**3GPP TSG RAN WG1 #113 R1-2304941**

**Incheon, Korea, May 22nd – May 26th, 2023**

**Agenda Item: 9.16.2**

**Source: Moderator (AT&T)**

**Title: Summary of UE features for expanded and improved NR positioning**

**Document for:** **Discussion/Decision**

# Introduction

This document presents the summary of email discussion [113-R18-UE\_features-02] during RAN1 #113. According to the Chairman’s Notes:

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| [113-R18-UE\_features-02] Email discussion on UE features for MIMO, positioning, NCR, NR-NTN, IoT-NTN, BWP without restriction – Ralf (AT&T)* To be used for sharing updates on online/offline schedule, details on what is to be discussed in online/offline sessions, tdoc number of the moderator summary for online session, etc
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The following was discussed and/or agreed during RAN1 #113 within the scope of [113-R18-UE\_features-02]. All proposals are based on the latest RAN1 UE features list for Rel-18 in [1].

# Summary of Contributions Submitted to RAN1 #113

The following is the moderator’s summary of contributions submitted to RAN1 #113 in this agenda item.

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| Company | Summary |
| Vivo [2] | **UE features for sidelink positioning**UE features for SL positioning reference signalFirstly, SL-PRS transmission and reception are introduced in SL positioning, which is a new signal compared to Rel-16/Rel-17 NR sidelink. Therefore, a UE capability of supporting transmission SL-PRS should be defined. In addition, similar to NR sidelink, a UE may not have the capability of reception SL-PRS, which is beneficial for the cost of UE. So, a UE feature of supporting reception of SL-PRS can be introduced.For the feature related to SL positioning reference signal, the comb-based and TDMed-based multiplexing in a slot are introduced for SL-PRS in the dedicated resource pool, and TDMed based multiplexing is not supported for SL-PRS for SL-PRS in the shared resource pool.

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| **Agreement** TDM-based multiplexing of SL PRS from different UEs in a slot is supported at least for dedicated resource pools.* FFS: TDM-based multiplexing of SL PRS from different UEs in a slot for shared resource pools.
* FFS: Details, including resource granularity and relationship to SCI/PSCCH associated with the SL PRS resources, additional AGC symbols.
* FFS: restrictions for the configuration of TDM-based multiplexing of SL PRS from different UEs in a slot, if any
* FFS: which resource allocation schemes are applicable
* FFS: whether or not this is a separate UE capability

**Agreement** * Comb-based multiplexing of SL PRS from different UEs in a slot is supported at least for dedicated resource pools.
	+ FFS: Comb-based multiplexing of SL PRS from different UEs in a slot for shared resource pools.
* For comb-based multiplexing of SL PRS from different UEs, support at least the case wherein a single (M,N) value is possible .
	+ FFS: Whether to support comb-based multiplexing of SL PRS from different UEs in a slot using multiple (M,N) values.
* FFS: additional restrictions (if any) due to e.g. the impact of synchronization and IBE interference between UEs

**Agreement**TDM-based multiplexing in a slot of SL PRS from different UEs is NOT supported for a shared resource pool. |

Correspondingly, the UE feature indicating the support of TDMed multiplexing and/or comb-based multiplexing of SL-PRS from different UEs in a slot should be introduced. Whether that should be mandatory or optional configured can be FFS. * ***For SL positioning reference signal, support the following UE features***
* ***Whether to support the transmission of SL-PRS***
* ***Whether to support the reception of SL-PRS***
* ***Whether to support TDMed multiplexing of SL-PRS from different UEs in a slot.***
* ***Whether to support comb-based multiplexing of SL-PRS from different UEs in a slot.***
* ***Other detailed UE features can wait for the progress in AI 9.5.1***

Besides, the open loop power control based for SL-PRS has been supported for SL-PRS, and in NR sidelink, it should indicate whether the UE supports the use of P0 parameters (i.e. dl-P0-PSSCH-PSCCH-r17, sl-P0-PSSCH-PSCCH-r17, dl-P0-PSBCH-r17, dl-P0-PSFCH-r17) for sidelink open loop power control. These power control parameters are based on PSSCH and/or PSCCH. In SL positioning, the power control may be based on the measurement of SL-PRS. Therefore, the UE feature indicating whether the UE supports power control based on SL PRS, e.g., the use of power control parameters for SL-PRS may need to be introduced.* ***The UE feature indicating whether the UE supports power control based on SL PRS (e.g., the use of power control parameter(s) for SL-PRS) should be introduced.***

