3GPP TSG-RAN WG2 Meeting #123bis R2-230xxxx

Xiamen, China, 09 – 13 October 2023

**Agenda item: x.x.x**

**Source: Nokia (Rapporteur)**

**Title: [Post123][402][POS] RAN2 impact of RAN1-led positioning objectives (Nokia)**

**WID/SID: NR\_pos\_enh2 - Release 18**

**Document for: Discussion and Decision**

# 1 Introduction

This document is the report of the following email discussion:

* [Post123][402][POS] RAN2 impact of RAN1-led positioning objectives (Nokia)

Scope: Analyse the expected RAN2 impact of the objectives on RedCap positioning, carrier phase positioning, and bandwidth aggregation for positioning, and develop a way forward for next meeting.

Intended outcome: Report to next meeting.

Deadline: September 22, 2023

# 2 Contact Points

Respondents to the email discussion are kindly asked to fill in the following table.

|  |  |  |
| --- | --- | --- |
| Company | Name | Email Address |
| Nokia (Rapporteur) | Mani Thyagarajan | mani.thyagarajan@nokia.com |
| Intel | Yi Guo | Yi.guo@intel.com |
| vivo | Xiang Pan | panxiang@vivo.com |
| CATT | Jianxiang Li | lijianxiang@catt.cn |
| Xiaomi | Xiaolong Li | lixiaolong1@xiaomi.com |
| ZTE | Yu Pan | pan.yu24@zte.com.cn |
| Huawei/HiSilicon | Rama Kumar Mopidevi | rama.kumar@huawei.com |
| Lenovo | Jie Hu | hujie14@lenovo.com |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

# 3 Discussion

## 3.1 Carrier phase positioning

This section provides a table with all RAN1 agreements for Rel-18 NR positioning enhancements for Carrier Phase Positioning. The right column of this table provides an assessment of impacts to RAN2 for each of the RAN1 agreements. These RAN1 agreements were taken from the RAN1#112, RAN1#112bis-e, RAN1#113 and RAN1#114. Please review the RAN2 impact assessment and **provide your comments on the assessment of impacts to RAN2 in the table that follows**.

Table 1 RAN2 impacts for carrier phase positioning.

|  |  |  |
| --- | --- | --- |
| Ref. | RAN1 agreement | RAN2 impacts |
| CPP-01 | To enable UE-based and UE-assisted NR carrier phase positioning (CPP), one or both of the following new measurements should be introduced:   * DL carrier phase (CP), which is obtained by a UE measuring the DL PRS signal(s) from a TRP.   + FFS: The detailed definition of the DL CP * DL carrier phase difference (CPD), which is the difference of two DL CPs from two TRPs   + FFS: The detailed definition of the DL CPD   To enable NG-RAN node-assisted NR carrier phase positioning (CPP), the following new measurement should be introduced:   * UL carrier phase (CP), which is obtained by a TRP measuring the UL SRS for positioning or MIMO SRS from a UE.   + FFS: The detailed definition of the UL CP | **Measurement and positioning modes:**  Update the Standard UE Positioning Methods in Section 4.3 of 38.305 to capture the use of new RSCP and RSCPD measurements. See CPP-07 for details.  Capture in 38.305 that both UE-based and UE-assisted CPP are supported in RRC\_CONNECTED, RRC\_INACTIVE and RRC\_IDLE (See CPP-11 and CPP-23) |
| CPP-02 | NR DL reference signal carrier phase (RSCP) (of i-th path) is defined as the phase of the channel response at the i-th path delay derived from the resource elements (REs) that carry the DL PRS signals configured for the measurement. A RSCP is associated with a specific RF frequency.   * FFS: the reference point of the RSCP * FFS: whether/how the measurement timing is defined * Note: the i-th path is used for the sake of definition, whether only the first path or additional paths will be supported is subject to further discussion * Note: Whether to capture the above definition into TS 38.215 depends on whether RAN1 decides to introduce DL carrier phase measurement for NR CPP | **New DL RSCP measurement definition:**  There is no RAN2 impact. Measurement definition is up to RAN1, and it may have impacts to RAN4. |
| CPP-03 | For NR carrier phase positioning, at least support the following approach: enable a UE/TRP to report carrier phase measurements together with the legacy positioning measurements to LMF   * FFS: which legacy positioning measurements among RSTD, RTOA, UE Rx-Tx time difference measurements, gNB Rx-Tx time difference measurements | **Standalone RSCP/RSCPD measurement reporting:**  Capture in 38.305 that carrier phase measurements (RSCP and RSCPD) are only reported along with existing measurements and not as a standalone measurement. See CPP-07 for details.  Rapp: Based on CPP-07 and CPP-14 and based on RAN1 parameter list in R1-2308483, RAN1 conclusion is to report RSCP and RSCPD together with the following legacy positioning measurements: a) RSTD, b) RTOA, c) UE Rx-Tx time difference, d) gNB Rx-Tx time difference. So, RSCP and RSCPD reporting applies to DL-TDOA, UL-TDOA and multi-RTT positioning methods. |
| CPP-04 | NR UL reference signal carrier phase (RSCP) (of i-th path) is defined as the phase of the channel response at the i-th path delay derived from the resource elements (REs) that carry the UL SRS signal for positioning purpose configured for the measurement. A UL RSCP is associated with a specific RF frequency.   * FFS: the reference point of the UL RSCP * FFS: whether/how the measurement timing is defined * Note: the i-th path is used for the sake of definition, whether only the first path or additional paths will be supported is subject to further discussion * Note: The support of MIMO SRS for positioning is transparent to UE | **New UL RSCP measurement definition:**  There is no RAN2 impact. Measurement definition is up to RAN1, and it may have impacts to RAN4/RAN3. |
| CPP-05 | To support NR carrier phase positioning, further consider the following options:   * Option 1: Support a UE/TRP to report the carrier phase measurements of more than one frequency within a PFL/carrier to LMF   + NOTE: the frequency can be the carrier frequency or the frequency of a subcarrier   + FFS: the details of reporting, e.g., the maximum number of reported frequencies within a PFL/ carrier * Option 2: Introduce and report a new type of UE/TRP measurement based on carrier phase differentials across multiple subcarriers within a PFL/carrier   + NOTE: carrier phase differentials across multiple subcarriers within a carrier can be related to time of arrival * Option 3: Support a UE/TRP to optionally report an estimated integer ambiguity and/or search range of the integer ambiguity to LMF * Option 4: Support LMF to provide the expected integer ambiguity range at least for UE-based NR CPP in the positioning assistance data. | **Additional enhancements for measurement reporting:**  These 4 options are still under discussion in RAN1. Wait for RAN1 progress. Some agreement in CPP-35. |
| CPP-06 | Rel-17 LOS/NLOS indication (when indicated) applies for the carrier phase measurement(s) in the same report. | **LOS/NLOS indicator reported by UE in measurement report:**  Update the field description of nr-los-nlos-Indicator-r17 reported in the signal measurement reporting IE in 37.355 for relevant positioning methods (DL-TDOA and multi-RTT) to mention the applicability for carrier phase measurement also. |
| CPP-07 | Introduce DL reference carrier phase (DL RSCP) and NR DL reference carrier phase difference (DL RSCPD) as DL carrier phase measurements.   * Note: It is up to RAN4 to decide whether and how to define the requirements for DL RSCP and/or DL RSCPD. No LS needed to RAN4 for this note. * DL RSCP can be reported together with UE Rx – Tx time difference measurement * DL RSCPD can be reported together with RSTD measurement * FFS: details on how to eliminate unknown initial Rx phase with RSCP/RSCPD reporting can be further discussed * Note: Whether to support standalone DL RSCP and/or DL RSCPD reporting, or DL RSCP/DL RSCPD reporting with other new types of measurements (if agreed), can be further discussed. | **DL RSCP/RSCPD measurement reporting by UE:**  extend NR-Multi-RTT-SignalMeasurementInformation IE and add DL RSCP measurement as an optional measurement quantity to be reported along with nr-UE-RxTxTimeDiff measurement.  extend NR-DL-TDOA-SignalMeasurementInformation IE and add DL RSCPD measurement as an optional measurement quantity to be reported along with nr-RSTD measurement.  See also CPP-37 and CPP-35. |
| CPP-09 | To enable simultaneous transmission of UL SRS for positioning by a target UE and a PRU, support the following enhancements:   * Enabling LMF to request the serving gNB of a UE to configure the transmission of the [indicated] UL SRS resources from the UE within indicated time window(s).   + FFS: the details of the time window, e.g., the start time, duration, periodicity for the time window(s), within the vicinity of a reference SRS configuration or use the existing message of Scheduled Location time * Enabling LMF to request the serving gNB and neighboring gNBs of the UE to measure the [indicated] UL SRS resources from the UE within indicated time window(s).   + Note: this may be a different indicated time window | **Simultaneous transmission of UL ‘SRS for positioning’ from UE and PRU:**  See CPP-20. |
| CPP-10 | To enable simultaneous measurements on same DL PRS by a target UE and a PRU, support the following enhancements:   * Enabling LMF to request the UEs, including target UE and PRU(s), to perform measurements on [indicated] DL PRS resources occurring within indicated time window(s). * FFS: the details of the configuration of the indicated time window(s), e.g., the start time, duration, periodicity for the time window(s), as well as the relationship with the Scheduled Location time. | **Simultaneous measurement of same DL PRS by UE and PRU:**  See CPP-20. |
| CPP-11 | Support the reuse of existing physical layer procedures for DL positioning (e.g., DL-TDOA) with the necessary enhancements in measurement configuration, request and report (e.g., adding the configuration related to the NR DL CPP) for both UE-based and UE-assisted NR DL carrier phase positioning, including   * UE in RRC\_CONNECTED state with measurement gap. * FFS: UE in RRC\_CONNECTED state without measurement gap * UE in RRC\_INACTIVE state | **Physical layer procedures:**  There is no RAN2 impact since the main requirement here is about physical layer procedures.  RAN2 should take into account that CPP is supported for RRC\_CONNECTED, RRC\_INACTIVE UE And RRC\_IDLE (see CPP-23)  DL carrier phase positioning of UE in RRC\_CONNECTED state without measurement gap is NOT supported in Rel-18. See CPP-24.  FFS: Impacts on Location Measurement Indication procedure in RRC specification for UE to get measurement gap configuration. |
| CPP-12 | The specific RF frequency associated with a DL carrier phase measurement is defined as the center frequency of the DL PFL by default.   * Note: It is open to further discussion whether a frequency other than the center frequency of the DL PFL can also be the specific RF frequency for non-default case(s), if RAN1 agrees to introduce them. | **Definition of RF frequency associated with DL carrier phase measurement:**  There is no RAN2 impact. |
| CPP-13 | The specific RF frequency associated with a UL carrier phase measurement is defined, by default, as the center frequency of the transmission bandwidth of the SRS for positioning purpose.   * Note: It is open to further discussion whether a frequency other than the center frequency of the UL carrier can also be the specific RF frequency for a non-default case(s), if RAN1 agrees to introduce them. | **Definition of RF frequency associated with UL carrier phase measurement:**  There is no RAN2 impact. |
| CPP-14 | * Support enabling a TRP to report UL RSCP together with RTOA and/or gNB Rx-Tx time difference measurements to LMF * Note 1: The report of UL carrier phase measurement with gNB Rx – Tx time difference does not necessarily require the report of DL carrier phase measurement with UE Rx – Tx time difference. * Note 2: This doesn’t preclude standalone UL carrier phase measurements reporting. | **UL RSCP measurement reporting by TRP:**  There is no RAN2 impact. |
| CPP-16 | For NR UL carrier phase positioning for UE in RRC\_CONNECTED and RRC\_INACTIVE states, support reuse of existing physical layer procedures for UL positioning (e.g., UL-TDOA), with necessary enhancements in the measurement configuration, measurement request and measurement report (e.g., the configuration related to the NR UL CPP).   * FFS: the details of the enhancements. | **Physical layer procedures:**  There is no RAN2 impact since the main requirement here is about physical layer procedures and UL CPP impacts are mainly for RAN3. |
