sub-topic 3-1: PRS aggregation for positioning measurements.

**Issue 3-1-1: Update to** $K\_{carrier,agg}$

* Proposals
	+ Option 1: CATT
		- The definition for $K\_{carrier,agg}$ in measurements without bandwidth aggregation can be reused and the symbols are updated as following:
			* $K\_{carrier, aggr}$ is a scaling factor for PRS-based NR positioning measurements in RRC\_INACTIVE. If the UE supports *parallelPRS-MeasRRC-Inactive-r17*, Kcarrier,agg = 1; otherwise,
			* If Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ, $K\_{carrier, aggr}=K\_{carrier}+1$, where $K\_{carrier}$ is defined in clause 4.2.2.4
			* If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, $K\_{carrier, aggr}=N\_{layers}+1$, where $N\_{layers}$ is defined in clause 4.2.2.7.
* Recommended WF
	+ Discuss the option(s).

**Issue 3-1-2: Update to** $N\_{Rx, TEG, aggr, m}$

* *Background:*
	+ *Agreement from RAN4#109 relating to this issue:*
		- *TEG is considered in measurement period requirements for PRS CA.*
* Proposals
	+ Option 1: CATT
		- For $N\_{Rx, TEG, aggr, m}$, the definition in measurements without bandwidth aggregation can be reused and the symbol is updated as following:
			* $N\_{Rx,TEG,aggr,m}$ is the Rx TEG specific scaling factor:
			* $N\_{Rx,TEG,aggr,m}$ = 1 if the UE is not configured by the LMF to measure a PRS resource with multiple Rx TEGs via measureSameDL-PRS-ResourceWithDifferentRxTEGs-r17 [34].
			* $N\_{Rx,TEG,aggr,m}$is defined as follows if the UE is configured by the LMF with measureSameDL-PRS-ResourceWithDifferentRxTEGs-r17 [34] to perform measurement on same DL PRS resource of a TRP using different Rx TEGs in NR-DL-TDOA-RequestLocationInformation [34]:
			* $N\_{Rx,TEG,aggr,m}$ = P, if the UE is not capable of receiving same DL PRS resource simultaneously from multiple Rx TEGs, where P is the number of UE Rx TEGs that the UE is requested by LMF to measure the same DL-PRS Resource of a TRP indicated by measureSameDL-PRS-ResourceWithDifferentRxTEGs-r17, and in case ‘n0’ is indicated, P is the maximum number of Rx TEGs with which UE can support to measure the same PRS resource as reported in NR-UE-TEG-Capability.
			* $N\_{Rx,TEG,aggr,m}$ = ⌈P/Q⌉, if the UE is capable of receiving the same DL PRS resource simultaneously from multiple Rx TEGs, where Q is the number of UE Rx TEGs for measuring the same DL-PRS Resource simultaneously indicated by measureSameDL-PRS-ResourceWithDifferentRxTEGsSimul-r17 in [34].

* Recommended WF
	+ Discuss the option(s).

**Issue 3-1-3: Nominal channel spacing for PRS aggregation**

* Proposals
	+ Option 1: QC
		- RAN4 to clarify in the specifications that requirements for PRS BW aggregation apply when the channel spacing between adjacent PFLs does not exceed the nominal channel spacing for intra-band contiguous CA defined in 38.101-1, clause 5.4A.1 for FR1 and in 38.101-2, clause 5.4A.1 for FR2-1.
* Recommended WF
	+ Discuss the option(s).

**Issue 3-1-4: Impact of PRS collision with other signals on PRS bandwidth aggregation requirement**

* *Background*
	+ *Agreement from RAN4#109 relating to this issue:*
		- *Further discussion on this issue is not precluded and based on contribution driven in the maintenance part.*
* Proposals
	+ Option 1: CATT
		- When PRS resources collide with other signals/channels and are dropped, if the rest of PRS resources are on one PFL or two contiguous PFLs, UE shall continue the on-going measurements with bandwidth aggregation and longer measurement period may be expected. Otherwise, it depends on UE implementation whether to perform positioning measurements based on two non-contiguous PFLs.
	+ Option 2: Xiaomi
		- When the PRS collision with other signals on PRS bandwidth aggregation requirement, UE’s measurement can rely on the PRS of the PFL which is not collided.
	+ Option 3: QC
		- RAN4 not to discuss further UE behavior when some PRS resources linked for aggregation are dropped due to collisions with higher priority DL signals/channels.
	+ Option 4: ZTE
		- RAN4 shall consider that the UE shall perform the measurement on the non-colliding PFLs which is the basic situation.
		- When 2PFLs have been considered and one of the PFLs collides with the high DL signal, the UE is configured to perform the PRS measurement on the non-colliding PFL and the legacy measurement requirements can be considered.
		- When 3PFLs have been considered and one of the PFLs collides with the high DL signal, the UE is configured to perform the PRS measurement on the other 2 contiguous PFLs and the measurement requirements can be considered by aggregating 2PFL:

Tmeasure,total = Taggregate + Tnon-aggregate+$T\_{margin}$

 Where,

* Taggregate is the total measurement period for aggregate measurements (i.e. measurements with bandwidth aggregation) across all PFLs
* $T\_{margin}=\max\_{ }\left(T\_{effect, i}\right) $ between where Teffect,i is the Teffect from aggregated PFLs which are configured for positioning measurement.
* Tnon-aggregate is equal to 0.
	+ - RAN4 shall also consider the non-contiguous PFLs when one of PFLs collides with high priority DL signals:
			* Tmeasure,total = Taggregate + Tnon-aggregate+$T\_{margin}$