UE features for Measurement and reporting for sidelink positioningFor SL measurement, the basic UE features of SL PRS processing capability should be introduced referring to FG 13-1, the common SL PRS Processing Capability is provided as follows. In addition, considering the support of shared and dedicated resource pool, separate SL PRS processing capabilities for a shared and dedicated resource pool will be introduced.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Common SL PRS Processing Capability | 1. Maximum SL PRS bandwidth in MHz, which is supported and reported by UE.

a) FR1 bands: {5, 10, 20, 40}b) FR2 bands: {50, 100}1. SL PRS buffering capability: Type 1 or Type 2
2. Type 1 – sub-slot/symbol level buffering
3. Type 2 – slot level buffering
4. Duration of SL PRS symbols N in units of ms a UE can process every T ms assuming maximum SL PRS bandwidth in MHz, which is supported and reported by UE.
5. T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
6. N: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms
7. Max number of SL PRS resources that UE can recept and process in a slot under it
	1. FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHz
	2. FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz
 |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |

In addition, the support of measurement type (e.g. Rx-Tx, RSTD, RSRP etc), and the support of simultaneous processing for different measurement types needs to be introduced as part of UE features. We provide two examples as following.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SL-PRS based Rx-Tx measurement | 1. The support type of SL-PRS based Rx-Tx measurement (e.g.,single sided, double sided)
2. Max number of SL-PRS based Rx–Tx time difference measurements corresponding to a single UE
 |  | No | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| the support of simultaneous processing | 1. Support of simultaneous processing for SL-PRS based Rx-Tx measurement and SL-PRS based AoA measurements
2. ….
 |  | No | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |

Therefore, we propose* ***Regarding UE feature group of SL Positioning measurement and reporting, support the following:***
* ***SL PRS Processing Capability and FG 13-1 can be as starting point***
* ***The support of measurement type (e.g. Rx-Tx, RSTD, RSRP etc.)***
* ***The support of simultaneous processing for different measurement types (e.g., timing&AoA&RSRP)***
* ***Other detailed UE features can wait for the progress in AI 9.5.1***

UE features for SL-PRS resource allocation Firstly, the resource allocation for shared resource pool with Rel-16/17/18 sidelink communication and dedicated resource pool for SL PRS should be supported as part of UE features.Then, it has been agreed that support scheme 1 based and scheme 2 based resource allocation for SL-PRS. For scheme 2 based resource allocation, sensing based and random selection resource allocation have been supported. Therefore, the UE capability of indicating whether transmitting scheme 1 and scheme 2 are supported should be introduced. And for scheme 2 resource allocation, the UE capability of supporting random resource selection for SL-PRS should be further introduced.Considering the inter-UE coordination and congestion control procedure have not been fulfilled, it can be further determined to wait for the process of detailed design.* ***Regarding the resource allocation for SL-PRS, support the following UE features***
* ***Resource allocation for shared resource pool and/or dedicated resource pool***
* ***Scheme 1 based resource allocation scheduled by Uu.***
* ***Scheme 2 based resource allocation.***
* ***Scheme 2 based resource allocation with random resource selection.***
* ***UE capabilities for inter-UE coordination and congestion control can be further introduced wait for the process of detailed design.***
* ***Other detailed UE features can wait for the progress in AI 9.5.1***

**UE features for carrier phase positioning**For carrier phase positioning, the basis UE feature is the support of carrier phase measurement and report. The example UE feature is provided as follows.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Carrier phase measurement and report together with TDOA positioning | 1. NR DL reference carrier phase difference per pair of TRPs. Values = {1, 2, 3, 4}
2. Support of carrier phase difference reporting for first path
3. Support of additional path carrier phase difference reporting for K additional path. K={2, 4, 6 , 8}
 | 13-3 and 13-6 | No | N/A |  |  | No | Yes | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| Carrier phase measurement and report together with Multi-RTT positioning | 1. DL reference carrier phase (DL RSCP) per TRP. Value={1, 2, 3, 4}
2. Support of carrier phase reporting for first path
3. Support of additional path carrier phase reporting for K additional path. K={2, 4, 6 , 8}
 | 13-4 and 13-11 | No | N/A |  | Per CC | No | Yes | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |

Therefore, we propose* ***Regarding UE feature group of carrier phase positioning together with TDOA positioning, support the following:***
* ***The number of carrier phase difference measurements per pair of TRPs***
* ***The support of carrier phase difference reporting for first path***
* ***The Support of additional path carrier phase difference reporting for K additional path***
* ***Regarding UE feature group of carrier phase positioning together with Multi-RTT positioning, support the following:***
* ***The number of carrier phase per TRP***
* ***The support of carrier phase reporting for first path***
* ***The support of additional path carrier phase reporting for K additional path***

In addition, considering the following agreement, the support of the measurement within indicated time window needs to be introduced to enable simultaneous measurements on the same DL PRS by a target UE and a PRU.

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| **Agreement**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.
 |

Therefore, we propose* ***Regarding UE feature group of carrier phase positioning, support the following:***
* ***Support of performing PRS measurement within MG within indicated time window***

UE features for LPHAPFirstly, according to the WID, it can be seen that ‘specify DL PRS measurements for a UE in RRC\_IDLE state and reporting of the measurements in RRC\_CONNECTED state’. Therefore, from RAN1 perspective, the capability of DL PRS measurements for a UE in RRC\_IDLE should be supported, and all the UE features and corresponding components of RRC\_INACTIVE can be reused.In addition, for another objective of ‘SRS configuration enhancements based on SRS positioning validity area to avoid frequent RRC connection for SRS (re)configuration’, the following agreement was made in RAN1#112bis-e.

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| **Working assumption**For the power control of an SRS for positioning configuration in multiple cells for a UE in RRC\_INACTIVE state, support the following options:* + Option 1: Pathloss RS is absent in the configuration.
	+ Option 2: Pathloss RS is provided in the configuration.

**Working assumption**For the spatial relation of an SRS for positioning configuration in multiple cells for UEs in RRC\_INACTIVE state, support that spatial relation information can be absent or present in the configuration.**Agreement**For the spatial relation of an SRS for positioning configuration in multiple cells for UEs in RRC\_INACTIVE state:* + When the spatial relation information is absent in the configuration, the UE may use a fixed spatial domain transmission filter for transmissions of the SRS configured by the higher layer parameter SRS-PosResource across multiple SRS resources or it may use a different spatial domain transmission filter across multiple SRS resources;
	+ When the spatial relation information is provided in the configuration, it is applicable across the cells within the SRS positioning validity area. Further study the configuration details.
		- FFS: spatial relation information validity criteria, and whether/how to determine UE fallback behavior if validity criteria for spatial relation of the configured RS is not met.

**Agreement**For the power control of an SRS for positioning configuration in multiple cells for a UE in RRC\_INACTIVE state, when pathloss RS is absent in the configuration, the UE determines the pathloss RS using a RS resource obtained from the SS/PBCH block of the camping cell that the UE uses to obtain MIB as the pathloss RS.**Agreement**For the power control of an SRS for positioning configuration in multiple cells for a UE in RRC\_INACTIVE state, when pathloss RS is provided in the configuration, support one or multiple of the following alternatives on how to configure pathloss RS (down-selection to be made in RAN1#113 meeting):* + Alt. 2-1: Reuse the configuration of pathloss RS in Rel-17;
		- Reuse the validity criteria of OPLC for SRS transmissions by RRC\_INACTIVE UEs in Rel-17, i.e. when the pathloss RS cannot be accurately measured. When the validity criteria of OPLC fail, pathloss is calculated based on the RS resources obtained from SS/PBCH block of the new camping cell that the UE uses to obtain MIB.
	+ Alt. 2-4: Configure a list of candidate pathloss RSs or candidate cells per SRS for positioning resource set. The UE transmits SRS resources in a SRS resource set using a pathloss RS determined from the candidate pathloss RSs based on its DL measurements on the candidate pathloss RSs;
		- FFS: whether/how to define validity criteria of OLPC and UE fallback behavior if validity criteria fail.
	+ Alt. 2-5: Reuse the configuration of pathloss RS in Rel-17. The UE only transmits SRS resources in a SRS resource set associated with pathloss RS that can be accurately measured.
		- FFS: whether/how to define validity criteria of OLPC and UE fallback behavior if validity criteria fail.
	+ Alt. 2-6: Reuse the configuration of pathloss RS in Rel-17;
		- A cell-agnostic DL RS can be the pathloss RS in the validity area and the cell-agnostic DL RS itself.
	+ Note: UE power consumption should be considered
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Based on above agreements, we have not found a direct conclusion about UE capability, and further RAN1 and RAN2 progress is required.* ***For LPHAP, support the UE feature of DL PRS measurements for a UE in RRC\_IDLE***
* ***All the FGs and corresponding components of RRC\_INACTIVE can be reused***
* ***Regarding other UE features, wait for further RAN1 and RAN2 progress.***