| CPP-18 | To address the impact of the phase delays on Tx/Rx RF chains, support one or more of the following options (down-selection in RAN1#113):   * Option 1a: introduce the definition of UE/TRP Tx/Rx phase error groups (PEGs) for the Tx/Rx of DL PRS/UL SRS signals   + Rel-17 definitions of UE/TRP Tx/Rx TEGs can be used as the starting point for defining UE/TRP Tx/Rx PEGs.   + FFS: the details of \the UE/TRP Tx/Rx PEGs * Option 1b: Introduce Tx/Rx RF antenna IDs or Tx/Rx RF chain IDs to identify the individual Tx/Rx RF chains for transmitting/receiving the DL PRS/UL SRS signals.   + FFS: the details of the Tx/Rx RF antenna IDs or Tx/Rx RF chain IDs   + Note: Device transmitting PRS or positioning SRS provides Tx antenna ID or Tx Chain ID. Device receiving PRS or positioning SRS provides Rx antenna ID or Rx Chain ID. * Option 1c: introduce the report of ARP ID for the Rx/Tx of DL PRS/UL SRS signals.   + The transmission/reception associated with the same ARP ID is assumed from the same ARP.   + FFS: the maximum number of ARP IDs. * Option 2: reuse or enhance the existing Rel-17 definitions of UE/TRP Tx/Rx TEGs with smaller margin value. * Option 3: RAN1 sends an LS to RAN4, requesting RAN4 to consider whether there is a need to define the new UE/TRP Tx/Rx phase error groups (PEGs), introduce new IDs (e.g., Tx/Rx RF antenna IDs ) to present the phase delays for the Tx/Rx of DL PRS/UL SRS signals, or reuse or enhance the existing Rel-17 definitions of UE/TRP Tx/Rx TEGs with smaller margin value, and provide the definitions if RAN4 decides it is needed. | **Impact of phase delays (PEGs, Tx/Rx RF antenna IDs, ARP ID, TEGs with smaller margin):**  These various options are still under discussion in RAN1. Wait for RAN1 progress. |
| CPP-19 | Support the following definition of the reference point of the UE/TRP carrier phase measurements:   * The reference point of the UE carrier phase measurements is defined the same as the reference point of RSTD for both frequency range 1 and frequency range 2. * The reference point of the TRP carrier phase measurements is defined the same as the reference point of RTOA for both frequency range 1 and frequency range 2. * Note: It is up to UE/TRP’s implementation on how to map the carrier phase to the reference point for measurement reporting. | **Reference point for UE/TRP carrier phase measurement:**  No impact to RAN2 specifications. |
| CPP-20 | Adopt the following modifications on the agreements made in RAN1#112bis-e:  To enable simultaneous transmission of UL SRS for positioning by a target UE and a PRU, support the following enhancements:   * Enabling LMF to request the serving gNB of a UE to configure the transmission of the UL SRS resources from the UE within indicated time window(s).   + FFS: the details of the time window, e.g., the start time, duration, periodicity for the time window(s), within the vicinity of a reference SRS configuration or use the existing message of Scheduled Location time * Enabling LMF to request the serving gNB and neighboring gNBs of the UE to measure the UL SRS resources from the UE within indicated time window(s).   + Note: this may be a different indicated time window   To enable simultaneous measurements on same DL PRS by a target UE and a PRU, support the following enhancements:   * Enabling LMF to request the UEs, including target UE and PRU(s), to perform measurements on indicated DL PRS resource sets occurring within indicated time window(s). * FFS: the details of the configuration of the indicated time window(s), e.g., the start time, duration, periodicity for the time window(s), as well as the relationship with the Scheduled Location time. | **Simultaneous transmission of UL ‘SRS for positioning’ from UE and PRU:**  **UL positioning:**  RAN3 impacts: LMF requests serving gNB to configure UE for transmission of SRS during a time window(s). LMF also sends measurement request to serving and neighbour gNBs by providing the time window(s). This impacts the UL-TDOA and multi-RTT positioning methods.  RAN2 impacts: SRS configuration signalling in RRC specification must provide a time window(s) information to the UE. This impacts the UL-TDOA and multi-RTT positioning methods. See also CPP-29.  **Simultaneous measurement on same DL PRS by UE and PRU:**  **UE-assisted DL positioning:**  LMF sends Request location information message to target UE and PRU to obtain carrier phase measurements for UE-assisted positioning.  To support Simultaneous measurement by target UE and PRU, nr-RequestedMeasurements bitmap in NR-DL-TDOA-RequestLocationInformation IE to be modified to add request for RSCPD measurement and the NR-DL-TDOA-RequestLocationInformation IE must include time window(s) information and DL PRS resource sets occurring within the indicated time window(s). **See also CPP-31 for time window configuration**.  To support Simultaneous measurement by target UE and PRU, nr-RequestedMeasurements bitmap in NR-Multi-RTT-RequestLocationInformation IE to be modified to add request for RSCP measurement and the NR-Multi-RTT-RequestLocationInformation IE must include time window(s) information and DL PRS resource sets occurring within the indicated time window(s). **See also CPP-31 for time window configuration**.  FFS: Whether simultaneous measurements is applicable only for CPP measurements or to all legacy DL and UL measurements. |
| CPP-21 | For UE-based carrier phase positioning, support enabling LMF to forward the DL carrier phase measurement reported by a PRU, with additional information of the same PRU to a target UE for UE-based carrier phase positioning in the positioning assistance data.   * Note: Whether the forwarded DL carrier phase measurement is DL RSCP and/or DL RSCPD depends at least on which of them is (are) supported by UE capability. * additional information of the same PRU includes at least PRU location.   + FFS: additional PRU information, e.g. the AoD of PRU to each TRP, etc. | **Simultaneous measurement on same DL PRS by UE and PRU:**  **UE-based DL positioning:**  LMF forwards DL carrier phase measurement reported by a PRU and the PRU location to the target UE in the Provide Assistance Data message sent to target UE for UE-based CPP positioning.  NR-DL-TDOA-ProvideAssistanceData IE (sent to target UE) to be extended to include RSCPD measurement of PRU along with PRU location information.  FFS: Check with RAN1 what exact PRU measurement(s) can be forwarded by LMF to target UE for UE-based carrier phase positioning.  See CPP-36 for related requirement. |
| CPP-22 | If a UE reports RSCPD measurements together with RSTD measurements in a measurement report element, the reference TRP for RSCPD is the same as the reference TRP reported for RSTD.   * The target and the reference TRP are in the same PFL | **Reference TRP for the reported RSCPD measurement:**  There is no new requirement for RAN2. RAN2 can reuse the dl-PRS-ReferenceInfo field in the NR-DL-TDOA-SignalMeasurementInformation IE. The use of reference TRP for the UE reported RSCPD measurement can be clarified in 37.355. |
| CPP-23 | From RAN1’s perspective, carrier phase positioning for UE in RRC\_IDLE state is supported for UE-based and UE-assisted positioning in Rel-18.   * Note: No additional specification work is expected specifically related to carrier phase positioning for UE in RRC\_IDLE state in RAN1. | **Carrier phase positioning in RRC\_IDLE:**  There is no impact to RAN2 specification for carrier phase positioning of UE in RRC\_IDLE.  FFS: Investigate if there are impacts to periodical reporting and posSIB for carrier phase measurements in RRC\_IDLE. |
| CPP-24 | From RAN1’s perspective, carrier phase positioning for UE in RRC\_CONNECTED state without measurement gap is not supported in Rel-18. | **DL RSCP/RSCPD measurement in RRC\_CONNECTED without measurement gap:**  There is no RAN2 specification impact. DL carrier phase positioning by UE in RRC\_CONNECTED state without measurement gap is NOT supported in Rel-18. |
| CPP-27 | CPP-27 is superseded by CPP-31. Any previous comments from companies on CPP-27 also applies for CPP-31. |  |
| CPP-28 | CPP-28 is superseded by CPP-31. Any previous comments from companies on CPP-27 also applies for CPP-29. |  |
| CPP-29 | When a LMF requests the serving gNB of a UE to configure the transmission of the UL positioning SRS resources from the UE within indicated time window(s),   * the duration of a time window can be configured by one of the following values:   + {1, 2, 4, 8, 12} OFDM symbols   + {1, 2, 4, 6, 8, 12, 16} slots   + FFS: additional values * the number of the time windows can be configured as:   + {1, 2, …, 16} | **Time window configuration in UE for UL ‘SRS for positioning’ transmission:**  This is a NRPPa signalling requirement for RAN3 but there is a corresponding requirement for RRC signalling for time window configuration for the UE.  RAN2 impacts: SRS configuration signalling in RRC specification must provide a time window(s) information to the UE. This impacts the UL-TDOA and multi-RTT positioning methods. The following parameters are signalled for **EACH** time window(s):   * Start of the time window:   Iindicated by a combination of system frame number, slot offset and symbol index with respect to the SFN initialization time   * Duration of the time window:   Given by a number of consecutive slots/symbols. The duration of a time window can be configured by one of the following values:   * + {1, 2, 4, 8, 12} OFDM symbols   + {1, 2, 4, 6, 8, 12, 16} slots   + FFS: additional values * (Optional) Periodicity of the time window:   Defined similar to IE PeriodicitySRS in “Requested SRS Transmission Characteristics” in TS 38.455   * the number of the time windows can be configured as:   {1, 2, …, 16} |
| CPP-31 | When an LMF requests the UEs, including target UE and PRU(s), to perform measurements on indicated DL PRS resource set(s) occurring within indicated time window(s)   * The duration of a time window can be configured as follows:   + {1, 2, 4, 6, 8, 12, 16} slots. * the number of the time windows can be:   + {1, 2}   + FFS: {4, 8} | **Time window configuration in target UE and PRU to receive and measure DL PRS:**  This is to support simultaneous measurements by target UE and PRU. See CPP-27 also.  Time window configuration parameters signalled in NR-DL-TDOA-RequestLocationInformation IE and NR-Multi-RTT-RequestLocationInformation IE contains the following parameters for **EACH** time window:   * Start of the time window:   Iindicated by a combination of system frame number, slot offset and symbol index with respect to the SFN initialization time   * Duration of the time window:   Given by a number of consecutive slots/symbols. The duration of a time window can be configured as follows:  o {1, 2, 4, 6, 8, 12, 16} slots.   * (Optional) Periodicity of the time window:   Defined similar to IE PeriodicitySRS in “Requested SRS Transmission Characteristics” in TS 38.455   * the number of the time windows can be:   + {1, 2}   + FFS: {4, 8}   FFS whether SFN number or subframe number is used for start of time window.  Wait for RAN1 progress on parameters discussions. |
| CPP-32 | Each DL RSCP/RSCPD measurement instance is obtained with sample only. | **Number of measurement samples:**  There is no impact to RAN2 specification. |
| CPP-33 | From RAN1’s perspective, the granularity and the range of the RSCP/RSCPD measurements can be defined by RAN4. | **Granularity and range of RSCP/RSCPD measurements:**  Wait for progress from RAN4. |
| CPP-34 | *For the timestamp associated with a reported RSCP/RSCPD measurement,* NR-TimeStamp, with the granularity of a slot, currently defined in TS 37.355, can be reused as the timestamp.   * Subject to UE capability, a UE may optionally provide an OFDM symbol index in the timestamp. * Note: It is up to RAN2/RAN3 how to signal the timestamp | **Timestamp associated with reported RSCP/RSCPD measurement:**  RAN2 can reuse the NR-TimeStamp as timestamp associated with the reported RSCP/RSCPD measurement. NR-TimeStamp IE to be extended to add an optional OFDM symbol index subject to UE capability. |
| CPP-35 | When DL RSCPD/RSCP measurements are reported together with the DL RSTD/ UE Rx – Tx time difference measurements, the DL RSCPD/RSCP measurements are obtained from a single DL PFL only.  Note: From RAN1’s perspective, the reporting of the carrier phase measurements from one DL PFL has no impact on the reporting of the DL RSTD and/or UE Rx – Tx time difference measurements from the same DL PFL or other DL PFLs. | **DL RSCP/RSCPD measurement reporting by UE:**  May be some impact to NR-Multi-RTT-SignalMeasurementInformation IE and NR-DL-TDOA-SignalMeasurementInformation IE to clarify that the reported RSCP or RSCPD measurement is for one PFL only.  FFS: When BW aggregation is used involving 2 or 3 PFLs, does the UE report the carrier phase measurement for each PFL or only one PFL? |
| CPP-36 | For UE-based carrier phase positioning, when LMF forwards the DL carrier phase measurement reported by a PRU to a target UE, the timestamp associated with the PRU carrier phase measurements should also be forwarded in positioning assistance data. | **Simultaneous measurement on same DL PRS by UE and PRU:**  **UE-based DL positioning:**  LMF forwards the timestamp associated with the PRU carrier phase measurement to the target UE in the Provide Assistance Data message sent to target UE for UE-based CPP positioning.  NR-DL-TDOA-ProvideAssistanceData IE (sent to target UE) to be extended to include the timestamp associated with the RSCPD measurement from PRU.  See related requirement in CPP-21. |
| CPP-37 | Support UE/TRP to report the phase quality indication for the RSCP/RSCPD measurements. The phase quality indication includes the following fields:   * phase quality index * phase quality resolution   The values of the phase quality index and phase quality resolution are left for RAN4. | **Quality indication of reported carrier phase measurement:**  extend NR-Multi-RTT-SignalMeasurementInformation IE and add an optional phase quality indication for the DL RSCP measurement.  extend NR-DL-TDOA-SignalMeasurementInformation IE and add an optional phase quality indication for the DL RSCPD measurement.  See also CPP-07. |