Where,

* + - * + Taggregate is equal to 0
				+ $T\_{margin}=\max\_{ }\left(T\_{effect, i}\right) $ between where Teffect,i is the Teffect from non-aggregated PFLs which are configured for positioning measurement.
				+ Tnon-aggregate is the total measurement period for non-aggregate measurements (i.e. measurements without bandwidth aggregation) across all PFLs.
		- In RRC\_CONNECTED state, for positioning PRS aggregation across CCs, if PRS in one of aggregated carriers is dropped in a symbol, stop PRS transmission in all aggregated carriers in the same symbol.
	+ Option 5: Nokia
		- In case of PRS collision with other signals on one or more PFLs, the following requirements applicability is proposed.
		- For the case when UE is configured to perform positioning measurements on 2 aggregated PFLs and one of the PFLs is dropped due to collision with other high priority DL signal, such as SSB, the legacy measurement period requirement applies.
		- For the case when UE is configured to perform positioning measurements on 3 aggregated PFLs in RRC\_CONNECTED state and one of the PFLs is dropped due to collision with other high priority DL signal such as SSB, and non-colliding PFLs are contiguous then UE shall meet measurement period requirement for positioning measurements by aggregating 2 PFLs.
		- For the case when UE is configured to perform positioning measurements on 3 aggregated PFLs in RRC\_CONNECTED state and one of the PFLs is dropped due to collision with other high priority DL signal such as SSB, and non-colliding PFLs are non-contiguous then UE determines PFL, among the non-colliding ones, to perform positioning measurements on. In this case legacy measurement period requirement applies.
		- In case of PRS resource dropping due to collision with signals on one or more PFLs, the UE indicates to LMF the number of PFLs the aggregated PRS measurement is based on (1 or 2).
	+ Option 6: HW
		- RAN4 not to define UE behaviour when there is no PRS resource dropping on any of the aggregated PFLs.
* Recommended WF
	+ Discuss the option(s).

**Issue 3-1-5: Requirement applicability.**

* Proposals
	+ Option 1: QC
		- Measurement requirements with PRS BW aggregation apply provided the number of PFL combinations for aggregation in the location request does not exceed UE capability (FG 41-4-2).
	+ Option 2: HW
		- Requirements for aggregate measurement are applicable to PRS resources in the resource sets that are indicated to be linked, provided that the alignment conditions defined by RAN1 are met.
* Recommended WF
	+ Discuss the option(s).

**Issue 3-1-5: Impact of shared PFL on BW aggregation core requirement.**

* Proposals
	+ Option 1: Nokia
		- RAN4 to evaluate whether the configuration with 2 PFL combinations and a shared PFL with split aggregation is to be considered in the measurement period requirements.
* Recommended WF
	+ Issue 3-1-5 correspond to Issue 1-1-6 under Topic #1 of this thread.
	+ Discuss the option(s).

### Sub-topic 3-3: SRS aggregation for positioning measurements.

**Issue 3-3-1: Considerations for UE Rx-Tx time difference measurement**

* Proposals
	+ Option 1a: Xiaomi
		- RAN4 can further discuss the impacts due to SRS bandwidth aggregation for UE Rx-Tx time difference requirements in RRC\_CONNECT state.
	+ Option 1b: Xiaomi, E///
		- The requirements of UE Rx-Tx time difference measurements with SRS aggregation is applicable only when there is no any dropped aggregated SRSs
	+ Option 2: Nokia
		- RAN4 not to define requirements for collision between SRS CA (outside initial BWP) with other UL/DL channels in RRC\_CONNECTED.
	+ Option 3: HW
		- RAN4 not to define new applicability rule for UE Rx-Tx requirements related to SRS dropping in case of SRS CA.
* Recommended WF
	+ Discuss the option(s).

**Issue 3-3-2: Interruption due to guard period for SRS aggregation**

* *Background:*
	+ *RAN4 received LS from RAN1 (R1-2306216) on guard period for PRS and SRS aggregation for the scenario when an SRS resource configured within a CC without PUSCH/PUCCH is linked for aggregation with an SRS resource configured within an UL active BWP of a UL communication CC.*
	+ *RAN4 (RF group) responded to the RAN1 LS as:*
		- *The following candidate values can be used for the guard period values as described in the second agreement.*
		- *{0us, 30us, 100us, 140us, 200us}.*
* Proposals
	+ Option 1: Xiaomi, QC
		- RAN4 to define interruption requirements for SRS transmission for BW aggregation on CC without PUSCH/PUCCH based on conclusions from RAN1 and RF session. Requirements for SRS carrier switching or antenna switching can be re-used as baseline.
	+ Option 2: HW
		- RAN4 not to define interruption requirements for SRS transmission for BW aggregation on CC without PUSCH/PUCCH, assuming that collision between the SRS and other channels/signals as well as the guard period are to be defined in RAN1.
	+ Option 3: E///
		- No interruption length is defined for the UEs supporting guard period of 0µs for SRS aggregation.
		- For UEs supporting guard period values {30µs, 100µs, 140µs, 200µs} interruption lengths are defined by reusing values in 8.2.2.2.9 of 38.133.
* Recommended WF
	+ Discuss the option(s).