**UE features for Bandwidth aggregation**2.4.1 UE feature group for DL PRS bandwidth aggregationFor DL PRS bandwidth aggregation, the basis UE feature (i.e., PRS processing capability) in RRC connected and inactivated state should be introduced. And we provide the example as follows

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| Common DL PRS Processing Capability for DL bandwidth aggregation in RRC connected and inactivated state | 1. The maximum number of supported aggregated PFLs(value:2,3) in a set of contiguous PFLs
2. Maximum aggregated DL PRS bandwidth in MHz, which is supported and reported by UE.

a) FR1 bands: {~~5, 10, 20, 40, 50,~~ 80, 100, 160, 200M}b) FR2 bands: {50, 100, 200, 400, 600, 800}1. DL PRS buffering capability: Type 1 or Type 2
	1. Type 1 – sub-slot/symbol level buffering
	2. Type 2 – slot level buffering
2. Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum aggregated DL PRS bandwidth in MHz, which is supported and reported by UE.
	1. T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
	2. N: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms
3. Max number of aggregated DL PRS resources that UE can process in a slot under it
	1. FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHz
	2. FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz

Note: The above parameters are reported assuming a configured measurement gap and a maximum ratio of measurement gap length (MGL) / measurement gap repetition period (MGRP) of no more than 30%. | 13-1 | No | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported.Notes for component 3:a.UE reports one combination of (N, T) values per band, where N is a duration of DL PRS symbols in ms processed every T ms for a given maximum bandwidth (B) in MHz supported by UEb.UE is not expected to support DL PRS bandwidth that exceeds the reported DL PRS bandwidth value~~c.UE DL PRS processing capability is defined for a single positioning frequency layer. UE capability for simultaneous DL PRS processing across positioning frequency layers is not supported in Rel.16 (i.e. for a UE supporting multiple positioning frequency layers, a UE is expected to process one frequency layer at a time)~~d.UE DL PRS processing capability is agnostic to DL PRS comb factor configuratione.The reporting of (N, T) values for maximum BW in MHz is not dependent on SCSNote: if the UE does not indicate this capability for a band or band combination, the UE does not support this positioning method in this band or band combination. | Optional with capability signaling |

Therefore, we propose* ***Regarding UE feature group of DL PRS bandwidth aggregation, support the following:***
* ***DL PRS Processing Capability for DL PRS bandwidth aggregation and FG 13-1 can be as a starting point***
	+ ***The applicable state: RRC connected and/or inactive state***
	+ ***The support of maximum number of supported aggregated PFLs***
	+ ***The support of the larger than 100M for FR1 or 400M for FR2***

UE feature group for UL SRS bandwidth aggregationFor UL SRS bandwidth aggregation, the basis feature is the support of simultaneous positioning SRS for UL bandwidth aggregation within a band across multiple carries.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| simultaneous positioning SRS for UL bandwidth aggregation within a band across multiple carries. | 1. The maximum number of supported aggregated carriers(value:2,3) in a set of contiguous carriers
2. Maximum aggregated UL SRS bandwidth in MHz, which is supported and reported by UE.

a) FR1 bands: { 80, 100, 160, 200M}b) FR2 bands: {50, 100, 200, 400, 600, 800}1. The support of periodic/semi-persistent/aperiodic UL SRS for UL bandwidth aggregation

Note: The support of simultaneous positioning SRS for UL bandwidth aggregation means the condition can be supported (e.g., the same PAPR across carriers., phase continuity across carriers | 13-8 | Yes | N/A |  | Per band | N/A | N/A | N/A | RAN1 kindly requests RAN2 to decide on the necessity for location server to know if the feature is supported | Optional with capability signaling |