### Question 1:

Please provide your comments on the assessment of impacts to RAN2 for each of the RAN1 agreements on Carrier Phase Positioning. In the table below enter the Ref number for the RAN1 agreement and in the comments column indicate if you agree with the assessment or disagree with the assessment or any parts of it, or list any missed impacts to RAN2 for the referenced RAN1 agreement etc.

|  |  |  |
| --- | --- | --- |
| Answers to Question 1 | | |
| Company | Ref | Comments |
| Intel | CPP-01  CPP-03  CPP-24 | General comments, in the table the issue listed in some references has been resolved in latest agreements/ref. It would be good to reduce the ref, i.e. only list the latest one.  Rapp: OK. I have deleted the RAN1 agreements that were superseded by RAN1 agreements from a later RAN1 meeting without renumbering the other Ref numbers since otherwise it may mess up the review from other companies. These deleted rows in the table are shown with change marks.  CPP-01, I do agree some changes are needed for stage 2, but It is unclear what changes will be based on the description.  Rapp: If there is general agreement that a stage-2 description is needed and what points needs to be captured in stage-2, RAN2 can then agree on a TP for stage-2 based on TP from company contribution or from the rapporteur.  CPP-07 Based on CPP-03, it is still open in RAN1 on for which legacy positionign method, the SRCP/RSCPD can be reported together. However, based on RAN1 parameter list, it has been resolved, and therefore would be good to clarify this in CPP-03.  Agreement  Introduce DL reference carrier phase (DL RSCP) and NR DL reference carrier phase difference (DL RSCPD) as DL carrier phase measurements.  • Note: It is up to RAN4 to decide whether and how to define the requirements for DL RSCP and/or DL RSCPD. No LS needed to RAN4 for this note.  • DL RSCP can be reported together with UE Rx – Tx time difference measurement  • DL RSCPD can be reported together with RSTD measurement  • FFS: details on how to eliminate unknown initial Rx phase with RSCP/RSCPD reporting can be further discussed  • Note: Whether to support standalone DL RSCP and/or DL RSCPD reporting, or DL RSCP/DL RSCPD reporting with other new types of measurements (if agreed), can be further discussed.  Conclusion  From RAN1’s perspective, the granularity and the range of the RSCP/RSCPD measurements can be defined by RAN4.  Rapp: Actually, based on CPP-14, RSCP and RSCPD can also be reported by TRP along with RTOA or gNB Rx-Tx time difference measurements, but these are impacts for RAN3. I have clarified under CPP-03 that legacy positioning methods for which the RSCP and RSCPD can be reported are DL-TDOA, multi-RTT and UL-TDOA. Please check the update to CPP-03.  CPP-24 From LPP perspective, shall LPP always trigger the RRC layer to check need of gap if RSCP/RSCPD are requested which may not be same as legacy DL PRS measurement.  Rapp: My understanding is, due to the RAN1 agreement that CPP measurements are done only with measurement gaps there is now impacts for LPP layer to trigger RRC layer which then triggers RRC Location Measurement Indication procedure. |
| vivo | CPP-07 | The following FFS is not needed.  FFS: Check with RAN1 if DL RSCP and RSCPD can be reported as additional measurements that are reported in NR-Multi-RTT-SignalMeasurementInformation IE and NR-DL-TDOA-SignalMeasurementInformation IE.  Rapp: OK. |
|  | CPP-20  CPP-28  CPP-29 | For UL simultaneous transmission, only impact on RAN3, and no extra RRC spec impact is needed. That is, gNB may use legacy signalling to ensure the SRS transmission is within the indicated time window. If so, the following RAN2 impacts can be removed.  RAN2 impacts: SRS configuration signalling in RRC specification must provide a time window(s) information to the UE. This impacts the UL-TDOA and multi-RTT positioning methods. See also CPP-28.  Rapp: UL positioning does involve some RRC signalling involvement for SRS configuration. How does the serving gNB ensure the UE transmitted SRSp is within the time window then? |
|  | CPP-21  CPP-36 | Multi-RTT does not support UE-based positioning, and the following can be removed:  NR-Multi-RTT-RequestLocationInformation IE (sent to target UE) to be extended to include RSCP measurement of PRU along with PRU location information.  Besides, the PRU measurements and location info are assistance data for positioning calculation. Thus we think they should be introduced in request/provide AD rather than locationinfo.  Rapp: Agree with comment on UE-based multi-RTT.  Fine to use AD signalling for forward PRU measurement and location but I thought adding to Request Location Information may help reduce latency. |
|  | CPP-23 | No RAN2 impact is expected.  Rapp: Needs further discussion. Any posSIB impacts for broadcasting periodic measurement assistance as Qualcomm commented? |
|  | CPP-31 | Follow RAN1 conclusion and the following FFS is not needed.  FFS why parameter values for duration of time window in number of consecutive symbols is not defined.  Rapp: OK. Will remove the FFS about parameter values for duration of time window. |
|  | CPP-34 | The new symbol index in the timestamp is not captured in the RAN2 impact column.  Rapp: OK Will add the impact for signalling the symbol index in timestamp. |
| CATT | CPP-07 | It is mentioned in CPP-07: FFS: Check with RAN1 if DL RSCP and RSCPD can be reported as additional measurements that are reported in NR-Multi-RTT-SignalMeasurementInformation IE and NR-DL-TDOA-SignalMeasurementInformation IE.  However according to the LS from RAN1 on CPP, there is no additional measurement of RSCP/RSCPD, considering only one PFL. CPP-32 also shows the proof. So we can delete the FFS in CPP-07.  Rapp: OK. Will delete the FFS in CPP-07. |
| CPP-36 | NR-Multi-RTT-RequestLocationInformation IE (sent to target UE) to be extended to include the timestamp associated with the RSCP measurement from PRU.  Above info can be deleted in CPP-36 because there is no UE-based for multi-RTT.  Rapp: OK. Vivo had the same comment. Will update CPP-36. |
| CPP-35 | Usually Resource SetID is associated with measurement report. So “May be the carrier frequency associated with the PFL needs to be reported as part of RSCP/RSCPD measurement.” is not necessary.  Rapp: OK. Will update CPP-35 to remove the sentence. |
| CPP-34 | There is impact on LPP that OFDM symbol index in the timestamp will be added as optional because of the below agreement:   * optionally provide an OFDM symbol index in the timestamp.   Rapp: OK. Vivo had the same comment. Will update CPP-34. |
| CPP-23 | There is no special requirement on target UE in RRC\_IDLE reports carrier phase measurements to LMF.  Rapp: OK. Will update CPP-23. |
| Xiaomi | CPP-27 | According to the RAN1 agreements, the LMF could indicate multiple time window for UE and PRU performing measurement. We are wondering how does UE report the measurement if multiple windows is configured? There may be some understanding as below:  UE reports a measurement instance for each time window;  UE reports a single measurement for all configured time window;  If there is only a single measurement reported, the RSCP/RSCPD measurement should be performed in one of the time windows since it supports sample only.  Rapp: Good question. I did notice the RAN1 agreement saying “time window(s)”. I am not sure what the intent is for configuring multiple time windows especially when a time window configuration also provides periodicity of time window. Should ask RAN1 for clarification. |
| Xiaomi | CPP-35 | When the bandwidth aggregation is configured, which PFL is used for UE performing RSCPD/RSCP measurement? Maybe the LMF could indicate the PFL for RSCPD/RSCP measurements when the bandwidth aggregation for RSTD or UE Rx-Tx time difference is configured.  Rapp: Good question. Need to check with RAN1. |
| ZTE | CPP-07 | Should additional path be considered for UE reporting RSCP and RSCPD?  Rapp: This is not very clear from the RAN1 agreements. There is CPP-06 saying LOS/NLOS indication applies for CP measurement(s) in the same report which seem to imply CP measurements may be associated with timing measurement for different paths. We need to ask RAN1 for clarification. |
| Huawei/HiSilicon | CPP-06 | Legacy indication can be reused, there is no need to update RAN2 specs. Legacy indication is based on LOS/NLOS measurements and not related to CPP.  Rapp: This comment is a bit unclear as to what is meant by “legacy indication”. Do you mean use the nr-los-nlos-Indicator-r17 that is reported with the legacy timing measurement and not create a new indicator specific to CP measurements? If so, that was my intent also. |
| CPP-11 | As in CPP-23, RRC\_IDLE should be considered.  Rapp: RRC\_IDLE, RRC\_CONNECTED and RRC\_INACTIVE are supported for CPP but since the RAN1 agreements were split into CPP-11 and CPP-23, I mentioned them separately. |
| CPP-20 | We disagree with the following statement regarding impact to RAN2 on the SRS configuration window, which is purely RAN3 signaling. UE sends the SRS following gNB configuration without any visibility how it is aligned with other UEs’ SRS transmission.  RAN2 impacts: SRS configuration signalling in RRC specification must provide a time window(s) information to the UE. This impacts the UL-TDOA and multi-RTT positioning methods. See also CPP-28.  Rapp: OK. We can leave CPP-20 for further discussion online. My assumption is NRPPa signalling is used to request the serving gNB for SRS configuration of UE and then there may be a RRC signalling impact due to that LMF trigger.  Also for “UE-assisted DL positioning”, it states that “the NR-DL-TDOA-RequestLocationInformation IE must include time window(s) information”. However, we suggest to reword “must” to “may” as the time window is only needed when the simultaneous DL PRS measurements by the UE and the PRU are required.  Rapp: OK. I didn’t intent to mandate the inclusion of time window. Just didn’t carefully choose my words here 😊. I will update it. |
| CPP-21 | With regards with which message to convey the PRU measurement, we prefer to use assistance data only. RequestLocationInformation message is not appropriate, since this information is for compensation after UE already has performed the measurement. RAN2 also needs to discuss whether to carry in posSIB.  Rapp: OK. Similar comments were raised by Qualcomm and other companies. I will update the impact analysis for this. |
| CPP-22 | LPP spec needs to describe that the reference TRP is applicable to RSCPD.  Rapp: OK. My point was the reference TRP used for RSTD is the same reference TRP for RSCPD also (my understanding of the RAN1 agreements) and similarly the reference TRP sent by UE in the measurement report is the one chosen by UE for the RSTD measurement, which is also used for RSCPD measurement. We can discuss it further. |
| CPP-23 | There is no need to discuss further. R18 RRC\_IDLE UE behaviour can be followed for CPP in RRC\_IDLE.  Rapp: Generally, that is also fine but as Qualcomm pointed out we need to investigate posSIB impacts also. |
| CPP-28  CPP-29 | Same comment as CPP-20, the following statement is not correct.  RAN2 impacts: SRS configuration signalling in RRC specification must provide a time window(s) information to the UE. This impacts the UL-TDOA and multi-RTT positioning methods. The following parameters are signalled for EACH time window(s):  Rapp: OK. We can leave CPP-20 and CPP-28/29 for further discussion online. |
| CPP-34 | The timestamp for CPP measurement should be extended with symbol index according to RAN1 agreement.  Rapp: OK. Also pointed out by other companies. |
| CPP-36 | We do not think UE-based positioning is supported for Multi-RTT with RSCP measurement. It should be limited to DL TDOA method. Also like CPP-21, we prefer to keep it in assistance data, instead of request location information.  Rapp: OK. |
| Qualcomm | CPP-21/23/36 | The carrier phase reference measurements (from PRUs) should be provided in the assistance data (not Request Location Information).  It should also be checked whether the periodic assistance data delivery procedures in LPP clause 5.2.1a/b are required for CPP. At least when periodic reporting is requested, these procedures seem needed. Also, the impact on posSIBs should be checked. It seems a new posSIB is required (e.g., to enable idle mode measurements).  Rapp: OK to add the PRU measurement forwarded by LMF to target UE in the Provide Assistance Data IE. It was also mentioned by other companies. Periodic assistance data delivery and impacts to posSIBs can be discussed further. If the reference measurement and location info of PRU are considered assistance data, then the issue of broadcast assistance data is a valid one to investigate further. Whether the PRU info forwarded to target UE is on a positioning session basis or if it is generic assistance data like in the case for corrections data from GNSS reference network needs further discussion. |
| Lenovo | CPP-04 | For new UL RSCP measurement definition, it may have impacts to RAN4 not RAN3.  Rapp: Agree, but I will say RAN4/RAN3 since RAN3 may want to look at this new measurement definition. |
| CPP-07 | Based on RAN1’ conclusions: RSCPD is not reported along with multi-RTT as multi-RTT does not deal with difference of two measurements from 2 different TRPs, i.e., RSCPD is only applicable to DL-TDOA.  Rapp: Based on comments from Vivo and CATT I have removed the FFS under CPP-07. |
| CPP-19/20 | Option to enable simultaneous measurements is not only limited to CPP measurements only but rather applicable to all legacy DL and UL measurements.  Rapp: Looking back at CPP-20, the agreement text is indeed generic and hence can apply to any measurement but not sure if the PRU measurement use implies the context to be applicable only for CPP measurements. This can be confirmed with RAN1. |
| CPP-21/31/36 | Based on RAN1's conclusions, LMF forwards the DL carrier phase measurement reported by a PRU and the PRU location to the target UE for UE-based carrier phase positioning in the positioning assistance data. Not Request location information.   * The NR-DL-TDOA-PorvideAssistancedata information IE and NR-Multi-RTT-ProvideAssistanceData information IE are extended to include the RSCP measurement of PRU along with PRU location information.   Rapp: OK. There was similar comment from others too. I will update it. |
| CPP-22 | Reference TRP may be different for DL RSTD and RSCPD measurements, since CPP only uses one PFL and DL-RSTD may be derived from multiple PFLs.  Rapp: CPP-22 is then confusing to me. It does say “*the reference TRP for RSCPD is the same as the reference TRP reported for RSTD*”. May be if the UE measures one PFL at a time and reports, it is possible the reference TRP is the same as target TRP but this needs further clarification from RAN1 then. |
| CPP-34 | Symbol index may need to be added to the legacy timestamp, subject to UE capability.  Rapp: OK Will add the impact for signalling the symbol index in timestamp. There was similar comment from Vivo and CATT too. |
| OPPO | CPP-06 | According to CPP04, RAN1 agreed that the CPP could not be a standalone measurement, then there is no need to update the RAN2 spec regarding the LOS indication  Rapp: I was thinking may be the field description needs some updates to say something like, this applies to the CPP measurement associated with the reported legacy measurement (exact TP to be determined). |
| Apple | CPP-20 | We don’t think RRC changes are needed to support simultaneous UL SRS transmissions  Rapp: This needs further discussion then. My understanding is, if LMF requests the serving gNB of a UE to configure the transmission of the UL SRS resources from the UE within indicated time window(s), then the time window(s) need to be signalled to UE by the serving gNB. |
| CPP-21 | Agree with Huawei and QCOM to provide measurements from PRU in assistance data.  Rapp: OK. I will update CPP-21. |
| Ericsson | RRC Impacts | The overall RRC impact looks ok. |
| CPP-21 | Probably RAN1 needs to detail exactly what measurements that should be forwarded to the target UE (i.e. what elements of the NR-DL-TDOA-MeasElement)  Rapp: My understanding is, only the carrier phase measurement from PRU is forwarded to target UE. We can discuss this further or ask RAN1 for clarification. |
| CPP-33 | Agreement from Toulouse meeting (RAN4#108)  **Reporting range for DL RSCPD:** *Agreements:*RSCDP is [-180, 180) degrees.  **Reporting granularity for DL RSCPD/RSCP:** *Agreements:*  Rapp: Second line in the comment above seems incomplete but, anyway, we can take care of value range details after we have common understanding of the RAN2 singalling impacts first. Meanwhile, an updated parameter list from RAN4 can be checked also. |
| CPP-34 | NR-TimeStamp currently does not support to indicate a specific symbol. To enable the "Subject to UE capability  Rapp: OK. Similar comments from others too. I will add the impact due to indicating specific symbol. The second sentence of the comment is incomplete. |

### Summary 1:

Following is a summary list of various comments received on the impacts to RAN2 for carrier phase positioning:

* Lenovo thinks the simultaneous measurement is applicable for all legacy DL and UL measurements (and not just for carrier phase measurements). RAN1 clarification is required. [CPP-20]
* ZTE raises the issue of whether carrier phase measurements are reported by UE for additional paths or only for the first path of the associated legacy timing measurement. This requires further clarification from RAN1. [CPP-07]
* OPPO points out that since carrier phase measurements cannot be standalone there is no need to update anything in the RAN2 specification regarding the LOS indication. [CPP-06]
* Lenovo thinks the Reference TRP may be different for DL RSTD and RSCPD measurements, since CPP only uses one PFL and DL-RSTD may be derived from multiple PFLs. RAN1 clarification is required. Huawei thinks we need to describe the applicability of reference TRP for RSCPD in LPP specification. [CPP-22]
* Vivo, CATT, Huawei, Qualcomm, Apple and Lenovo think the PRU measurement and PRU location information are to be forwarded by LMF in the Provide Assistance Data message (and not Provide Location Information message). [CPP-21]
* Vivo, CATT, Huawei, Lenovo and Ericsson pointed out that NR-TimeStamp IE must be extended to add an optional OFDM symbox index subject to UE capability. [CPP-34]
* Vivo, Huawei and Apple think there is no impact to RRC specification for signalling of time window(s) configuration to support simultaneous transmission of UL SRS for positioning from UE and PRU. [CPP-20/CPP-28/CPP-29]
* Xiaomi wonders how multiple time windows is used by UE for carrier phase measurements. The configuration and use of multiple time windows with indicated DL PRS resource set(s) occurrence for UE to perform carrier phase measurements requires further clarifications from RAN1. A time window configuration includes start of time window, duration of time window and an optional periodicity of time window which seems sufficient to indicate multiple windows in time domain. It is not clear whether there will be multiple separate time window configurations where each is characterized by the three parameters mentioned above. [CPP-27]
* Xiaomi also wonders about interactions between bandwidth aggregation and carrier phase positioning. When BW aggregation is used involving 2 or 3 PFLs, does the UE report the carrier phase measurement for each PFL or only one PFL? [CPP-35]
* Vivo, CATT and Huawei think there is no impact to RAN2 specifications for support of carrier phase positioning for UE in RRC\_IDLE. Qualcomm thinks we need to investigate impacts to posSIB to enable RRC\_IDLE measurements. [CPP-23]

### Proposals on Carrier phase positioning

Shown below are some way-forward proposals from the rapporteur based on the RAN2 impact analysis shown in table in Section 3.1 taking all the comments received into account and noting the FFS issues identified from the discussion.