### Sub-topic 3-4: Requirements for RSRP and RSRPP measurements based on bandwidth aggregation.

 **Issue 3-4-1: RSRP and RSRPP measurement reporting.**

* Proposals
	+ Option 1: Nokia
		- RAN4 to specify in TS 38.133 that,
			* in case of aggregated PFLs for RSTD and UE Rx-Tx time difference, PRS-RSRP and PRS-RSRPP need to be measured and reported over aggregated PFLs, too, and
			* in case of aggregated PFLs for UL-RTOA and gNB Rx-Tx time difference measurements, SRS-RSRP and SRS-RSRPP need to be measured and reported over aggregated PFLs, too.
		- RAN4 to specify this for PRS-RSRP in the new subclause 9.9.3.9 and for PRS-RSRPP in the new subclause 9.9.6.9, whilst for SRS-RSRP in the existing subclause 13.3.1 for report mapping and for SRS-RSRPP in the existing subclause 13.6.1 for report mapping.
	+ Option 2: HW, E///
		- For aggregated measurements, when PRS-RSRP(P) is requested with TOA measurement, TOA and PRS-RSRP(P) measurements are performed over the same measurement period.

* Recommended WF
	+ Discuss the option(s).

## Draft CRs.

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Title** |
| [**R4-2400084**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2400084.zip) | **CATT** | **(NR\_pos\_enh2-Core) CR on correction of measurement period requirements with BWA** |
| [**R4-2401872**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401872.zip) | **Nokia, Nokia Shanghai Bell** | **Corrections to measurement period requirements for PRS BW aggregation** |
| [**R4-2402183**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402183.zip) | **Huawei, HiSilicon** | **draftCR on RRM requirements for PRS CA** |
| [**R4-2402682**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402682.zip) | **Ericsson** | **DraftCR to 38.133 Corrections to core requirements for bandwidth aggregation based positioning measurements** |

# Topic #4: Work plan for performance requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2402685**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402685.zip) | Ericsson | * **RAN4#110:**
	+ Approve the work plan for RRM performance requirements for positioning.
	+ Approve the simulation assumptions (if necessary) for defining UE positionining measurement accuracies.
	+ Discussion on report mapping for UE positionining measurements
	+ Discussion on report mapping for gNB positionining measurements
	+ Identify initial list of RRM test cases for positionining.
	+ Discussion on RRM test configurations.
* **RAN4#110bis:**
	+ Companies provide simulation results for defining UE positionining measurement accuracies.
	+ Initial agreement on UE positionining measurement accuracies.
	+ Agreements on report mapping for UE positionining measurements
	+ Agreements on report mapping for gNB positionining measurements
	+ Approve list of RRM test cases.
	+ Further discussion and agreements on RRM test configurations.
	+ Agreement on UE side conditions for applicable bands for UE positionining measurements
	+ Agreement on work split for providing draft CRs for RRM performance requirements for positioning.
* **RAN4#111:**
	+ Companies provide, if needed, further/additional simulation results for defining UE positionining measurement accuracies.
	+ Final agreement on UE positionining measurement accuracies.
	+ Endorsement of draft CRs based on the work split covering:
		- UE positionining measurement accuracies,
		- gNB positioning measurement report mapping,
		- UE positioning measurement report mapping,
		- RRM test configurations,
		- RRM test cases and
		- Applicable side conditions.
	+ Agreement of Big CR.
 |

## Open issues summary

### Sub-topic 4-1: Work plan for performance requirements.

**Issue 3-1: Rapporteur input to work plan for completion of performance requirement.**

* Proposals
	+ Option 1: E///
		- RAN4#110:
			* Approve the work plan for RRM performance requirements for positioning.
			* Approve the simulation assumptions (if necessary) for defining UE positionining measurement accuracies.
			* Discussion on report mapping for UE positionining measurements
			* Discussion on report mapping for gNB positionining measurements
			* Identify initial list of RRM test cases for positionining.
			* Discussion on RRM test configurations.
		- RAN4#110bis:
			* Companies provide simulation results for defining UE positionining measurement accuracies.
			* Initial agreement on UE positionining measurement accuracies.
			* Agreements on report mapping for UE positionining measurements
			* Agreements on report mapping for gNB positionining measurements
			* Approve list of RRM test cases.
			* Further discussion and agreements on RRM test configurations.
			* Agreement on UE side conditions for applicable bands for UE positionining measurements
			* Agreement on work split for providing draft CRs for RRM performance requirements for positioning.
		- RAN4#111:
			* Companies provide, if needed, further/additional simulation results for defining UE positionining measurement accuracies.
			* Final agreement on UE positionining measurement accuracies.
			* Endorsement of draft CRs based on the work split covering:
			* UE positionining measurement accuracies,
			* gNB positioning measurement report mapping,
			* UE positioning measurement report mapping,
			* RRM test configurations,
			* RRM test cases and
			* Applicable side conditions.
			* Agreement of Big CR.
* Recommended WF
	+ Discuss the work plan above.

