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.

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# 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**.

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| 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 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.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.See also CPP-37 and CPP-35. |
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| 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 and RRC\_INACTIVE UE.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. |
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| 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. |
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| 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-28.**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.nr-RequestedMeasurements bitmap in NR-DL-TDOA-RequestLocationInformation IE to be modified to add request for RSCPD measurement and if RSCPD measurement is requested by LMF, 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-27 for time window configuration**.nr-RequestedMeasurements bitmap in NR-Multi-RTT-RequestLocationInformation IE to be modified to add request for RSCP measurement and if RSCP measurement is requested by LMF, 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-27 for time window configuration**. |
| 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 Request location information message sent to target UE for UE-based CPP positioning.NR-DL-TDOA-RequestLocationInformation IE (sent to target UE) to be extended to include RSCPD measurement of PRU along with PRU location information.NR-Multi-RTT-RequestLocationInformation IE (sent to target UE) to be extended to include RSCP measurement of PRU along with PRU location information.NOTE: The PRU information and measurement forwarded to target UE can also be implemented as part of the NR-DL-TDOA-ProvideAssistanceData IE or NR-Multi-RTT-ProvideAssistanceData IE.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. |
| 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:**From RAN1 perspective carrier phase measurements by UE in RRC\_IDLE is supported but from RAN2 perspective signalling impacts for forwarding of PRU reported carrier phase measurements for use by target UE while in RRC\_IDLE (for UE-based CPP) and how a target UE in RRC\_IDLE reports carrier phase measurements to LMF needs further discussion. |
| 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. |
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| CPP-26 | To enable LMF to request the serving gNB and neighboring gNBs of a UE to measure the UL SRS resources from the UE within indicated time window(s), each time window is defined with the following parameters:* The start of the time window, which is indicated by a combination of subframe number, slot offset and symbol index with respect to the SFN initialization time
* The duration of the time window, which is given by a number of consecutive slots/symbols
	+ FFS: the number of consecutive slots/symbols
* (Optional) The periodicity of the time window, which is defined similar to IE Measurement Periodicity in MEASUREMENT REQUEST in TS 38.455.
* FFS: the maximum number of the windows
 | **Time window configuration in TRPs to receive and measure UL ‘SRS for positioning’:**This impacts RAN3 only. The impacts to NRPPa for time window signalling should be the same as for RRC signalling in CPP-28 but there are some discrepancies between CPP-26 and CPP-28 that needs to be resolved with RAN1. |
| CPP-27 | To enable LMF to request the UEs, including target UE and PRU(s), to perform measurements on indicated DL PRS resource set(s) occurring within indicated time window(s), each time window is defined with the following parameters:* The start of the time window, which is indicated by a combination of subframe number, slot offset and symbol index
* The duration of the time window, which is given by a number of consecutive slots/symbols
	+ FFS: the number of consecutive slots/symbols
* (Optional) The periodicity of the time window, which is defined similar to IE NR-DL-PRS-Periodicity-and-ResourceSetSlotOffset in TS 37.355.FFS: the maximum number of the windows
 | **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.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* (Optional) Periodicity of the time window:

Defined similar to IE PeriodicitySRS in “Requested SRS Transmission Characteristics” in TS 38.455FFS whether SFN number or subframe number is used for start of time window. |
| CPP-28 | Confirm the following working assumption with modification made in RAN1#113:Working assumptionTo enable LMF to optionally request the serving gNB of a UE to configure the transmission of the UL positioning SRS resources from the UE within indicated time window(s), support:* Option 1D: Each of the time windows is defined with the following parameters:
	+ The start of the time window, which is indicated by a combination of system frame number, slot offset and symbol index with respect to the SFN initialization time
	+ The duration of the time window, which is given by a number of consecutive slots/symbols
		- FFS: the number of the consecutive slots/symbols
	+ (Optional) The periodicity of the time window, which is defined similar to IE PeriodicitySRS in “Requested SRS Transmission Characteristics” in TS 38.455.
* FFS: the maximum number of the windows
 | **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. See CPP-20.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* (Optional) Periodicity of the time window:

Defined similar to IE PeriodicitySRS in “Requested SRS Transmission Characteristics” in TS 38.455NOTE: Assumption here is, this working assumption is now turned into an agreement with this RAN1 confirmation.See CPP-29 which provides details of duration of time window and number of time windows. |
| 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-30 | When a LMF requests the serving gNB and neighboring gNBs of a UE to measure the UL SRS resources from the UE 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, …, 16}
 | **Time window configuration in TRPs to receive and measure UL ‘SRS for positioning’:**This impacts RAN3 only. Time window parameters signalled in NRPPa from LMF to serving gNB and neighbour gNBs:* 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, …, 16}See CPP-26 also. |
| 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.FFS why parameter values for duration of time window in number of consecutive symbols is not defined.Wait for RAN1 progress on parameters discussions. |
| CPP-32 | Each DL RSCP/RSCPD measurement instance is obtained with $N\_{sample}=1$ 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. |
| 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. May be the carrier frequency associated with the PFL needs to be reported as part of RSCP/RSCPD measurement. |
| 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 Request location information message sent to target UE for UE-based CPP positioning.NR-DL-TDOA-RequestLocationInformation IE (sent to target UE) to be extended to include the timestamp associated with the RSCPD measurement from PRU.NR-Multi-RTT-RequestLocationInformation IE (sent to target UE) to be extended to include the timestamp associated with the RSCP 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.

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| Answers to Question 1 |
| Company | Ref | Comments |
| Intel | CPP-01CPP-03CPP-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.AgreementIntroduce 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.ConclusionFrom 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. |
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**Summary 1**: TBD.

**Proposal 1**: TBD.

## 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**.

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| 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

ConclusionThe 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 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:**No RAN2 impacts for short switching time for RF retuning between adjacent hops. FFS if RAN1 and/or RAN4 parameters list results in any configuration signalling impacts for RAN2. |
| 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
 | 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. |
| 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. |
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| 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 hopping and that 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.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:**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.NRPPa specification needs update to have serving gNB signal the ‘SRS for positioning’ Tx frequency hopping pattern that is configured for the UE. The 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 upto RAN3 to discuss and decide.FFS: Exact ‘SRS for positioning’ Tx frequency hopping patterns possible and how to characterize it depends on further inputs from RAN1. See RED-14. |
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| 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 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.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 FFS depending 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:**Ensure that measurement gap configuration for measurement of PRS with Rx frequency hopping is applicable for both RRC\_INACTIVE and RRC\_IDLE RedCap UEs. |
| 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.
 | Wait for RAN1 progress on parameters for RedCap positioning. |
| 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:**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 FFS depending 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.

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| Answers to Question 2 |
| Company | Ref | Comments |
| Intel | RED-03RED-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. |
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**Summary 2**: TBD.

**Proposal 2**: TBD.

## 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**.

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| 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.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.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. |
| 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) |
| 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. |
| 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.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 |
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| 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. |
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| 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:**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.- 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. |
| 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:**There is no impact to RAN2. |
| 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 $P\_{cmax}\left(i\right).$ * 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. |
| 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. |
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| 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. |
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| 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.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.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. |
| 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:**This is about UE behaviour for joint/aggregated measurement in terms of how it prioritizes the TRPs/PRS resource sets for the measurement. This could be clarified under in a field description under NR-DL-PRS-AssistanceData IE. |
| 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 by serving gNB (RRC 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
 | **UE 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. |
| 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.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.

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| Answers to Question 3 |
| Company | Ref | Comments |
| Intel | BWA-01/02/18BWA-07BWA-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-RequestLocationInformationRapp: 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. |
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**Summary 3**: TBD.

**Proposal 3**: TBD.

# 4 Conclusion

TBD.