**Proposal 1**: For Multi-RTT positioning, if requested by LMF, the UE reports the RSCP measurement along with the UE Rx-Tx time difference measurement. Extend NR-Multi-RTT-SignalMeasurementInformation IE and add DL RSCP measurement as an optional measurement quantity to be reported along with nr-UE-RxTxTimeDiff measurement.

**Proposal 1a**: Extend NR-Multi-RTT-SignalMeasurementInformation IE to include a timestamp associated with the reported DL RSCP measurement and a quality indication for the reported RSCP measurement.

**Proposal 2**: For DL-TDOA positioning, if requested by LMF, the UE reports RSCPD measurement along with the RSTD measurement. Extend NR-DL-TDOA-SignalMeasurementInformation IE and add DL RSCPD measurement as an optional measurement quantity to be reported along with nr-RSTD measurement.

**Proposal 2a**: Extend NR-DL-TDOA-SignalMeasurementInformation IE to include a timestamp associated with the reported DL RSCPD measurement and a quality indication for the reported RSCPD.

**Proposal 3**: Update the field description for nr-los-nlos-Indicator in NR-DL-TDOA-SignalMeasurementInformation IE to clarify that the indication applies also to the RSCPD measurement associated with the RSTD measurement in the reported DL-TDOA measurement.

**Proposal 4**: Update the field description for nr-los-nlos-Indicator in NR-Multi-RTT-SignalMeasurementInformation IE to clarify that the indication applies also to the RSCP measurement associated with the UE Rx-Tx time difference measurement in the reported Multi-RTT measurement.

**Proposal 5**: For UE-assisted DL-TDOA positioning, to support Simultaneous measurement by target UE and PRU, extend the NR-DL-TDOA-RequestLocationInformation IE to be able to request RSCPD measurement.

**Proposal 6**: For UE-assisted Multi-RTT positioning, to support Simultaneous measurement by target UE and PRU, extend the NR-Multi-RTT-RequestLocationInformation IE to be able to request RSCP measurement.

**Proposal 7**: Extend the NR-DL-TDOA-RequestLocationInformation IE and NR-Multi-RTT-RequestLocationInformation IE to include time window(s) configuration and DL PRS resource sets occurring within the indicated time window(s).

**Proposal 7a**: Each time window configuration in Request Location Information IE contains the following: Start of time window, Duration of time window, Periodicity of time window (Optional). The number of time windows is configurable and signalled as part of the time window configuration.

**Proposal 8**: For UE-based DL-TDOA positioning, extend the NR-DL-TDOA-ProvideAssistanceData IE to include the following PRU related information: reference RSCPD measurement reported by PRU, timestamp associated with the reference RSCPD measurement, and PRU location information.

## 3.2 RedCap positioning

This section provides a table with all RAN1 agreements for Rel-18 NR positioning enhancements for RedCap Positioning. The right column of this table provides an assessment of impacts to RAN2 for each of the RAN1 agreements. These RAN1 agreements were taken from the RAN1#112, RAN1#112bis-e, RAN1#113 and RAN1#114. Please review the RAN2 impact assessment and **provide your comments on the assessment of impacts to RAN2 in the table that follows**.

Table 2 RAN2 impacts for RedCap UE positioning.

|  |  |  |
| --- | --- | --- |
| Ref. | RAN1 agreement | RAN2 impacts |
| RED-01 | For RedCap UEs, support at least measurements on DL PRS with Rx frequency hopping using a measurement gap   * FFS: details on RedCap UE processing capabilities for DL PRS with Rx frequency hopping and MG * FFS: the use of a single or multiple instances of a MGs * FFS: the use of PPW   Conclusion  The scope for RedCap positioning includes FR1 and FR2. | **Measurement gap configuration for measurements on DL PRS with Rx frequency hopping:**  FFS: Impacts to measurement gap configuration aspects (introduction of MG ID 24 and 25 for RedCap UE) in RRC specification depending on further details from RAN4.  RAN1 agreed to have only a single instance of measurement gap for measurements on DL PRS with Rx frequency hopping. See RED-12. |
| RED-02 | For Positioning enhancements for redcap UEs for UL SRS Tx and DL PRS Rx frequency hopping, from the RAN1 perspective, short switching time to allow RF retuning between adjacent hops may be beneficial in terms of accuracy and latency performance. | **Switching time for RF retuning between adjacent hops:**  FFS if RAN1 and/or RAN4 parameters list results in any signalling impacts for RAN2 for configuring switching related parameters for UL Tx/DL Rx hopping. |
| RED-03 | For positioning for RedCap UEs with DL PRS Rx Hopping, the UE hops within a DL PRS resource   * FFS: whether there is specification update needed for RAN1 * FFS: remaining details | **DL PRS Rx hopping within a DL PRS resource:**  RAN2 could capture the concept in 38.305 that UE Rx or Tx frequency hopping by RedCap UE is within a PRS or SRS resource from one TRP under one PFL.  FFS: Whether LMF needs to signal the DL PRS Rx frequency hopping pattern to UE. |
| RED-04 | For RedCap UEs, support SRS for positioning frequency hopping by   * Using a configuration separate from the existing BWP configuration   + FFS: hopping is configured within a SRS resource or across SRS resources | **BWP configuration for RedCap UE ‘SRS for positioning’ transmission frequency hopping:**  RRC specification needs update to be able to configure a separate BWP configuration for RedCap UE ‘SRS for positioning’ transmission frequency hopping.  FFS: whether the separate BWP configuration is inside each existing data BWP or outside any data BWP. |
| RED-06 | For the positioning of redcap UEs, for the DL PRS reception and UL SRS transmission, the maximum hopping bandwidth for a single hop is 20MHz for FR1 and 100MHz with FR2. | **Maximum supported bandwidth per hop:**  Rapp: Depending on UE capabilities discussion in RAN1, there will be impacts to Capability Transfer/Indication LPP procedures in 37.355. |
| RED-07 | For RedCap UEs, SRS for positioning Tx frequency hopping is configured within one SRS for positioning resource. | **Span of ‘SRS for positioning’ Tx frequency hopping:**  RAN2 could capture the concept in 38.305. See RED-03. |
| RED-08 | For DL Rx hopping or UL Tx hopping, support the UE or gNB to report the following:   * A single measurement based on receiving multiple hops of the DL PRS or UL SRS for positioning * One measurement where a measurement is associated with one received hop * FFS: indication of how many received hops / which received hops where used in the measurement report. * Note: no new measurement definition is introduced in RAN1 * FFS: conditions when the above measurements are reported, and whether the above measurements can be reported together | **UE/gNB Measurement reporting with frequency hopping:**  Relevant measurement reporting IE in 37.355 needs to be updated to clarify that a RedCap UE reported measurement is based on multiple hops or single hop.  FFS: Confirm that this impacts RSTD, RSRP, RTOA, UE Rx-Tx time difference and gNB Rx-Tx time difference measurements for DL-TDOA, UL-TDOA and Multi-RTT positioning methods. |
| RED-09 | For UL SRS Tx hopping, the frequency hopping pattern is configured with overlapping or non-overlapping hops.   * FFS: exact patterns to be supported * FFS: whether the overlapping hops may or may not be adjacent in the time domain * Note: RAN1 assumes that no additional UE requirements shall be specified for the case of Tx hopping with non-overlapping hops compared to the case of Tx hopping with overlapping hops, e.g., a UE is not responsible for keeping phase continuity across the hops in either case of overlapping or non-overlapping hops. | **‘SRS for positioning’ Tx frequency hopping pattern configuration:**  FFS: RRC specification needs update for serving gNB to configure UE with ‘SRS for positioning’ Tx frequency hopping pattern. This can be done as part of the SRS configuration provided to the UE.  FFS: Exact ‘SRS for positioning’ Tx frequency hopping patterns possible and how to characterize it depends on further inputs from RAN1. See RED-14. |
| RED-11 | * It is RAN1’s view that for UL SRS for positioning Tx frequency hopping, switching time before the first hop and after the last hop need to be defined for the SRS for positioning with Tx frequency hopping.   + RAN4 is kindly requested to evaluate the applicable switching time (if any) required ahead of the first hop and after the last hop, considering potential differences (in e.g. SCS, bandwidth, CP) between initial/active UL BWP and UL SRS for positioning Tx frequency hopping. | **Switching time before the first hop and after the last hop for ‘SRS for positioning’ Tx frequency hopping:**  No RAN2 specification impacts identified at this moment. The impact of having switching time before the first hop and after the last hop for the SRS for positioning Tx frequency hopping is mainly expected to be for RAN4. FFS if there are any RAN2 impacts based on progress in RAN4. |
| RED-12 | From RAN1 perspective, for DL PRS Rx hopping, a single instance of a measurement gap is used for receiving all the hops for DL PRS with Rx frequency hopping.   * Note: this does not assume that the reported measurement has to be based on a single instance of a measurement gap * Send an LS to RAN4 to confirm RAN1’s understanding, and if needed ensure that the measurement gap has the proper duration. | **Measurement gap configuration for measurements on DL PRS with Rx frequency hopping:**  FFS: Impacts to measurement gap configuration aspects (introduction of MG ID 24 and 25 for RedCap UE) in RRC specification depending on further details from RAN4 including whether any new measurement gap configuration is introduced. |
| RED-13 | SRS Tx Frequency hopping is supported for both RRC\_CONNECTED and RRC\_INACTIVE state. | **Supported RRC states for ‘SRS for positioning’ Tx frequency hopping:**  Ensure that RRC signalling of ‘SRS for positioning’ Tx frequency hopping pattern is applicable for both RRC\_CONNECTED and RRC\_INACTIVE RedCap UEs. |
| RED-14 | For the SRS Tx hopping pattern configuration support at least the staircase pattern, including a wrapped staircase pattern.   * Support configuring the starting PRB of the first hop * FFS: details of signalling of PRB overlap across consecutive hops and bandwidth of each hop | **‘SRS for positioning’ Tx frequency hopping pattern configuration:**  Related to RED-09.  FFS: RRC specification impacts. The ‘SRS for positioning’ Tx frequency hopping pattern configuration provided to UE as part of the SRS configuration includes the starting PRB of the first hop. Further signalling details depends on RAN1 progress on parameters discussions. |
| RED-15 | For RedCap UEs positioning transmitting the UL SRS with frequency hopping, regarding the collisions between other UL and DL signals/channels and the UL SRS with frequency hopping, support both of the following options   * Option 1: UL time window where the UE is not expected to []transmit other signals/channels and is only expected to transmit FH SRS for positioning.   + FFS details of an UL time window   + Note: it implies that UE drops the transmission of other signals/channels and transmits SRS for positioning * Option 2: new collision rules between the UL SRS with frequency hopping and other UL and DL signals/channels/. Option 2 can apply without [or outside] UL time window (i.e. option 1)   + FFS: details on the collision rules   Note: it is understood that option 2 is a component of the feature for UL SRS Tx hopping (FG 41-5-2), and option 1 is a separate feature group. | **Handling collision between UL SRS Tx frequency hopping and other UL/DL signals/channels:**  For Option 1 for handling collision between UL SRS Tx frequency hopping and other UL/DL signals/channels, the serving gNB needs to configure UE with UL time window for UL ‘SRS for positioning’ Tx frequency hopping. See RED-20.  For Option 2 for handling collision between UL SRS Tx frequency hopping and other UL/DL signals/channels, RAN1 could define the collision rules in their specification. |
| RED-16 | PRS Rx frequency hopping for RRC\_INACTIVE state and for RRC\_IDLE state is supported for a RedCap UE. | **Supported RRC states for DL PRS Rx frequency hopping:**  FFS: Whether there are any impacts to RAN2 to enable support for PRS Rx frequency hopping for RRC\_INACTIVE and RRC\_IDLE. |
| RED-17 | For the SRS Tx hopping, both hopping patterns (i.e. one cycle containing all the hops) that can span across slots or fit within one slot are supported.   * FFS: determination of the starting symbol position for each hop * FFS: duration of each hop | **‘SRS for positioning’ Tx frequency hopping pattern configuration (time domain):**  Wait for RAN1 progress on parameters for RedCap positioning. |
| RED-18 | SRS for positioning with Tx hopping can be configured outside of the active UL BWP.   * The configuration may include SCS, CP size and bandwidth (position and size), which can use a SCS, CP size and bandwidth different from the UL active BWP. | **‘SRS for positioning’ Tx frequency hopping outside active UL BWP:**  RAN2 specification needs update to create a virtual BWP for SRS Tx hopping similar to what was done for RRC\_INACTIVE. |
| RED-19 | For SRS Tx hopping, the configuration includes:   * a hop bandwidth common to all hops   + FFS: possible values * a single overlap value can be configured for all hops for the SRS resource   + FFS: possible values * The starting slot offset and starting symbol for the SRS resource with tx hopping (first hop)   + FFS: possible values * the starting slot offset and symbol for each of the hops following the first hop,   + Note Up to ran2 to design signaling of the starting position for each hop, i.e. how the SRS resource configuration signaling indicates the starting slot offset and starting symbol for the hops following the first hop   + FFS: possible values * The number of consecutive symbols in a hop common to all hops   + FFS: possible values * The number of hops   + FFS: possible values * UE does not expect to be configured for any hops across slot boundaries, i.e.the starting position + duration of a hop cannot exceed a slot duration * FFS: whether/how special handling for the last hop overlap | **‘SRS for positioning’ Tx frequency hopping pattern configuration:**  FFS: RRC signalling for ‘SRS for positioning’ Tx frequency hopping pattern configuration includes the following:  Number of hops, per-hop duration in terms of consecutive number of symbols, per-hop bandwidth, frequency domain overlap between hops, offset to the starting slot of the first hop, starting symbol of the first hop, offset to the starting slot of each subsequent hops, starting symbol of each subsequent hops.  Detailed signalling depends on RAN1 progress on parameters discussions. |
| RED-20 | The UL time window for UL SRS for positioning with Tx hopping can be configured to be periodic with configurable starting SFN, slot and symbol number, periodicity, duration   * FFS values for starting SFN, slot and symbol number, periodicity and duration. | RRC specification needs update for serving gNB to configure UE with UL time window for UL ‘SRS for positioning’ Tx frequency hopping. This can be done as part of the SRS configuration provided to the UE. UL time window is periodic and determined by the following parameters:  Starting SFN, starting slot and symbol number, periodicity and duration. Detailed signalling FFS depending on RAN1 progress on parameters discussions. |