# Topic #5: RedCap positioning performance requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2400085**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2400085.zip) | **CATT** | **Proposal 1: The brackets in the side conditions for 1Rx without FH under fading propagation condition can be removed, i.e., the side conditions should be:****• RSTD accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-6, -10, -10) dB.****• UE Rx-Tx accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-3, -10, -10) dB.****• PRS-RSRP accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-3, -10, -10) dB.****• PRS-RSRPP accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-3, -10, -10) dB.****Proposal 2: One accuracy requirement table is used for measurements without FH and with FH, i.e., do not differentiate FH when defining accuracy requirements.** **Proposal 3: New accuracy requirements need to be defined for large bandwidths for each SCS configuration to cover FH cases.** **Proposal 4: For 1Rx RedCap UE, new accuracy requirements are defined based on simulation results under the agreed side conditions.** **Proposal 5: For 2Rx RedCap UE, Rel-17 accuracy requirements are reused for applicable BW for both AWGN and fading channel in FR1 and FR2.** **Proposal 6: The effective bandwidth for PRS measurements for RedCap with FH can be derived by the equation:** $BW\_{effective}=min⁡(BW\_{PRS},\left(N\_{RB\_{hop}}-N\_{RB\_{overlap}}\right)\*N\_{hop}+N\_{RB\_{overlap}})$**, where,** * $BW\_{PRS}$ **is the configured BW for PRS.**
* $N\_{RB\\_hop}$ **is the number of RBs per hop.**
* $N\_{hop}$ **is number of hops.**
* $N\_{RB\\_overlap}$ **is the number of overlapping RBs between hops.**

**Proposal 7: Similar test cases to the ones defined for normal UE should be defined. Detailed lists are provided in the tables below. Test case list for requirements with FH are also provided (check** [**R4-2400085**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2400085.zip) **for the list of proposed test cases).**  |
| [**R4-2401048**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401048.zip) | **CMCC** | **Proposal 1: for RedCap with 1RX (including both without FH and with FH), it is proposed to define accuracy requirements for following side conditions:*** **RSTD accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-6, -10, -10) dB.**
* **UE Rx-Tx accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-3, -10, -10) dB.**
* **PRS-RSRP accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-3, -10, -10) dB.**
* **PRS-RSRPP accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-3, -10, -10) dB.**

**Proposal 2: for RedCap with 2RX without FH, it is proposed to reuse existing accuracy requirements.** **Propsal 3: For RedCap positioning, it is proposed to define tests for RSTD, PRS-RSRP, UE Rx-Tx time difference and PRS-RSRPP.**  |
| [**R4-2401225**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401225.zip) | **Qualcomm Incorporated** | **Proposal 1:*** **For RSTD accuracy requirements for 1Rx RedCap UE under fading propagation condition with Nsamples = 4, the reference and target SINR side-conditions are SINRref = -6 dB, SINRtarget = -10 dB.**
* **For UE Rx-Tx accuracy requirements for 1Rx RedCap UE under fading propagation condition with Nsamples = 4, the SINR side-conditions are (-3, -10) dB.**

**Proposal 2: RAN4 to define a single set of PRS-RSRP accuracy requirements for 1Rx RedCap UEs under both AWGN and fading conditions with Nsamples = 4, at SINR side-conditions (-3, -10) dB.****Proposal 3: RAN4 to define PRS-RSRPP accuracy requirements for 1Rx RedCap UEs under the 2-tap channel model used in Rel-17 with Nsamples = 4, at SINR side-conditions (-3, -10) dB.** |
| [**R4-2401226**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401226.zip) | **Qualcomm Incorporated** | **Contains simulation results for RedCap positioning for UE Rx-Tx and RSTD measurements.** |
| [**R4-2402189**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402189.zip) | **Huawei, HiSilicon** | **Proposal 1: For RedCap with 2RX without FH, existing accuracy requirements are reused except for the applicable BW.****Proposal 2: For RedCap with 1RX without FH, new accuracy requirements are defined based on the agreed Es/Iot side condition and related simulation results.** **Proposal 3: For RedCap with FH, new accuracy requirements are defined based same channel, Es/Iot side condition and sample number as requirements for non-FH.** **Proposal 4: For RedCap with FH, RAN4 to discuss the per hop BW and total measurement BW across all hops for defining accuracy requirements.****Proposal 5: Define a single set of TCs for 1RX and 2RX RedCap UEs.****Proposal 6: Use existing TCs for normal UE as baseline for new TCs for RedCap UE without FH.****Proposal 7: Use a single set of TCs to verify both delay and accuracy for RedCap UE with FH.** |
| [**R4-2402687**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402687.zip) | **Ericsson** | **Observation 1: The propagation conditions for FR2 between without FH case and with FH case needs to be aligned.** **Observation 2: The requirements for fading channel in Rel. 17 are derived based on TDL-A (30 ns delay spread, 5Hz) and TDL-C (60 ns delay spread, 300 Hz) channel models for FR1 and FR2 respectively.****Observation 3: Agreed simulation assumptions for RedCap positioning with FH considers TDL-A (30 ns delay spread, 5Hz) channel model for RSTD and UE Rx-Tx measurements for both FR1 and FR2.****Observation 4: Channel model for RedCap positioning with FH in FR2 should be updated to TDL-C (60 ns delay spread, 300 Hz).****Proposal 1: Accuracy requirement for RedCap positioning with FH in FR2 is defined for TDL-C (60 ns delay spread, 300 Hz). R4-2314460 (simulation assumption document) is updated accordingly.****Observation 5: Rel-17 side conditions are reused for defining corresponding PRS requirements for 2Rx RedCap UE with FH.****Proposal 2: RSTD accuracy requirement for 1Rx RedCap UE (for both without FH and with FH cases) under fading propagation condition is defined for SINR values (-6, -10, -10) dB.****Proposal 3: UE Rx-Tx accuracy requirement for 1Rx RedCap UE (for both without FH and with FH cases) under fading propagation condition is defined for SINR values (-3, -10, -10) dB.****Proposal 4: PRS-RSRP accuracy requirement for 1Rx RedCap UE (for both without FH and with FH cases) is defined for SINR values (-3, -10, -10) dB.****Proposal 5: PRS-RSRPP accuracy requirement for 1Rx RedCap UE (for both without FH and with FH cases) under two path propagation condition is defined for SINR values (-3, -10, -10) dB.** **Proposal 6: For with FH, the PRS configuration up to 100MHz after FH in FR1 and up to 400MHz after FH in FR2 shall be considered to derive the accuracy requirement for positioning measurements. Simulations results submitted by companies with 1 PRB overlap between hops are used to derive the accuracy requirements.** |
| [**R4-2402688**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402688.zip) | **Ericsson** | **Contains simulation results for RedCap positioning with FH in FR2.** |
| **R4-2402689** | **Ericsson** | **Summary of simulation results for RedCap positioning.** |
| [**R4-2402735**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402735.zip) | **Nokia, Nokia Shanghai Bell** | **Proposal 1: RAN4 to discuss whether to define the same or different accuracy requirements depending on the number of hops within a single MG occasion.** **Proposal 2: RAN4 to define separate accuracy requirement at least for two cases such as a single frequency hop and multiple frequency hops.** **Proposal 3: RAN4 to discuss the modeling of the frequency impairments due to phase shifts between frequency hops and include the PRB overlap as a parameter in the simulation assumptions.** |
| [**R4-2402736**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402736.zip) | **Nokia, Nokia Shanghai Bell** | **Contains simulation Results for RedCap Positioning with Frequency Hopping.** |
| **R4-2402689** | **Ericsson** | **Summary of simulation results for RedCap positioning** |