* ***Regarding UE feature group of UL SRS bandwidth aggregation, support the following:***
	+ ***simultaneous positioning SRS for UL bandwidth aggregation within a band across multiple carries***
	+ ***The applicable state: RRC connected and/or inactive state***
	+ ***The support of maximum number of supported aggregated carriers***
	+ ***The support of the larger than 100M for FR1 or 400M for FR2***
	+ ***The support of SRS type for UL bandwidth aggregation***

**UE features for RedCap positioning**Switching time for frequency hoppingBased on RAN4 LS [2], for RedCap positioning frequency hopping, the switching time between hops can be the following.

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| * For RedCap UE UL SRS Tx frequency hopping, RAN4 considers the switching time of {70us, 140us} for FR1 as the starting point
	+ SRS Tx frequency hopping range can be up to 100MHz.
	+ Which specific value for frequency hopping is applied depends on UE capability, if multiple values are agreed.
* For UL SRS Tx frequency hopping, RAN4 considers the switching time of {35us, 70us, 140us} for FR2 as the starting point
* SRS Tx frequency hopping range can be up to 400MHz
* Which specific value for frequency hopping is applied depends on UE capability, if multiple values are agreed
* For RedCap UE DL PRS Rx frequency hopping, RAN4 considers the switching time of {70us, 140us} for FR1 as the starting point
	+ PRS Rx frequency hopping range can be up to 100MHz
	+ Which specific value for frequency hopping is applied depends on UE capability, if multiple values are agreed
* For DL PRS Rx frequency hopping, RAN4 considers the switching time of {35us, 70us, 140us} for FR2 as the starting point
* PRS Rx frequency hopping range can be up to 400MHz
* Which specific value for frequency hopping is applied depends on UE capability, if multiple values are agreed
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Switching time can be UE capability for DL Rx and UL Tx frequency hopping. However, from UE perspective, current values of switching time may be too challenging. For example, in FR1, with the SCS of 30kHz, the UE needs to complete the switching within 4 symbols at most; while with the SCS of 15kHz, the UE has to complete the switching within 2 symbols. Considering low power and low complexity features of RedCap UEs, large switching time should be introduced up to UE capability, such as 210us, 500us for FR1, 210us for FR2.* ***For RedCap positioning, support the switching time between hops as a UE capability***
* ***The following values of the switching time should be additionally supported.***
* ***210us, 500us for FR1***
* ***210 us for FR2***

DL PRS Rx frequency hoppingRegarding DL PRS Rx frequency hopping reporting, the following agreement was made in RAN1#112 and RAN1#112bis-e.

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| **Agreement(RAN1#112)**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

**Agreement(RAN1#112)**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

**Agreement(RAN1#112bis)**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 [or more] measurements where each 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
 |

Correspondingly, for DL PRS Rx hopping reporting, the following UE capabilities should be introduced.* Rx frequency hopping using a measurement gap
* Rx frequency hopping within a DL PRS resource
* Single measurement based on receiving multiple hops
* One [or more] measurements with each based on one received hop

For other capabilities for DL PRS Rx hopping, it may be necessary to wait further for corresponding progress. For example, for MG-based Rx hopping operations, the details of PRS Rx hopping is dependent on RAN4 requirement, and it is still not clear which capabilities are needed, and how these capabilities work. In our view, the UE capability of detailed Rx hopping can also be determined by RAN4 together with other Rx hopping details.* ***For PRS Rx frequency positioning, support following UE features***
* ***Rx frequency hopping using a measurement gap***
* ***Rx frequency hopping within a DL PRS resource***
* ***Single measurement based on receiving multiple hops***
* ***One [or more] measurements with each based on one received hop***
* ***The UE features of other detailed Rx hopping can be determined by RAN4 together with other Rx hopping details.***

SRS for positioning frequency hoppingRegarding SRS for positioning hopping, the following agreement was made in RAN1#112 and RAN1#112bis-e.

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| **Agreement (RAN1#112)**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

**Agreement (RAN1#112bis)**For RedCap UEs, SRS for positioning Tx frequency hopping is configured within one SRS for positioning resource.**Agreement (RAN1#112bis)**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.