### Question 2:

Please provide your comments on the assessment of impacts to RAN2 for each of the RAN1 agreements on RedCap Positioning. In the table below enter the Ref number for the RAN1 agreement and in the comments column indicate if you agree with the assessment or disagree with the assessment or any parts of it, or list any missed impacts to RAN2 for the referenced RAN1 agreement etc.

|  |  |  |
| --- | --- | --- |
| Answers to Question 2 | | |
| Company | Ref | Comments |
| Intel | RED-03  RED-06 | RED-03, should RAN1 or RAN2 to capture this? Would be good to check RAN1 whether they are going to provide TP for TS 38.305.  Rapp: OK. Let us see what other companies’ comments are on this. I agree it is good to check RAN1 plans for any TP for 38.305 in general for all three features in this email discussion. May be WID rapporteurs can check the status in RAN1. My understanding is they are not planning on a stage-2 TP but if needed we need to send a formal LS to RAN1 seeking stage-2 TP.  RED-06, I assume we need to capture it somewhere, e.g. RedCap capability as precondition for all related positioning capabilities, and we may need to capture new capabilities based on RAN1 inputs.  Rapp: OK. I agree we need to wait for RAN1 inputs to make progress on UE capabilities. I have updated RED-06. Please check. |
| vivo | RED-08 | In the measurement, the following info is not indicated by RAN1 and should be removed:  the total virtual bandwidth used for the measurement is larger than the RedCap UE bandwidth capability. The number of hops and per-hop bandwidth can also be reported.  For per-hop measurements, the measurement report can indicate the per-hop bandwidth used for the reported measurement.  Rapp: I agree the listed items in red are not in the RAN1 agreement but there are FFS that implies these may be under consideration? I will remove it for now. |
|  | RED-09 | No need for LMF to provide the explicit pattern to gNB:  LMF must be able to distribute the ‘SRS for positioning’ Tx frequency hopping pattern to the TRPs/gNB that are requested to perform UL measurement. NRPPa impacts are up to RAN3 to discuss and decide.  Rapp: OK. I admit I am not clear on the hopping pattern impacts. We can wait for RAN1 parameter list updates. |
|  | RED-16 | MG is not needed for non-connected states.  Rapp: OK. Agree. |
| CATT | RED-16 | There is no measurement gap for measurement in RRC\_IDLE so far. RAN2 will wait for RAN4 on how to support Rx hopping in RRC\_IDLE for Redcap.  Rapp: OK. Same comment as Vivo. Will update RED-16. |
| Xiaomi | RED-03  RED-07 | There may be NRPPa spec impact, considering the SRS and PRS configuration are determined by gNB, the LMF could indicate the requested SRS and PRS configuration is for Tx frequency hopping and Rx frequency hopping respectively, and then the gNB provides the feasible configurations.  Rapp: NRPPa impacts can be discussed in RAN3. If the serving gNB needs to signal something to the UE to indicate that the hopping is within one resource, then RRC signalling impacts for RED-07 can be discussed. |
| ZTE | RED-16 | IDLE and INACTIVE does not have measurement gap configuration. Does this mean RED-12 also applies to IDLE and INACTIVE?  Rapp: OK. There were comments from others too that measurement gap applies only for RRC\_CONNECTED state RedCap UE for PRS Rx frequency hopping. |
| Huawei/HiSilicon | RED-04 | We prefer to clarify whether the separate BWP configuration is inside each existing data BWP or outside any data BWP.  Rapp: Needs further discussion or checking with RAN1. I am not sure about the answer to this one. |
| RED-08 | RAN1 has not reached the following agreements and hence we do not think RAN2 can capture them directly in the spec:   * The number of hops and per-hop bandwidth can also be reported * For per-hop measurements, the measurement report can indicate the per-hop bandwidth used for the reported measurement.   Rapp: OK. Pointed out by Vivo also. I will update it. |
| Lenovo | RED-02 | RAN2 needs to identify the configuration and UE behaviours to switch between different hops. RRC Specification needs to capture the network configuration for switching between different hops and corresponding UE behaviours.  Rapp: Based on RED-02 and RED-11 it is not clear to the rapporteur whether switching time is a configurable parameter(s). The RAN1 parameter list in R1-2308483 does not have anything concrete about switching time parameter(s). Since RAN4 is working on this, we can wait for further updates from RAN4 parameter list or we could ask RAN1/RAN4 whether switching times require configurability or not. |
| RED-03 | LPP specification needs to be updated (stage 3 impact is foreseen) for the LMF to provide a UE with a DL PRS Rx hopping pattern, this can be done as part of LPP Assistance data delivery to the UE.  Rapp: Let us keep this as FFS for now. In the RAN1 parameter list in R1-2308483 a new parameter is mentioned, with a description of “*To configure Tx frequency hopping within one SRS for positioning resource*” but details are not finalized yet in RAN1. We need to see what a similar impact for DL Rx hopping would be. |
| OPPO | RED-08 | RAN1 didn’t ask the measurement report to indicate the per-hop bandwidth used for the reported measurement, and report the number of hops.  Rapp: OK. Vivo and Huawei had the same comment. I will update it. |
| Apple | General | No need to discuss NRPPa impacts in RAN2  Rapp: Agree. |
|  | RED-16 | Agree MG is not applicable, but there maybe other RAN2 stage-3 impacts to support IDLE and INACTIVE.  Rapp: Agree. Will revisit this later again. |
| Ericsson | RED-01 | MG ID 24 and 25 will be introduced for RedCap UEs in general (meaning valid for RedCap UEs not limited to positioning). **R4-2314353**. Details will be captured in big CR to be endorsed in the next RANP.  Rapp: Let us revisit this again when we get the parameter list and UE features list from RAN4. |
| RED-02 | The RF switching time for PRS/SRS FH is 70us, 140us and 210us in FR1 and 35us, 70us and 140us in FR2, and therefore it is expected that the UE can report its capability to network.  Rapp: Where is this parameter value coming from? Let us revisit this again when we get the parameter list from RAN4. |
| RED-08 | Agreement from Toulouse meeting (RAN4)  0.1     PRS measurement report mapping for RedCap  **Issue 2-4-1: PRS measurement report mapping for RedCap with and without FH**  **Agreements***:*  Existing measurement report mapping table is re-used to report positioning measurements performed by RedCap UE with and without FH.  Rapp: This email discussion on RAN1-led positioning objectives focused only on RAN1 agreements. Since it is late now to provide coverage for all RAN4 agreements on these RAN1-led positioning objectives, rapporteur suggests we wait for RAN4 parameter list and UE features list or have a separate discussion on all RAN4 agreements for the RAN1-led positioning objectives. |
| RED-12 | MG ID 24 and 25 will be introduced for RedCap UEs in general (meaning valid for RedCap UEs not limited to positioning). **R4-2314353**. Details will be captured in big CR to be endorsed in the next RANP  Rapp: Let us revisit this again when we get the parameter list and UE features list from RAN4. |
| RED-18 | We think RAN2 can start. This agreement just means there is a need to create a virtual BWP for SRS hopping, similar to what was done for RRC inactive.  Rapp: I will capture that RAN2 specification needs update to create a virtual BWP for SRS Tx hopping similar to what was done for RRC\_INACTIVE. Ericsson could provide a TP for impact analysis for RED-18 showing specifics of what will be updated for this virtual BWP. |

### Summary 2:

Following is a summary list of various comments received on the impacts to RAN2 for RedCap UE positioning:

* Intel wonders whether RAN1 will provide text proposal for 38.305 for a stage-2 description of RedCap positioning. They also point out that there are UE capabilities impacts for RAN2 depending on RAN1 inputs on RedCap UE capabilities.
* Xiaomi points out there are impacts to NRPPa for DL PRS Rx frequency hopping. However, Apple points out that in general RAN2 should not focus on NRPPa or any RAN3 related impacts for RedCap UE positioning. [RED-03]
* Lenovo thinks LMF needs to signal the hopping pattern for DL PRS Rx frequency hopping, and this has impacts to LPP specification. To the rapporteur, it is not clear from the current RAN1 agreements whether hopping pattern is signalled to UE for DL Rx hopping. However, RAN1 agreements explicitly mention signalling the hopping pattern to UE for UL Tx hopping. Vivo thinks there is no need to signal the hopping pattern even for SRS for positioning Tx frequency hopping. [RED-03/RED-09/RED-14]
* Vivo, Huawei and OPPO commented that there is no need for RedCap UE to report the virtual bandwidth, per-hop bandwidth and number of hops and that it should be removed. [RED-08]
* Huawei wonders, with regards to BWP configuration for RedCap UE ‘SRS for positioning’ transmission frequency hopping, whether a separate BWP configuration is inside each existing data BWP or outside any data BWP. [RED-04]
* Ericsson thinks RAN2 can work on details of configuring SRS for positioning with Tx hopping outside of the active BWP and they think it means there is a need to create a virtual BWP for SRS hopping similar to what was done for RRC\_INACTIVE. [RED-18]
* Vivo, CATT, ZTE, Apple pointed out that use of measurement gap for RedCap UE measurement of DL PRS with Rx frequency hopping is applicable only for RRC\_CONNECTED state. [RED-16]
* Ericsson points out that RAN4 agreements related to introduction of new measurement gap configurations (MG ID 24 and 25) which applies to RedCap UE in general and hence apply for RedCap UE positioning also. They also point out that RAN4 have agreed to re-use existing measurement report mapping table for RedCap UE positioning measurement reporting also. Rapporteur thinks we need to do a separate impact analysis based on RAN4 agreements and RAN4 parameter list. [RED-01]
* Lenovo thinks there are RRC specification impacts for configuration of switching (between hops) related parameters for DL PRS Rx frequency hopping and UL SRS Tx frequency hopping by RedCap UE. Ericsson points out that RAN4 had already agreed on RF switching time values for PRS/SRS frequency hopping and this may have impacts to UE capabilities signalling. [RED-02]

### Proposals on RedCap UE positioning

Shown below are some way-forward proposals from the rapporteur based on the RAN2 impact analysis shown in table in Section 3.2 taking all the comments received into account and noting the FFS issues identified from the discussion.

**Proposal 9**: Support RedCap UEs capable of DL PRS Rx frequency hopping, hopping within a single PRS resource of a TRP under one positioning frequency layer, to report positioning measurement in LPP Provide Location Information message with an indication whether the reported measurement is based on multiple hops or a single hop.

## 3.3 Bandwidth aggregation

This section provides a table with all RAN1 agreements for Rel-18 NR positioning enhancements for Bandwidth Aggregation for Positioning. The right column of this table provides an assessment of impacts to RAN2 for each of the RAN1 agreements. These RAN1 agreements were taken from the RAN1#112, RAN1#112bis-e, RAN1#113 and RAN1#114. Please review the RAN2 impact assessment and **provide your comments on the assessment of impacts to RAN2 in the table that follows**.