## Open issues summary

### Sub-topic 5-1: Performance requirements.

**Issue 5-1-1: Side conditions and channel models for RSTD and UE Rx-Tx measurements for 1Rx UE without Rx FH**

* Proposals
	+ Option 1: CATT, CMCC, QC, E///
		- The brackets in the side conditions for 1Rx without FH under fading propagation condition can be removed, i.e., the side conditions should be:
			* RSTD accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-6, -10, -10) dB.
			* UE Rx-Tx accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-3, -10, -10) dB.
* Recommended WF
	+ Discuss above option(s).

**Issue 5-1-2: Side conditions and channel models for RSRP measurements for 1Rx UE without Rx FH**

* Proposals
	+ Option 1: CATT, CMCC
		- PRS-RSRP accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-3, -10, -10) dB.
	+ Option 2: QC, E///
		- RAN4 to define a single set of PRS-RSRP accuracy requirements for 1Rx RedCap UEs under both AWGN and fading conditions with Nsamples = 4, at SINR side-conditions (-3, -10) dB.
* Recommended WF
	+ Discuss above option(s).

**Issue 5-1-3: Side conditions and channel models for RSRPP measurements for 1Rx UE without Rx FH**

* Proposals
	+ Option 1: CATT, CMCC
		- PRS-RSRPP accuracy requirement for 1Rx RedCap UE under fading propagation condition is defined for SINR values (-3, -10, -10) dB.
	+ Option 2: QC, E///
		- RAN4 to define PRS-RSRPP accuracy requirements for 1Rx RedCap UEs under the 2-tap channel model used in Rel-17 with Nsamples = 4, at SINR side-conditions (-3, -10) dB.
* Recommended WF
	+ Discuss above option(s).

**Issue 5-1-4: Accuracy requirements for Rx FH and without Rx FH**

* Proposals
	+ Option 1: CATT
		- One accuracy requirement table is used for measurements without FH and with FH, i.e., do not differentiate FH when defining accuracy requirements.
		- New accuracy requirements need to be defined for large bandwidths for each SCS configuration to cover FH cases.
	+ Option 2: HW
		- For RedCap with FH, new accuracy requirements are defined based same channel, Es/Iot side condition and sample number as requirements for non-FH.
	+ Option 3: Nokia
		- RAN4 to discuss the need for new performance requirements for the measurement types indicated by RAN1 when frequency hopping is in use for RedCap positioning.
* Recommended WF
	+ Discuss above option(s).

**Issue 5-1-5: Accuracy requirements for 1 Rx UE**

* Proposals
	+ Option 1: CATT, HW
		- For 1Rx RedCap UE, new accuracy requirements are defined based on simulation results under the agreed side conditions.
* Recommended WF
	+ Discuss above option(s).

**Issue 5-1-6: Accuracy requirements for 2 Rx UE**

* Proposals
	+ Option 1: CATT, CMCC, HW
		- For 2Rx RedCap UE, Rel-17 accuracy requirements are reused for applicable BW for both AWGN and fading channel in FR1 and FR2.
* Recommended WF
	+ Discuss above option(s).