**Agreement (RAN1#112bis)**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, study whether to support one or both of the following options, according to UE capabilities:* Option 1: UL time window where the UE is not expected to receive/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: additional collision rules between the UL SRS with frequency hopping and other UL and DL signals/channels
	+ FFS: details on the collision rules
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Correspondingly, for SRS for positioning hopping, the following UE capabilities should be introduced.* Separate configuration from existing BWP configuration
* Configuration within one SRS for positioning resource
* Overlapping bandwidth
* ***For SRS for positioning frequency positioning, support following UE features.***
* ***Separate configuration from existing BWP configuration***
* ***Configuration within one SRS for positioning resource***
* ***Overlapping bandwidth***
* ***The other UE features can further wait for the progress of detailed frequency hopping design.***
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| Huawei/HiSilicon [3] | **SL positioning**RRC/SLPP/LPPSince SL positioning involve both RRC procedures (e.g. resource pool level parameters, resource allocation, etc.) and SLPP procedures (assistance data, measurement request/report), the UE capabilities should be considered for both the ones reported to gNB and the ones reported to a UEs or a LMF.***Proposal 1: Define UE capabilities from RRC and SLPP/LPP perspective.***With regards to how to capture the corresponding capability reporting options, Rel-16/Rel-17 labeling (“need for gNB to know”, “need for the location server to know”) can be reused. In addition, we think that another labeling of “need for a UE to know” should also be introduced.***Proposal 2: Reuse the current labelling of “need for gNB to know” and “need for the location server to know”, and add a new labeling of “need for a UE to know”.***Basic feature groupsFor the first release of SL positioning, there may be some discussions on whether or not a basic feature group that correspond to the minimum common set of features to allow SL positioning to operate should be defined.According to our understanding, it may be challenging to converge on the need for such a basic FG or any components pertaining to the “basic FG” without seeing the overall UE feature structure, and thus we prefer to hold on such a discussion.***Proposal 3: The discussion on the basic FG for SL positioning should be on-hold.***Below is our initial preference on the structure of UE feature group.

|  |  |  |  |
| --- | --- | --- | --- |
| Description | Components | Type | Need to know |
| gNB | LMF | UE |
| SL-PRS transmission in shared RP | 1. Support SL-PRS transmission in shared resource pool 2. Support SL-PRS open loop power control3. Support SCI formats indicating SL-PRS | Per band | X | X | X |
| SL-PRS transmission in dedicated RP | 1. Support SL-PRS transmission in shared resource pool and dedicated resource pool2. Support SL-PRS open loop power control3. Support periodic reservation and non-periodic reservation for SL-PRS transmission4. Support SCI formats indicating SL-PRS | Per band | X | X | X |
| SL-PRS reception in shared RP | 1. Support SL-PRS reception in shared resource pool2. Support RSRP reporting for open loop power control3. Support receiving SCI formats indicating SL-PRS | Per band | X | X | X |
| SL-PRS reception in dedicated RP | 1. Support SL-PRS reception in dedicated resource pool2. Support RSRP reporting for open loop power control3. Support receiving SCI formats indicating SL-PRS | Per band | X | X | X |
| SL-PRS resource allocation scheme 1 | 1. Support dynamic grant, configured grant type 1, and configured type 2 for SL-PRS transmission | Per band | X |  |  |
| SL-PRS resource allocation scheme 2 | 1. Support sensing-based resource allocation and random resource selection2. Support congestion control for SL-PRS | Per band | X |  |  |
| SL-PRS transmission request | 1. Support transmitting SL-PRS transmission request via lower layers2. Support receiving SL-PRS transmission request via lower layers | Per band |  |  | X |
| Inter-UE coordinate for SL-PRS in scheme 2 | 1. Support to recommend SL-PRS resource for the purpose of resource selection of another UE in scheme 2 resource allocation2. Support to receive the recommendation from another UE for the purpose of resource selection in scheme 2 resource allocation | Per band |  |  | X |
| SL RSTD measurement | Support SL RSTD measurement reporting | Per band |  | X | X |
| SL RTOA measurement | Support SL RTOA measurement reporting | Per band |  | X | X |
| UE Rx – Tx time difference measurement | Support UE Rx – Tx time difference measurement reporting | Per band |  | X | X |
| SL PRS-RSRP measurement | Support SL PRS-RSRP measurement reporting | Per band |  | X | X |
| SL PRS-RSRPP measurement | Support SL PRS-RSRPP measurement reporting | Per band |  | X | X |
| SL AoA measurement  | Supported SL AoA measurement reporting: {LCS without translation, LCS with or without translation and GCS} | Per band |  | X | X |