Table 3 RAN2 impacts for PRS/SRS bandwidth aggregation.

|  |  |  |
| --- | --- | --- |
| Ref. | RAN1 agreement | RAN2 impacts |
| BWA-01 | To enable PRS bandwidth aggregation between PRS in two or three different PFLs, the following conditions should be satisfied for the aggregated PRS resources from a TRP across the aggregated PFLs:   * In the same slot, in same symbols, by the same TRP associated with the same ARP, from the same RF chain (i.e. the same antenna), this implies   + FFS: The same gNB Tx TEG and the same UE Rx TEG, the maximum TX timing error margin   + The same QCL * The same number of symbols, symbol location within one slot, repetition factor, * FFS: the same periodicity and slot offset * FFS muting pattern * The same numerology, i.e. the same CP and SCS * The same or different bandwidths * The same comb size * FFS: The same number of PRS resource sets and resources for a TRP * The same power per subcarrier * FFS: the same *NR-DL-PRS-SFN0-Offset* * Aggregated PFLs are configured on the same aligned numerology grid * FFS: How to maintain contiguous PRS pattern across aggregated bandwidths even in the presence of guard tones (e.g, PFLs with different RE-offset configurations, PFLs with different point A) * Phase continuity between aggregated PFLs | **Conditions for PRS bandwidth aggregation:**  These are conditions that UE checks to determine if two PRS resources from different PRS resource sets in different PFLs are linked and can be used for aggregation.  FFS: If anything needs to be captured in RAN2 specification that LMF must ensure that PRS assistance data provided to UE for PRS BW aggregation have PRS configuration that satisfies these conditions.  See also BWA-31. |
| BWA-02 | To enable SRS bandwidth aggregation between SRS in two or three carriers, the following conditions should be satisfied for the aggregated SRS resources across the aggregated carriers   * In the same slot, in same symbols, from the same antenna, this implies   + FFS: The same gNB Rx TEG and the same UE Tx TEG   + The same spatial relation * The same *startPosition, nrofSymbols* * FFS: *periodicityAndOffset,* and *slotOffset* * The same numerology, i.e. the same CP and SCS * The same or different bandwidths * The same comb size * FFS: The same number of SRS resource sets and resources * The same Tx PSD (power per subcarrier)   + FFS whether to need the same pathloss RS, Po and alpha   + Note: the Tx PSD is not captured in RAN1 specifications * FFS: SRS with RE-offset configuration which maintains contiguous SRS pattern across aggregated bandwidths even in the presence of guard tones * Phase continuity between aggregated SRS in different carriers | **Conditions for SRS bandwidth aggregation:**  These are conditions that UE checks to determine if two SRS resources from different SRS resource sets in different carriers are linked and can be used for aggregated SRS transmission.  FFS: If anything needs to be captured in RAN2 specification that LMF/serving gNB must ensure that SRS configuration provided to UE for SRS BW aggregation have SRS configuration that satisfies these conditions.See also BWA-29 and BWA-38.  Any NRPPa impacts can be discussed in RAN3. |
| BWA-03 | For PRS bandwidth aggregation across PFLs, support enhancement of PRS configuration to inform UE by LMF (or inform LMF by NG-RAN) PRS resources from which two or three PFLs are linked.   * FFS whether the link is for all TRPs or per TRP basis * FFS whether the link is per PRS resource set basis or per PRS resource basis. | **PRS assistance data configuration and signalling for PRS BW aggregation:**  PRS configuration assistance provided to UE by LMF in the NR-DL-PRS-AssistanceData IE in the ProvideAssistanceData message needs to be enhanced to indicate which PRS resource sets from a TRP in which PFLs are linked together for PRS BW aggregation. This impacts the ProvideAssistanceData for DL-TDOA and multi-RTT positioning methods (see BWA-04 and BWA-32)  FFS: whether information of the aggregated PFLs and the corresponding resource sets across the PFLs is captured in Location Information request message or within the PRS assistance data  Any NRPPa impacts can be discussed in RAN3. |
| BWA-04 | Support joint measurement and report for the PRS resources aggregated across the PFLs for DL-TDOA and multi-RTT positioning methods   * In a measurement report element, single RSTD or single UE Rx-Tx time difference is reported for the PRS resources across aggregated PFLs   + FFS: RSRP, RSRPP * FFS: In a measurement report, PFL aggregation indication is supported to indicate whether/which PFLs are aggregated for the PRS measurement * FFS whether to use PRS assistance data or use location information request message to indicate UE to perform joint measurement across aggregated PFLs * FFS RSTD reference configuration or report should be enhanced | **DL-TDOA and multi-RTT UE measurement reporting with PRS BW aggregation:**  The RSTD measurement reported in NR-DL-TDOA-SignalMeasurementInformation and the UE Rx-Tx time difference measurement reported in NR-Multi-RTT-SignalMeasurementInformation can be based on measurement done by UE on aggregated PRS resources from different PFLs from a TRP. |
| BWA-05 | For SRS bandwidth aggregation across two or three carriers, support enhancement of SRS configuration to indicate the SRS resources from which two or three carriers are linked   * SRS resources are per BWP per carrier configuration * FFS whether the link is per SRS resource set basis or per SRS resource basis. | **Linkage of SRS resources across carriers for SRS BWA:**  RAN2 impact: SRS configuration provided to UE by serving gNB (RRC signalling) needs to be enhanced to indicate which SRS resource in which 2 or 3 carriers are linked together for aggregated SRS transmission by UE. See also BWA-39. |
| BWA-06 | * Support LMF-initiated and UE-initiated on-demand PRS request for PRS bandwidth aggregation   + FFS details * Support preconfigured on-demand PRS across PFLs for PRS bandwidth aggregations   + FFS details | **On-demand PRS support for PRS BW aggregation:**  Enhancements to on-demand PRS for PRS BW aggregation is to be supported but details are up to RAN2 to discuss and decide. |
| BWA-07 | From RAN1 perspective, support UE performs PRS measurement across multiple aggregated PFLs in RRC\_CONNECTED, RRC\_INACTIVE and RRC\_IDLE state. | **RRC states applicable for UE measurement using PRS BW aggregation:**  The impact of this agreement is that RSTD and UE Rx-Tx time difference measurements done by UE using PRS BW aggregation is applicable in RRC\_CONNECTED, RRC\_INACTIVE and RRC\_IDLE state. This impacts the RAN1 measurement definition specification but for RAN2 this mainly impacts the stage-2 descriptions in 38.305.  FFS: Support of UE Rx-Tx measurement in RRC\_IDLE. Check with RAN1.  FFS: Decide if anything needs to be captured in RAN2 specifications for RRC\_IDLE support of PRS BW aggregation. |
| BWA-08 | Support joint measurement and report for the SRS resources across the aggregated carriers for UL-TDOA and Multi-RTT positioning methods   * Single UL RTOA or gNB Rx-Tx time difference is reported for the SRS resources across aggregated carriers   + FFS: RSRP or RSRPP * FFS: SRS carrier aggregation indication is reported along with the measurement results to indicate whether/which carriers are aggregated for the joint SRS measurement * Support LMF to request gNB for the UL positioning measurement from aggregated SRS resources across multiple CCs | **UL-TDOA and multi-RTT UE measurement reporting with SRS BW aggregation:**  The RTOA and gNB Rx-Tx time difference measurement reported by gNBs/TRPs can be based on measurement done by TRPs on aggregated SRS resources transmitted on different carriers by a UE.  This mainly impacts RAN3.  For RAN2 the impacts are to 38.305 to describe that SRS BW aggregation applies to UL-TDOA and multi-RTT positioning methods. |
| BWA-09 | At least support periodic positioning SRS and semi-persistent positioning SRS for bandwidth aggregation   * Support single MAC CE activating positioning SRS resource sets across the linked carriers * FFS whether support aperiodic positioning SRS for bandwidth aggregation for UEs in RRC\_CONNECTED state. Study a single DCI scheduling positioning SRS across the linked carriers, and check whether the conclusion/agreements in agenda of multi-cell PUSCH/PDSCH scheduling with a single DCI can be reused * FFS MIMO SRS can be supported for bandwidth aggregation, e.g. with UE transparent way | **SRS types supported for SRS BWA:**  MAC CE signalling enhancement needed to have MAC CE activate the SRS resource sets across the linked carriers. See also BWA-41.  Stage-2 and MAC specification updates may be needed to capture that periodic, semi-persistent and aperiodic positioning SRS are supported for SRS BW aggregation. See also BWA-15 |
| BWA-12 | Study whether single TRP Tx TEG ID or UE Rx TEG ID is applied across PRSs in aggregated PFLs for TEG information reporting, i.e. single TEG ID is reported across the aggregated PRS resources for TRP Tx TEG association reporting, or for UE Rx TEG ID reporting in the measurement reporting. | **Impact on TEG information reporting by UE due to PRS BW aggregation:**  Wait for RAN1 conclusions on TEG information reporting when PRS BW aggregation is used. |
| BWA-14 | The legacy definition of DL RSTD, UL RTOA, UE Rx-Tx time difference, gNB Rx-Tx time difference is reused with the assumption that the subframe timings of the intra-band contiguous carriers are the same.   * Note: multiple PRS/SRS resources which can be used to determine the start of subframe can be from multiple intra-band continuous carriers, * Note: no RAN1 spec impact * Send an LS to RAN4 to confirm RAN1’s understanding | **Measurement definition for RSTD, RTOA, UE Rx-Tx time difference and gNB Rx-Tx time difference:**  There is no RAN2 impact. Measurement definitions is a RAN1 and RAN4 issue. |
| BWA-15 | Support aperiodic positioning SRS for bandwidth aggregation for UEs in RRC\_CONNECTED state.   * FFS the details | **SRS types supported for SRS BWA:**  Stage-2 and MAC specification updates may be needed to capture that periodic, semi-persistent and aperiodic positioning SRS are supported for SRS BW aggregation. See also BWA-09. |
| BWA-16 | For PRS resources aggregated across PFLs for DL-TDOA and multi-RTT positioning methods, use similar signaling as the existing Rel-16/Rel-17 DL PRS measurement of single PFL with the necessary update.   * FFS: In a measurement report element, single RSRP or single RSRPP is reported * In a measurement report element, PFL aggregation indication is supported to indicate whether/which measurement is aggregated * Support new signaling in location information request message to indicate UE whether to perform joint measurement across aggregated PFLs * Single RSTD reference in assistance data and measurement report is used for PRS bandwidth aggregation measurement   + FFS RSTD reference is aggregated or not | **DL-TDOA and multi-RTT UE measurement reporting with PRS BW aggregation:**  See related agreement in BWA-33.  In NR-DL-TDOA-SignalMeasurementInformation add a new indicator field to indicate whether the reported RSTD measurement is a joint/aggregated measurement or not. RAN1 recommendation is to add a new field in the NR-DL-TDOA-MeasElement IE with value {enabled} which is included and set to enabled if the reported RSTD measurement is a joint measurement.  In NR-Multi-RTT-SignalMeasurementInformation add a new indicator field to indicate whether the reported UE Rx-Tx time difference measurement is a joint/aggregated measurement or not.  **Request for Location Information with PRS BW aggregation for DL-TDOA and multi-RTT:**  NR-DL-TDOA-RequestLocationInformation IE and NR-Multi-RTT-RequestLocationInformation IE need to be enhanced as follows:  - Add a field indicating UE needs to perform joint measurement across aggregated PFLs. FFS whether this explicit indication is required or not.  - add a field indicating which two or three PFLs to be used for performing joint measurement  - indicate the DL PRS resource sets in the two or three DL PFLs that are linked for DL PRS BW aggregation (has corresponding impact to NRPPa signalling as indicated in the parameter list R1-2308483)  - Extend the NR-DL-TDOA-ReportConfig IE and NR-Multi-RTT-ReportConfig IE and add a new timingReportingGranularityFactor-Ext-r18 field with values {-1, -2}. Other values FFS. See R1-2308483. For multi-RTT since there is no extension marker for NR-Multi-RTT-ReportConfig IE we may have to introduce a new NR-Multi-RTT-ReportConfig-Ext-r18 IE  **Reference PRS information used for RSTD measurement using PRS BW aggregation:**  The existing nr-DL-PRS-ReferenceInfo field in NR-DL-PRS-AssistanceData IE and the existing dl-PRS-ReferenceInfo field in *NR-DL-TDOA-SignalMeasurementInformation* IE can be reused since a single RSTD reference is to be used for PRS BW aggregation measurement. Some field description changes may be needed. |
| BWA-17 | The details for on-demand PRS on PRS bandwidth aggregation are up to RAN2 and RAN3. | **On-demand PRS support for PRS BW aggregation:**  Enhancements to on-demand PRS for PRS BW aggregation is to be supported but details are up to RAN2 to discuss and decide and decide based on company contributions. Previously (BWA-06) RAN1 agreed the following:  • Support LMF-initiated and UE-initiated on-demand PRS request for PRS bandwidth aggregation  • Support preconfigured on-demand PRS across PFLs for PRS bandwidth aggregations |
| BWA-18 | For SRS bandwidth aggregation between SRS in two or three carriers, the aggregated SRS resources are of the same SRS resource-Type. | **SRS resource type used in SRS BW aggregation:**  Serving gNB must ensure that the SRS resource type for the provided SRS configuration to the UE are of the same SRS resource type for the two linked SRS resources used for SRS BW aggregation. |
| BWA-19 | At least from UE capability perspective, the UE support of positioning SRS bandwidth aggregation in RRC\_CONNECTED state is decoupled from the UE support of communication CA. | **Dependencies between SRS BWA and Communication CA:**  Wait for RAN1 UE features list to see if there are any RAN2 impacts. |
| BWA-20 | Support the same power prioritization between the aggregated carriers in the case when total UE transmit power in a transmission occasion I exceeds   * The UE allocates power to the multiple SRS resources in the transmission occasion i of the aggregated carriers such that the UE’s transmit power in each transmitted resource element is equal. * FFS further details, e.g. power scaling between aggregated carriers | **Power control with SRS BW aggregation:**  There is no RAN2 impact. |
| BWA-21 | Introduce new UE capability(-ies) to support PRS bandwidth aggregation measurement   * FFS the details include the processing capability (N, T), the maximum number of PRS resources that can be process in a slots over the aggregation. * FFS the details on the PFL bandwidth combinations, including maximum number of PFLs, the total aggregated bandwidth, etc. * This is applicable for DL-TDOA and Multi-RTT positioning methods. | **UE positioning capabilities for PRS BW aggregation:**  There are definite impacts to UE positioning capabilities signalling but these can be discussed separately after the RAN2 impacts analysis to introduce core functionalities for BW aggregation is decided. |