**Issue 5-1-7: Effective bandwidth for Rx FH case**

* Proposals
	+ Option 1: CATT
		- The effective bandwidth for PRS measurements for RedCap with FH can be derived by the equation: $BW\_{effective}=min⁡(BW\_{PRS},\left(N\_{RB\_{hop}}-N\_{RB\_{overlap}}\right)\*N\_{hop}+N\_{RB\_{overlap}})$, where,
			* $BW\_{PRS}$ is the configured BW for PRS.
			* $N\_{RB\\_hop}$ is the number of RBs per hop.
			* $N\_{hop}$ is number of hops.
			* $N\_{RB\\_overlap}$ is the number of overlapping RBs between hops.
	+ Option 2: HW
		- For RedCap with FH, RAN4 to discuss the per hop BW and total measurement BW across all hops for defining accuracy requirements.
	+ Option 3: E///
		- For with FH, the PRS configuration up to 100MHz after FH in FR1 and up to 400MHz after FH in FR2 shall be considered to derive the accuracy requirement for positioning measurements. Simulations results submitted by companies with 1 PRB overlap between hops are used to derive the accuracy requirements.
	+ Option 4: Nokia
		- RAN4 to discuss whether to define the same or different accuracy requirements depending on the number of hops within a single MG occasion.
* Recommended WF
	+ Discuss above option(s).

**Issue 5-1-8: Accuracy requirement for measurement per hop and single measurement based on multiple hops**

* Proposals
	+ Option 1: Nokia
		- RAN4 to define separate accuracy requirement at least for two cases such as a single frequency hop and multiple frequency hops.
* Recommended WF
	+ Discuss above option(s).

### Sub-topic 5-2: Simulation for RedCap positioning.

**Issue 5-2-1: Channel model for Rx FH in FR2**

* Proposals
	+ Option 1: E///
		- Accuracy requirement for RedCap positioning with FH in FR2 is defined for TDL-C (60 ns delay spread, 300 Hz). R4-2314460 (simulation assumption document) is updated accordingly.
* Recommended WF
	+ Discuss above option(s).

**Issue 5-2-2: Frequeny impairment for Rx FH**

* Proposals
	+ Option 1: Nokia
		- RAN4 to discuss the modeling of the frequency impairments due to phase shifts between frequency hops and include the PRB overlap as a parameter in the simulation assumptions.
* Recommended WF
	+ Discuss above option(s).

**Issue 5-2-3: Summary of simulation results submitted to RAN4#110**

* Recommended WF
	+ All simulation results for RedCap positioning submitted to RAN4#110 will be captured in R4-2402689.

### Sub-topic 5-2: Test cases for RedCap positioning

**Issue 5-2: Test cases to be defined for RedCap positioning**

* Proposals
	+ Option 1: CATT
		- Similar test cases to the ones defined for normal UE should be defined. Detailed lists are provided in the tables below. Test case list for requirements with FH are also provided (check R4-2400085 for the list of proposed test cases).
	+ Option 2: CMCC
		- For RedCap positioning, it is proposed to define tests for RSTD, PRS-RSRP, UE Rx-Tx time difference and PRS-RSRPP.
	+ Option 2: HW
		- For RedCap positioning, it is proposed to define tests for RSTD, PRS-RSRP, UE Rx-Tx time difference and PRS-RSRPP.
		- Define a single set of TCs for 1RX and 2RX RedCap Ues.
		- Use existing TCs for normal UE as baseline for new TCs for RedCap UE without FH.
		- Use a single set of TCs to verify both delay and accuracy for RedCap UE with FH.
* Recommended WF
	+ List of test cases in R4-2400085 can be a good starting point.