**CPP**With regards to CPP, we think the UE feature structure could follow the first path RSRPP. We can consider two FGs, one for DL-TDOA, and the other for Multi-RTT.

|  |  |  |  |
| --- | --- | --- | --- |
| Description | Components | Type | Need to know |
| gNB | LMF |
| First path RSCPD measurement for UE-assisted DL-TDOA | Support first path RSCPD measurement reporting for UE-assisted DL-TDOA | Per band |  | X |
| First path RSCP measurement for Multi-RTT | Support first path RSCP measurement reporting for Multi-RTT | Per band |  | X |
| UE-based CPP | Support assistance data for UE-based CPP | Per UE |  | X |
| CPP measurement window | Support the CPP measurement window | Per UE |  | X |

**LPHAP**For LPHAP, we think that RAN1 could only consider the feature related to multi-cell SRS configuration and RRC\_IDLE state positioning. The following structure can be considered.For RRC\_IDLE state positioning, we think that the existing RRC\_INACTIVE state positioning capabilities should be reused, therefore, we think that UE supporting RRC\_IDLE state positioning should support RRC\_INACTIVE state positioning

|  |  |  |  |
| --- | --- | --- | --- |
| Description | Components | Type | Need to know |
| gNB | LMF |
| SRS positioning validity area | 1. Support SRS configuration valid across multiple cells.2. Support SRS pathloss based on the SSB from the camping cell3. Support using SRS Tx timing based on the current camping cell DL timing and the TA command from the last serving cell | Per band | X | X |
| PRS measurement in RRC\_IDLE | 1. Support PRS measurement in RRC\_IDLENote: UE shall also support PRS measurement in RRC\_INACTIVE for the band. The processing capabilities are the same as that for the RRC\_INACTIVE state | Per band | X | X |

**BW aggregation**For BW aggregation, we consider the following FGs.

|  |  |  |  |
| --- | --- | --- | --- |
| Description | Components | Type | Need to know |
| gNB | LMF |
| PRS BW aggregated measurement within MG in RRC\_CONNECTED state | 1. Supported bandwidth class for PRS BW aggregation2. Supported (N, T) value3. Number of aggregated PRS resources that UE can process within a slot | Per band |  | X |
| PRS BW aggregated measurement in RRC\_INACTIVE state | 1. Supported bandwidth class for PRS BW aggregation2. Supported (N, T) value3. Number of aggregated PRS resources that UE can process within a slot | Per band |  | X |
| SRS BW aggregated transmission in RRC\_CONNECTED state | 1. Supported bandwidth class for SRS BW aggregation2. Number of aggregated SRS resources within a slot3. Support the same SRS power reduction across aggregated carriers | Per band | X | X |
| SRS BW aggregated transmission in RRC\_INACTIVE state | 1. Supported bandwidth class for SRS BW aggregation2. Number of aggregated SRS resources within a slot3. Support the same SRS power reduction across aggregated carriers | Per band | X | X |

**RedCap UE positioning**For RedCap UE positioning, RAN4 agreed the switching time in their LS R1-2304316, we assume that those features should be captured in RAN4’s UE feature list. ***Observation 1: It is expected that RAN4 will capture the switching time capability in their UE feature list.***From RAN1 perspective, we consider the following FGs of SRS frequency hopping transmission.

|  |  |  |  |
| --- | --- | --- | --- |
| Description | Components | Type | Need to know |
| gNB | LMF |
| SRS frequency hopping transmission for RRC\_CONNECTED state | 1. Support of SRS transmission outside the active UL BWP.2. Support the configuration of positioning SRS resource with frequency hopping. | Per FS | X | X |
| SRS frequency hopping transmission for RRC\_INACTIVE state | 1. Support of SRS transmission outside the initial UL BWP.2. Support the configuration of positioning SRS resource with frequency hopping. | Per band | X | X |

 |
| CATT [4] | **Sidelink positioning related UE features**The following agreements had been agreed in RAN1#112 related to UE features for sidelink positioning [1].

|  |
| --- |
| **Agreement** Support SCS values for SL PRS include:* 15 kHz, 30 kHz, 60 kHz for FR1, and 60 kHz, 120 kHz for FR2
	+ Which SCS values are required, and which ones are optional follow Rel-16 UE capabilities.