| BWA-22 | Study whether single UE Tx TEG ID or TRP Rx TEG ID is applied across SRSs in aggregated carriers for TEG information reporting, i.e. single UE Tx TEG ID is reported across the aggregated SRS resources for UE Tx TEG association reporting, or for TRP Rx TEG ID reporting in measurement reporting. | **Impact on TEG information reporting by UE due to SRS BW aggregation:**  Wait for RAN1 conclusions on TEG information reporting when SRS BW aggregation is used. |
| BWA-23 | Positioning SRS bandwidth aggregation is supported for UEs in RRC\_CONNECTED.  Positioning SRS bandwidth aggregation is supported for UEs in RRC\_INACTIVE state.   * For the details, Rel-17 positioning SRS configuration for UE in RRC\_INACTIVE state outside initial UL BWP can be the starting point | **RRC states applicable for SRS BW aggregation:**  For RAN2 this mainly impacts the stage-2 descriptions in 38.305.  RRC Specification may need to be updated to indicate the aggregated SRS resources across different carriers for UEs in RRC\_INACTIVE to perform positioning SRS bandwidth aggregation. |
| BWA-24 | From RAN1 perspective, MG-based bandwidth aggregation measurement is supported. Decide whether PPW is supported for PRS bandwidth aggregation measurement in RAN1#113 meeting.   * FFS the details for PPW if supported | **Measurement gap configuration for joint/aggregated measurements:**  FFS: Impacts to measurement gap configuration aspects in RRC specification depending on further details from RAN4 including whether any new measurement gap configuration is introduced.  See BWA-36 for PPW. |
| BWA-27 | For the SRS resources across aggregated carriers for UL-TDOA and Multi-RTT positioning methods, use similar signaling as the existing Rel-16/Rel-17 SRS measurement of single carrier with the necessary update   * FFS: Single RSRP or RSRPP is reported for the SRS resources across aggregated carriers * SRS carrier aggregation indication is reported along with the measurement results to indicate whether/which measurement is aggregated | **SRS aggregation indication in measurement result from TRP:**  This mainly has RAN3 impact. |
| BWA-31 | For PRS bandwidth aggregation between PRS in two or three different PFLs, the following are needed for the aggregated PRS resources for a TRP:   * The same periodicity and slot offset * The same muting pattern * The same *NR-DL-PRS-SFN0-Offset* value * UE expects to be configured with PRS resources that maintain a per-symbol uniformly spaced PRS pattern across aggregated bandwidths in frequency domain (Note: It does not preclude dropping some REs in the guardband between two PFLs). * FFS same antenna port from RAN1 perspective | **Conditions for PRS bandwidth aggregation:**  These are conditions that UE checks to determine if two PRS resources from different PRS resource sets in different PFLs are linked and can be used for aggregation.  FFS: If anything needs to be captured in RAN2 specification that LMF must ensure that PRS assistance data provided to UE for PRS BW aggregation have PRS configuration that satisfies these conditions.  See BWA-01 also.  FFS: it is unclear if the following condition is still undecided and kept open or not:   * The same number of PRS resource sets and/or resources per set for a TRP |
| BWA-32 | For PRS bandwidth aggregation across PFLs, support   * Option 2: Per TRP basis and per PRS resource set basis.   + For each TRP, support new signaling to indicate which PRS resource sets across PFLs are linked.   + It is assumed that the PRS resources across the linked PRS resource sets are linked if the conditions are satisfied. For the non-linked PRS resource sets, no aggregation is assumed even if the conditions are satisfied. | **Granularity of linkage of resources across PFL for a TRP:**  RAN2 impact: PRS configuration assistance provided to UE by LMF in the NR-DL-PRS-AssistanceData IE in the ProvideAssistanceData message needs to be enhanced to indicate which PRS resource sets from a TRP in which PFLs are linked together for PRS BW aggregation.  FFS: whether information of the aggregated PFLs and the corresponding resource sets across the PFLs is captured in Location Information request message or within the PRS assistance data.  For a TRP, link resource sets across different PFLs. A resource within the linked resource set is considered linked if certain conditions are satisfied. Two resources from two resource sets that are not linked are considered not linked even if the conditions are satisfied. |
| BWA-33 | For PRS bandwidth aggregation across PFLs, in a measurement report element, support   * Single RSRP or single RSRPP   + FFS: the single RSRP/RSRPP is based on aggregated PRS resources across aggregated PFLs * The aggregated reference RSTD * The used PRS resource set IDs for the aggregated measurement which are shared for RSRP/RSRPP and/or timing measurement results | **DL-TDOA and multi-RTT UE measurement reporting with PRS BW aggregation:**  The RSRP or RSRPP measurement reported in NR-DL-TDOA-SignalMeasurementInformation IE and the NR-Multi-RTT-SignalMeasurementInformation IE can be based on measurement done by UE on aggregated PRS resources from different PFLs from a TRP.  The NR-DL-TDOA-SignalMeasurementInformation IE and the NR-Multi-RTT-SignalMeasurementInformation IE needs to be enhanced to indicate the PRS resource set IDs used for the reported joint/aggregated measurement.  FFS: Meaning of aggregated reference RSTD is unclear. Need more clarification from RAN1.  FFS: Wait for further updates on RAN1 parameters list. |
| BWA-34 | 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, a guard period is needed before and after the aggregated SRS transmissions.   * Send an LS to RAN4 with the above information and a request to provide the retuning time values needed. | **SRS resource configured within a CC without PUSCH/PUCCH is linked with an SRS resource configured within an UL active BWP of a UL communication CC:**  There is no RAN2 impact. |
| BWA-35 | For PRS bandwidth aggregation, with regards to the signaling in the location information request message, introduce the following:   * A request to indicate UE which two or three PFLs to be used for performing joint measurement * A new ReportingGranularityfactor smaller than 0 which can be applicable at least when the LMF requests aggregated measurements   + Support at least the values of k={-1,-2}     - FFS other values e.g. -3, -4, -5, -6   + Send RAN4 an LS to confirm the feasibility | **Request for Location Information with PRS BW aggregation for DL-TDOA and multi-RTT:**  NR-DL-TDOA-RequestLocationInformation IE and NR-Multi-RTT-RequestLocationInformation IE need to be enhanced to indicate UE to perform joint measurement across aggregated PFLs by providing 2 or 3 PFLs to be used for joint/aggregated measurement. RAN2 should discuss if the PFL index based on the PFL list in the provided assistance data can be used to indicate the PFLs.  Also, the timingReportingGranularityFactor field in NR-DL-TDOA-RequestLocationInformation IE and NR-Multi-RTT-RequestLocationInformation IE need to be extended to allow values smaller than 0. |
| BWA-36 | For PRS bandwidth aggregation, PPW is not supported in Rel-18. | **PPW configuration for joint/aggregated measurements:**  There is no RAN2 specification impact. If needed, we can capture in 38.305 that PPW for BW aggregation is not supported in this release. |
| BWA-37 | When the UE receives a request to perform aggregated measurements,   * TRP(s) that include PRS aggregation have higher priority than the TRPs that do not include PRS aggregation   + If 2 or more TRPs include linked resources, then their priority follows the legacy priority, i.e., sorted in the configuration according to priority * If a PRS resource set is linked for aggregation, then it has higher priority compared to the PRS resource set not linked for aggregation.   + If both sets in a PFL are linked for aggregation, then their priority follows the legacy priority, i.e., sorted in the configuration according to priority. | **TRP and PRS resource set prioritization by UE for measurement using PRS BW aggregation:**  There is no impact to RAN2. |
| BWA-38 | For SRS bandwidth aggregation between SRS in two or three carriers, the following is needed for the aggregated SRS resources   * The same *periodicityAndOffset,* and *slotOffset* * The configuration of pathloss RS, Po and alpha to ensure the same Tx PSD (power per subcarrier)   + The same configuration of Po and alpha.   + Note: UE may either perform pathloss RS measurement across CCs and form a single path loss value to apply across CCs or perform pathloss RS measurement in a single CC and apply across CCs. | **Conditions for SRS bandwidth aggregation:**  These are conditions that UE checks to determine if two SRS resources from different SRS resource sets in different carriers are linked and can be used for aggregated SRS transmission.  LMF/serving gNB must ensure that SRS configuration provided to UE for SRS BW aggregation have SRS configuration that satisfies these conditions.  See BWA-02 and BWA-29. |
| BWA-39 | For SRS bandwidth aggregation across two or three carriers, support   * Option 2: Per SRS resource set basis.   + Support new signaling to indicate which SRS resource sets across carriers are linked.   + It is assumed that the SRS resources across the linked SRS resource sets are linked if the conditions are satisfied. For the non-linked SRS resource sets, no aggregation is assumed even if the conditions are satisfied. | **Granularity of linkage of resources across carriers for SRS BWA:**  RAN2 impact: SRS configuration provided to UE by serving gNB (RRC signalling) needs to be enhanced to indicate which SRS resource sets in which 2 or 3 carriers are linked together for aggregated SRS transmission by UE. |
| BWA-40 | To support intra-band contiguous SRS bandwidth aggregation for UE in RRC\_INACTIVE state, frequency information (e.g. point A, offset to carrier) of one or two additional carriers with respective SRS configurations should be provided to the UE, where the newly introduced carrier(s) and the carrier of the initial BWP should be intra-band contiguous carriers. | **Intra-band contiguous SRS BW aggregation:**  RAN2 impact: SRS configuration provided to UE in RRC\_INACTIVE by serving gNB (RRCRelease with suspend config signalling) needs to be enhanced to indicate frequency information (e.g. point A, offset to carrier) of one or two additional carriers for aggregated SRS transmission by UE. |
| BWA-41 | Working assumption  For semi-persistent positioning SRS for bandwidth aggregation, a single MAC CE can activate or deactivate:   * SRS resource set(s) in one or two or three of three aggregated carriers * SRS resource set(s) in one or two of two aggregated carriers.   Note: the single spatial relation is indicated by the MAC CE for each of two or three aggregated SRS resources.  Send an LS to RAN2 to confirm the feasibility. | **Semi-persistent positioning SRS type activation for SRS BWA:**  MAC CE impacts for RAN2. Already some agreements made in RAN2#123. |
| BWA-42 | For positioning SRS aggregation transmission in RRC\_INACTIVE state, reuse Rel-17 prioritization rule of SRS outside initial BWP, i.e. SRS is dropped in the symbol(s) of all aggregated carriers where collision occurs. | **Prioritization rule of SRS outside initial BWP for SRS BW aggregation:**  There is no RAN2 impact. |
| BWA-43 | For a carrier including positioning SRS for aggregation,   * Positioning SRS can be transmitted only when the carrier is activated   + This is also applicable for the carrier only including positioning SRS for aggregation | **Conditions for SRS bandwidth aggregation:**  There is no impact to RAN2. |
| BWA-44 | With regard to support of aperiodic positioning SRS for bandwidth aggregation for UEs in RRC\_CONNECTED state, at least the existing Rel-17 DCI framework (i.e. use multiple DCIs schedule SRSs in multiple carriers) can be reused   * FFS: whether Rel-18 DCI framework for multi-cell PDSCH/PUSCH scheduling with a single DCI (i.e. single DCI schedules SRSs in multiple carriers) can also be reused with or without specification work in RAN1. | **Aperiodic positioning SRS type and DCI:**  There is no RAN2 impact. |
| BWA-45 | For SRS bandwidth aggregation across carriers, support   * Single RSRP or RSRPP is reported   + FFS: the single RSRP/RSRPP is based on aggregated SRS resources across aggregated carriers * The used SRS resource IDs for the aggregated measurement are shared for RSRP/RSRPP and/or timing measurement results | **TRP measurement reporting with SRS BW aggregation:**  The RSRP or RSRPP measurement reported to LMF by TRPs can be based on measurement done by TRP on aggregated SRS resources from different carriers from a UE.  This mainly impacts RAN3. |
| BWA-46 | For PRS/SRS bandwidth aggregation between two or three different PFLs/carriers, send a reply LS to request RAN4 to capture the condition of ‘the same RF chain (same antenna)’ in RAN4 specification. | **Conditions for PRS bandwidth aggregation:**  There is no RAN2 impact for capturing the condition that the same RF chain is used for the aggregated resources. Wait for RAN4 progress to assess if there are any RAN2 impacts. |
| BWA-47 | For the case when PRS in one of aggregated PFL is dropped because of collision with other signals, for LMF based positioning, it is up to UE implementation to perform positioning measurement based on one or more of the PRS resources in the aggregated PFLs.   * Note: it is up to RAN4 whether or not to define performance requirements for this case of collision with other signals. | **UE measurement when PRS in one of the aggregated PFL is dropped:**  May be a NOTE in 37.355 can be captured but wait for RAN4 progress.  FFS: What if one of a PRS in a pair of aggregated PRS resource set is not received by UE, and other PRSs in the pair of aggregated PRS resource set are received by UE and UE performs aggregated measurements, how can UE report such kind of measurements(single + aggregated measurements)? |
| BWA-48 | 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. | **UE SRS transmission when SRS in one of the aggregated carriers is dropped:**  There is no RAN2 impact. FFS if MAC specification needs any update.  This defines the UE behaviour for SRS transmission if SRS in one of aggregated carriers is dropped in a symbol which should be covered by a physical layer procedure. |
| BWA-49 | With regard to aperiodic positioning SRS for bandwidth aggregation for UEs in RRC\_CONNECTED state, support both Option 2 and Option1.   * Option 2: Support to use a DCI format 0\_3 or 1\_3 for multi-cell PDSCH/PUSCH scheduling to trigger SRS resources for bandwidth aggregation in multiple CCs. * Option 1: Support a Rel-17 single DCI scheduling positioning SRS resource sets across the linked carriers, as a separate UE capability.   + Reuse Rel-17 DCI framework without modification.   + If a single DCI indicates transmission of an aperiodic positioning SRS resource set, UE transmits aperiodic positioning SRS resource sets across all linked carriers for bandwidth aggregation. | **Aperiodic positioning SRS type and DCI:**  There is no RAN2 impact. |