# Topic #6: PRS/SRS bandwidth aggregation performance requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2401869**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401869.zip) | **Nokia, Nokia Shanghai Bell** | **Proposal 1: RAN4 to send another LS to RAN2 and RAN3 correcting the minimum reporting quantities for Differential RSTD, k=-6, Additional path for UE Rx-Tx, k=-3, Additional path for UL-RTOA, k=-3 and Additional path for gNB Rx-Tx, k=-3.**  |
| [**R4-2400086**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2400086.zip) | **CATT** | **Proposal 1: The Rel-17 side conditions for RSTD and UE Rx-Tx time difference can be reused for PRS based positioning measurement with bandwidth aggregation.** **Proposal 2: The accuracy requirements can be defined based on the simulation results submitted by all companies with Rel-17 side conditions used.** **Proposal 3: Some of the possible maximum aggregated bandwidth in the latest RAN1 UE features list can be chosen to define accuracy requirements.** **Proposal 4: No need to differentiate the number of aggregated PFLs when defining accuracy requirements, i.e., one accuracy requirement table can be shared for both 2 aggregated PFLs and 3 aggregated PFLs.** **Proposal 5: RAN4 should define new reporting tables with k = {-1, -2, -3, -4, -5, -6} for timing measurements for other applicable positioning scenarios, e.g., RedCap UE positioning and Sidelink positioning. And no need to reply this LS.****Proposal 6: The existing test cases for positioning can be used as baseline. Different number of aggregated PFLs / total aggregated bandwidth should be considered when specifying configurations. The test case lists are provided in Table 2 of R4-2400086.**  |
| [**R4-2400199**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2400199.zip) | **CATT** | **Contains simulation results for PRS/SRS BW aggregation.** |
| [**R4-2401051**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401051.zip) | **CMCC** | **Proposal 1: PRS/SRS BW aggregation, it is proposed to define accuracy requirements for both 2 PFLs case and 3 PFLs case.** **Proposal 2: for PRS/SRS BW aggregation, it is proposed to define accuracy requirements for RSTD and UE Rx-Tx time difference.****Proposal 3: for PRS/SRS BW aggregation, it is proposed to define test cases for RSTD and UE Rx-Tx time difference for both RRC inactive state and RRC connected state.** |
| [**R4-2401228**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401228.zip) | **Qualcomm Incorporated** | **Contains Simulation results for PRS BW aggregation.** |
| [**R4-2401874**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401874.zip) | **Nokia, Nokia Shanghai Bell** | **Contains Simulation results for PRS BW aggregation.** |
| [**R4-2401869**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2401869.zip) | **Nokia, Nokia Shanghai Bell** | **Proposal 1: RAN4 to send another LS to RAN2 and RAN3 correcting the minimum reporting quantities for Differential RSTD, k=-6, Additional path for UE Rx-Tx, k=-3, Additional path for UL-RTOA, k=-3 and Additional path for gNB Rx-Tx, k=-3.** **Proposal 6: RAN4 to specify the aggregated reference RSTD reporting requirement in the WI performance part.**  |
| [**R4-2402690**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402690.zip) | **Ericsson** | **Observation 1: When UE reports aggregated timing measurement, the single reported RSRP/RSRPP is based on the aggregated PRS resources across aggregated PFLs/carriers.****Observation 2: Simulation assumptions agreed for bandwidth aggregation for positioning measurements does not consider PRS-RSRP and PRS-RSRPP measurements.****Proposal 1: RAN4 to define accuracy requirements for PRS-RSRP and PRS-RSRPP measurements based on bandwidth aggregation.** **Proposal 2: PRS-RSRPP accuracy requirement is defined for Two-tap channel model and AWGN channel model.****Observation 3: Accuracy requirement for RSTD measurement based on single PFL is defined as a sum of Y, Z, Δ and estimation accuracy.****Observation 4: Applicability of Y, Z, and Δ are limited to single PFL RSTD measurement.****Observation 5: Accuracy requirement for UE Rx-Tx measurement based on single PFL is defined as a sum of δ and estimation accuracy.****Observation 6: Applicability of δ for UE Rx-Tx time difference measurement is limited to single PFL measurement.****Proposal 3: When UE performs RSTD measurement by aggregating PRS resources from different PFL groups, for the scenario where the number of aggregated PFLs in reference and target TRPs is not the same, the RSTD accuracy to be met by the UE is the accuracy corresponding to the largest accuracy value among different PFL groups.** **Proposal 4: Applicability of Y, Z (defined in Table 10.1.23.2-5 for FR1 and Table 10.1.23.2-6 for FR2), and Δ (defined in Table 10.1.23.2-5a for FR1 and Table 10.1.23.2-6a for FR2) values are extended to bandwidth aggregation based RSTD measurement.****Proposal 5: Applicability of δ values in tables 10.1.25.2-5 and 10.1.25.2-6 is extended to bandwidth aggregation-based UE Rx-Tx time difference measurement.****Proposal 6: Define test cases for measurement delay and measurement accuracy validation for bandwidth aggregation based RSTD and UE Rx-Tx measurements.****Proposal 7: Define test cases only for measurement accuracy validation for bandwidth aggregation based PRS-RSRP and PRS-RSRPP measurements.** |
| [**R4-2402691**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402691.zip) | **Ericsson** | **Contains simulations results for PRS aggregation.** |
| [**R4-2402692**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402692.zip) | **Ericsson** | **Draft CR to 38.133 Update to measurement report mapping for positioning measurements** |

## Open issues summary

### Sub-topic 6-1: Issues related to measurement report mapping table

**Issue 6-1-1: Measurement report mapping for new values of k**

* Proposals
	+ Option 1: Nokia
		- RAN4 to send another LS to RAN2 and RAN3 correcting the minimum reporting quantities for Differential RSTD, k=-6, Additional path for UE Rx-Tx, k=-3, Additional path for UL-RTOA, k=-3 and Additional path for gNB Rx-Tx, k=-3.
	+ Option 2: CATT
		- RAN4 should define new reporting tables with k = {-1, -2, -3, -4, -5, -6} for timing measurements for other applicable positioning scenarios, e.g., RedCap UE positioning and Sidelink positioning. And no need to reply this LS.
	+ Option 2: HW
		- RAN4 to correct the report mapping for differential RSTD and UE Rx-Tx.
		- The new reporting granularities with k = {-1, -2, -3, -4, -5, -6} are applicable for both aggregate and non-aggregate measurements.
* Recommended WF
	+ DraftCR R4-2402692 addresses the issue. Companies to check if the R4-2402692 can be endorsed. Report mapping for SL-pos shall be discussed as a part of [110][218] NR\_pos\_enh2\_part2 thread.

### Sub-topic 6-2: Issues related to accuracy requirements

**Issue 6-2-1: Side conditions for BW aggregation based RSTD and UE Rx-Tx measurements.**

* Proposals
	+ Option 1: CATT, HW
		- The Rel-17 side conditions for RSTD and UE Rx-Tx time difference can be reused for PRS based positioning measurement with bandwidth aggregation.
* Recommended WF
	+ Discuss the option(s) above.

**Issue 6-2-2: Accuracy requirements for positioning measurements based on bandwidth aggregation**

* Proposals
	+ Option 1: CATT
		- The accuracy requirements can be defined based on the simulation results submitted by all companies with Rel-17 side conditions used.
* Recommended WF
	+ Discuss the option(s) above.

**Issue 6-2-3: Bandwidth configuration to define accuracy requirements for positioning measurements based on bandwidth aggregation**

* Proposals
	+ Option 1: CATT
		- Some of the possible maximum aggregated bandwidth in the latest RAN1 UE features list can be chosen to define accuracy requirements.
	+ Option 2: HW
		- For PRS CA, RAN4 to use the following per PFL BW as starting point to define accuracy requirements for RSTD and UE Rx-Tx.
			* 15kHz SCS: 104 (20M)
			* 30kHz SCS: 132 (50M), 272 (100M)
			* 60kHz SCS FR1: 64 (50M), 132 (100M)
			* 60kHz SCS FR2: 64 (50M), 132 (100M)
			* 120kHz SCS: 64 (100M), 128 (200M)
* Recommended WF
	+ Discuss the option(s) above.

**Issue 6-2-4: Separate accuracy requirement for positioning measurements based on bandwidth aggregation depending on the number of PFLs**

* Proposals
	+ Option 1: CATT
		- No need to differentiate the number of aggregated PFLs when defining accuracy requirements, i.e., one accuracy requirement table can be shared for both 2 aggregated PFLs and 3 aggregated PFLs.
	+ Option 2: CMCC, HW
		- PRS/SRS BW aggregation, it is proposed to define accuracy requirements for both 2 PFLs case and 3 PFLs case
* Recommended WF
	+ Discuss the option(s) above.

**Issue 6-2-5: Measurements for which accuracy requirements are defined**

* Proposals
	+ Option 1: CMCC
		- for PRS/SRS BW aggregation, it is proposed to define accuracy requirements for RSTD and UE Rx-Tx time difference.
	+ Option 2: E///
		- RAN4 to define accuracy requirements for PRS-RSRP and PRS-RSRPP measurements based on bandwidth aggregation.
		- PRS-RSRPP accuracy requirement is defined for Two-tap channel model and AWGN channel model.
* Recommended WF
	+ Discuss the option(s) above.

**Issue 6-2-6: Considerations for RSTD accuracy requirement**

* Proposals
	+ Option 1: E///
		- When UE performs RSTD measurement by aggregating PRS resources from different PFL groups, for the scenario where the number of aggregated PFLs in reference and target TRPs is not the same, the RSTD accuracy to be met by the UE is the accuracy corresponding to the largest accuracy value among different PFL groups.
* Recommended WF
	+ Discuss the option(s).

**Issue 6-2-7: Margins for RSTD and UE Rx-Tx measurements**

* Proposals
	+ Option 1: E///
		- Applicability of Y, Z (defined in Table 10.1.23.2-5 for FR1 and Table 10.1.23.2-6 for FR2), and Δ (defined in Table 10.1.23.2-5a for FR1 and Table 10.1.23.2-6a for FR2) values are extended to bandwidth aggregation based RSTD measurement.
		- Applicability of δ values in tables 10.1.25.2-5 and 10.1.25.2-6 is extended to bandwidth aggregation-based UE Rx-Tx time difference measurement.
* Recommended WF
	+ Discuss the option(s).

**Issue 6-2-8: Aggregated reference RSTD measurement**

* Proposals
	+ Option 1: Nokia
		- RAN4 to specify the aggregated reference RSTD reporting requirement in the WI performance part.
* Recommended WF
	+ Discuss the option(s).

### Sub-topic 6-3: Issues related to test cases

**Issue 6-3-1: Test cases to be defined for bandwidth aggregation based positioning measurements**

* Proposals
	+ Option 1: CATT
		- The existing test cases for positioning can be used as baseline. Different number of aggregated PFLs / total aggregated bandwidth should be considered when specifying configurations. The test case lists are provided in Table 2 of R4-2400086.
	+ Option 2: CMCC
		- for PRS/SRS BW aggregation, it is proposed to define test cases for RSTD and UE Rx-Tx time difference for both RRC inactive state and RRC connected state.
	+ Option 3: E///
		- Define test cases for measurement delay and measurement accuracy validation for bandwidth aggregation based RSTD and UE Rx-Tx measurements.
		- Define test cases only for measurement accuracy validation for bandwidth aggregation based PRS-RSRP and PRS-RSRPP measurements.
* Recommended WF
	+ Discuss the option(s).

**Issue 6-3-2: Considerations for test case setup**

* Proposals
	+ Option 1: HW
		- For RRM test for PRS CA, only set up the PRS resources for aggregate measurement.
* Recommended WF
	+ Discuss the option(s).

## Draft CRs

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2402692**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_110/Docs/R4-2402692.zip) | **Ericsson** | **Draft CR to 38.133 Update to measurement report mapping for positioning measurements** |