### Question 3:

Please provide your comments on the assessment of impacts to RAN2 for each of the RAN1 agreements on Bandwidth Aggregation for Positioning. In the table below enter the Ref number for the RAN1 agreement and in the comments column indicate if you agree with the assessment or disagree with the assessment or any parts of it, or list any missed impacts to RAN2 for the referenced RAN1 agreement etc.

|  |  |  |
| --- | --- | --- |
| Answers to Question 3 | | |
| Company | Ref | Comments |
| Intel | BWA-01/02/18  BWA-07  BWA-16 | BWA-01/02/18, what's the spec impact? Normally we do not capture the network requirement. These conditions are already captured in the RAN1 spec..  Rapp: I was thinking, if needed/agreed, a NOTE can be captured in 37.355 providing guidance for network implementations. I have listed under BWA-01/02/18 what is the impact to network. It is more a configuration guidance for the network.  BWA-07, RAN2 has not capture anything related to measurement in IDLE and report in CONNECTED. Therefore what's the stage 2 impact on this?  Rapp: If we follow the existing principle then we do not have to capture anything related to measurement in IDLE with reporting in CONNECTED. However, if needed/agreed, a generic description on supported RRC states for BWA can be captured in 38.305.  BWA-16, would be good to mention that RAN1 has agreed the parameter to be contained in NR-DL-TDOA-RequestLocationInformation and NR-Multi-RTT-RequestLocationInformation  Rapp: OK. So far, I did not go into details on parameters since the parameter list from RAN1 is only a first iteration now and also since this is the first time in RAN2 we are going into details for RAN1-led positioning objectives. However, I updated BWA-16 and BWA-33 based on what I saw in RAN1 parameter list in R1-2308483. |
| vivo | BWA-01  BWA-02 | No need for UE to check, the NW is responsible for ensuring the configuration is correct:  These are conditions that UE checks to determine if two PRS resources from different PRS resource sets in different PFLs are linked and can be used for aggregation.  These are conditions that UE checks to determine if two SRS resources from different SRS resource sets in different carriers are linked and can be used for aggregated SRS transmission.  Rapp: Need to check with RAN1. My understanding is, not all resources between the two linked resource sets are linked. Hence the UE needs to check whether the resources between two linked resource sets meets the conditions or not. |
|  | BWA-15 | Stage 2 change should be captured in 38305.  Rapp: OK. |
| CATT | BWA-03/BWA-32 | For BWA-03/32, need to discuss whether information of the aggregated PFLs and the corresponding resource sets across the PFLs is captured in Location Information request message or within the PRS assistance data.  Rapp: OK. We can discuss it. |
| BWA-37 | This only needs to be captured in RAN1 spec.  Rapp: Few other companies also thinks this has no RAN2 spec impact. So, fine with your comment. |
| BWA-16 | For BWA-16, since anyway UE need to indicate the aggregated resource sets for the joint measurement results within the measurement reporting message, so maybe this information is enough to indicate to the LMF that joint measurement is performed.  Rapp: Discuss if an explicit signalling whether the reported measurement is a joint measurement or not is needed or if the signalling of resource sets can implicitly indicate this. |
| Xiaomi | BWA-02  BWA-03 | Since the SRS/PRS bandwidth aggregation should satisfy some conditions, the gNB should know the required SRS/PRS configuration is for the bandwidth aggregation, and then determines the feasible SRS/PRS configuration. So, there may be NRPPa impact, for example, LMF indicates the requested SRS/PRS configuration will be used for bandwidth aggregation.  Rapp: NRPPa impacts can be discussed in RAN3. Whether there is such impact can be checked with RAN1. |
| ZTE | BWA-16  BWA-32  BWA-35  BWA-39  BWA-40  BWA-47 | BWA-16： In the request location information:  *- Add a field indicating UE needs to perform joint measurement across aggregated PFLs.*  *- add a field indicating which two or three PFLs to be used for performing joint measurement*  If second bullet is introduced, the first bullet is not needed  Rapp: I agree. But, in the RAN1 parameter list there were two parameters described as follows: i) Request from the LMF to the UE indicating which two or three PFLs to be used for performing joint measurement and another new parameter viz. ii) This field indicates whether to perform joint measurement across aggregated PFLs for DL-TDOA. This example is for DL-TDOA but there is discussion for multi-RTT also. That was the basis for my impact analysis text that you quoted. If others agree we can drop the first parameter but it needs to be communicated to RAN1 also.  BWA-32：We need to consult R1 whether only one pair of PFLs in a TRP can be linked in a same signaling, or more than one pairs of PFLs in a TRP can be linked in the same signaling. This impacts RAN2’s detailed ASN.1 design  Rapp: According to BWA-01 and BWA-35, I see it as 2 or 3 PFLs can be aggregated and you can also signal 2 or 3 PFLs in one message. The following are said in those agreements: “To enable PRS bandwidth aggregation between PRS in two or three different PFLs” and “A request to indicate UE which two or three PFLs to be used for performing joint measurement”.  BWA-35: We need to consult R1 whether only one pair of PFLs in a TRP can be indicated to UE in a single signaling, or more than one pairs of PFLs in a TRP can be indicated to UE in a single signlaing. This impacts RAN2’s detailed ASN.1 design  Rapp: see my response to your comment on BWA-32.  BWA-39: Note that this is to add linkage SRS config in RRC Reconfiguration  Rapp: I believe that is what I also mentioned in BWA-39.  BWA-40: Note that this is to change SRS config in RRC\_INACTIVE(RRCRelease with Suspend config)  Rapp: OK. I can add that the RRC signalling involved is the RRCRelease with suspend config.  BWA-47: What if one of a PRS in a pair of aggregated PRS resource set is not received by UE, and other PRSs in the pair of aggregated PRS resource set are received by UE and UE performs aggregated measurements, how can UE report such kind of measurements(single + aggregated measurements)?  Rapp: That is a question for RAN1. There were agreements on how to handle if one PFL in the aggregated PFLs is dropped or an SRS in a set of aggregated carriers is dropped. Similar to those, RAN1 needs to address the scenario you raise. |
| Huawei/HiSilicon | BWA-19 | RAN2 can follow the UE feature list provided by RAN1  Rapp: OK. I will update BWA-19 as suggested. |
| BWA-33 | This can be jointly considered with BWA-16. For example, it can be based on a new indication field.  Rapp: OK. Due to separate agreements from RAN1, I listed them separately but I did link BWA-16 and BWA-33 together. |
| BWA-36 | We think stage 2 spec needs to capture the restriction, i.e., description in the lines of the following needs to be captured in stage 2 spec:  There needs to be restriction on the PPW configuration that it should only be supported when bandwidth aggregation is not supported.  Rapp: We can also capture somewhere with a NOTE that PPW for BWA is not supported in this release. Open to further discussion of specific text proposal. |
| BWA-37 | This is UE behaviour at PHY. So, no need to capture in RAN2.  Rapp: OK. Similar comment that there should be no LPP spec impact was mentioned by Qualcomm also. |
| BWA-48 | We think there is some impact to MAC spec.  Rapp: We can investigate it further. If you can provide some impact analysis text for this BWA-48, much appreciated. |
| Qualcomm | BWA-37 | This may not have RAN2 spec impacts, since RAN2 decided in Rel-16 that the "PRS prioritization" should not be captured in LPP (although, it was captured for LTE OTDOA). RAN1 updated the "prioritization" in 38.214, clause 5.1.6.5 already.  Rapp: OK. |
| Lenovo | BWA-07 | Positioning assistance delivery and joint PRS measurement reporting should be enhanced to support PRS BW aggregation in RRC\_INACTIVE and RRC\_IDLE state.  Rapp: We can revisit this later. There are other agreements that captures the impacts to assistance data delivery and measurement reporting for BWA. If you know of a specific change that must be done for BWA-07, we could list it. |
| BWA-23 | RRC Specification impacts needed to indicate the aggregated SRS resources across different carriers for UEs in RRC\_INACTIVE to perform positioning SRS bandwidth aggregation.  Rapp: BWA-23 does not specifically talk about signalling of aggregated SRS resources to UE in RRC\_INACTIVE but see BWA-05 and BWA-39. |
| BWA-33 | Aggregated reference RSTD refers to whether or more reference TRPs may be used to derive an aggregated RSTD measurement. Our understanding from the RAN1 agreements is that the aggregated RSTD measurement is based on a single reference TRP and not across multiple reference TRPs  Rapp: OK. We will keep it FFS for now. |
| OPPO | BWA-01/02/18 | Share the same view as Rapp. Although we usually do not capture NW requirements, a NOTE would be good to help NW implementation.  Rapp: OK. Can be discussed when we get to reviewing running CRs. |
| Apple | General | No need to discuss NRPPa in RAN2  Rapp: Agree. |
| BWA-19 | No RAN2 impact for now, but eventually there may be some impact when we define capabilities signalling  Rapp: OK. I will update to say: “There is no RAN2 impact now but revisit when we discuss UE features list”. |
| BWA-17 | We understand this is not up for discussion here but company contributions are expected. Would be good to clarify.  Rapp: OK. I will update it as: “Enhancements to on-demand PRS for PRS BW aggregation is to be supported but details are up to RAN2 to discuss and decide based on company contributions”. |
| Ericsson | BWA-24 | No new measurement gap for BW aggregation will be introduced.  Rapp: Can you provide some agreement reference for this comment please? |
| BWA-07 | UE Rx-Tx measurement may not be valid for RRC\_IDLE state. Only DL measurements are supported in RRC\_IDLE state. UE Rx Tx has Tx component involved. Need to check with RAN1.  Rapp: OK. I can add “Support of UE Rx-Tx measurement in RRC\_IDLE is FFS pending RAN1 confirmation”. |

### Summary 3:

Following is a summary list of various comments received on the impacts to RAN2 for PRS/SRS for positioning Bandwidth Aggregation:

* Intel thinks there are no RAN2 specification impacts for capturing the conditions that needs to be satisfied for PRS bandwidth aggregation since we usually do not capture network requirements in the specification. Rapporteur suggested that we consider adding a note in LPP specification as a network guidance which OPPO also agrees. Vivo thinks there are no UE requirement to check the conditions for PRS bandwidth aggregation. Rapporteurs’ understanding is, according to RAN not all resources between two linked resource sets are linked and hence the UE needs to check whether the resources between two linked resource sets meets the conditions for PRS bandwidth aggregation or not. This needs further discussion in RAN2 and additional guidance from RAN1. [BWA-01/BWA-02]
* CATT and ZTE think there is no need for an explicit indication in the request message from LMF to UE that the UE needs to perform joint measurement across aggregated PFLs. They think the request message which includes the PFLs to be aggregated and the resource set IDs of the resource sets in different PFLs that are used for aggregation can implicitly indicate to UE that a joint measurement is required. [BWA-16]
* BWA-23: Lenovo thinks RRC Specification may need to be updated to indicate the aggregated SRS resources across different carriers for UEs SRS bandwidth aggregation in RRC\_INACTIVE.
* CATT thinks RAN2 need to discuss, for PRS bandwidth aggregation, whether information about aggregated PFLs and the corresponding resource sets across the PFLs (linked PRS resource sets) is signalled to UE in Location Information Request message or in the Provide Assistance Data message.
* ZTE wonders whether only one pair of aggregated PFLs or more than one pair of aggregated PFLs can be signalled in one LPP message. Rapporteurs’ understanding is that 2 or 3 PFLs can be signalled in one LPP message. These issues need to be discussed further. [BWA32]
* ZTE points out that for Intra-band contiguous SRS BW aggregation in RRC\_INACTIVE state the RRCRelease message with suspend configuration information needs changes. [BWA-40]
* ZTE thinks the UE behaviour when one of the PRS in a pair of aggregated PRS resource set is not received by UE while the other PRSs in the pair of aggregated PRS resource set are received by UE needs to be clarified. [BWA-47]
* Huawei thinks there are impacts to MAC specification for capturing details of UE SRS transmission when SRS in one of the aggregated carriers is dropped. This needs further discussion. [BWA-48]
* Ericsson thinks no new measurement gap configuration for BW aggregation will be introduced. This can be discussed further based on inputs from RAN4. [BWA-24]
* For RRC\_IDLE UE measurements using PRS bandwidth aggregation, Intel thinks we do not need to capture anything in RAN2 specifications while Lenovo thinks there are impacts to LPP specification for enhancing the assistance data delivery and joint measurement reporting procedures (Lenovo’s comment is also for RRC\_INACTIVE support). Ericsson thinks UE Rx-Tx time difference measurement is not supported for PRS bandwidth aggregation in RRC\_IDLE. [BWA-07]
* CATT, Huawei and Qualcomm think there is no need to capture anything in RAN2 specifications for TRP and PRS resource set prioritization by UE for measurement using PRS BW aggregation. [BWA37]
* Vivo thinks that the support for different SRS types for SRS bandwidth aggregation needs to be captured in 38.305 also. [BWA-15]
* Xiaomi think there may be impacts to NRPPa for SRS/PRS bandwidth aggregation. Apple points out that in general RAN2 should not focus on NRPPa or any RAN3 related impacts for bandwidth aggregation for positioning. [BWA-03]
* Huawei and Apple commented that depending on UE features list received from RAN1, there may be additional impacts to RAN2 for dependencies between SRS BWA and Communication CA. [BWA-19]
* Huawei thinks RAN2 should capture in 38.305 that PPW configuration should only be supported when BWA is not supported. Rapporteur suggestion is to add a note that PPW for BWA is not supported in this release. [BWA-36]
* Apple points out that enhancements to on-demand PRS for support of PRS bandwidth aggregation can be based on company contributions. [BWA-17]

### Proposals on PRS/SRS bandwidth aggregation

Shown below are some way-forward proposals from the rapporteur based on the RAN2 impact analysis shown in table in Section 3.3 taking all the comments received into account and noting the FFS issues identified from the discussion.

**Proposal 9**: Enhance the NR-DL-TDOA-RequestLocationInformation IE and NR-Multi-RTT-RequestLocationInformation IE as follows:

- add a field indicating the UE needs to perform joint measurement across aggregated PFLs.

- indicate the DL PRS resource sets IDs from two or three different PFLs that are linked for DL PRS BW aggregation that UE needs to use for the joint measurement.

- extend the NR-DL-TDOA-ReportConfig IE and add a new timingReportingGranularityFactor-Ext-r18 field with values {-1, -2}. Other values FFS.

- introduce a new NR-Multi-RTT-ReportConfig-Ext-r18 IE add a new timingReportingGranularityFactor-Ext-r18 field with values {-1, -2}. Other values FFS.

**Proposal 10**: To support PRS BW aggregation, enhance the PRS configuration assistance data provided in NR-DL-PRS-AssistanceData IE in the Provide Assistance Data message for DL-TDOA and multi-RTT positioning to provide linkage information between PRS resource sets from a TRP for two or three PFLs.

**Proposal 11**: Extend the NR-DL-TDOA-SignalMeasurementInformation IE and add a new field to indicate whether the reported RSTD/RSRP/RSRPP measurement is a joint measurement or not.

**Proposal 12**: Extend the NR-Multi-RTT-SignalMeasurementInformation IE and add a new field to indicate whether the reported UE Rx-Tx time difference/RSRP/RSRPP measurement is a joint measurement or not.

# 4 Conclusion

TBD.