**Agreement** TDM-based multiplexing of SL PRS from different UEs in a slot is supported at least for dedicated resource pools.* FFS: TDM-based multiplexing of SL PRS from different UEs in a slot for shared resource pools.
* FFS: Details, including resource granularity and relationship to SCI/PSCCH associated with the SL PRS resources, additional AGC symbols.
* FFS: restrictions for the configuration of TDM-based multiplexing of SL PRS from different UEs in a slot, if any
* FFS: which resource allocation schemes are applicable
* FFS: whether or not this is a separate UE capability
 |

According to the above 1st agreement, RAN1 has agreed that the supporting SCS values for SL PRS transmission include 15 kHz, 30 kHz, 60 kHz for FR1, and 60 kHz, 120 kHz for FR2. Which SCS values are required, and which ones are optional follow Rel-16 UE capabilities. Then, Rel-16 UE capabilities on SCS values for SL data transmission should be reused for Rel-18 UE capabilities on SCS values for SL PRS transmission.Therefore, regarding the UE capabilities to support SCS values for SL PRS, the following component S1 should be included, which follow Rel-16 UE capabilities:* Component S1 name: UE can receive using certain subcarrier spacing(s) with normal CP in FR1, certain subcarrier spacing(s) with normal CP in FR2.
* Component S1 candidate values:
	+ Candidate value set in FR1: {{15 kHz}, {30 kHz}, {60 kHz}, {15, 30 kHz}, {30, 60 kHz}, {15, 60 kHz}, {15, 30, 60 kHz}}
	+ Candidate value set in FR2: {{60 kHz}, {120 kHz}, {60, 120 kHz}}.

**Proposal : Regarding the UE capabilities to support SCS values for SL PRS, the following component S1 should be included, which follow Rel-16 UE capabilities:*** **Component S1 name: UE can receive using certain subcarrier spacing(s) with normal CP in FR1, certain subcarrier spacing(s) with normal CP in FR2.**
* **Component S1 candidate values:**
	+ **Candidate value set in FR1: {{15 kHz}, {30 kHz}, {60 kHz}, {15, 30 kHz}, {30, 60 kHz}, {15, 60 kHz}, {15, 30, 60 kHz}}**
	+ **Candidate value set in FR2: {{60 kHz}, {120 kHz}, {60, 120 kHz}}.**

According to the above 2nd agreement, RAN1 has agreed that TDM-based multiplexing of SL PRS from different UEs in a slot is supported at least for dedicated resource pools. Whether or not this is a separate UE capability should be further studied. In our view, TDM multiplexing of SL-PRS from different UEs in a slot means that the UE needs to detect and decode the starting OFDM symbols and occupied OFDM symbols of multiple possible SL-PRS resources in the same time slot, which means higher hardware requirements for the UE. Therefore, TDM-based multiplexing of SL PRS from different UEs in a slot for dedicated resource pools should be a separate UE capability, corresponding component S2 as follows: * Component S2 name: UE can transmit TDM-based multiplexing of SL PRS with another UE(s) in a slot for dedicated resource pool(s).
* Component S2 candidate values: {support, not support}.

**Proposal : TDM-based multiplexing of SL PRS from different UEs in a slot for dedicated resource pools should be a separate UE capability, corresponding component S2 as follows:** * **Component S2 name: UE can transmit TDM-based multiplexing of SL PRS with another UE(s) in a slot for dedicated resource pool(s).**
* **Component S2 candidate values: {support, not support}.**

**Carrier phase positioning related UE features**In this section, we discuss the UE features related to NR carrier phase positioning based on the following agreements.

|  |
| --- |
| **Agreement**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

**Agreement**For NR DL reference signal carrier phase difference (RSCPD) measurement for NR CPP, the RSCPD is defined as the difference of RSCPs measured from the DL PRS signals from target TRP and reference TRP.* FFS: whether/how to define per path RSCPD
* Note: Whether/how to capture the above definition into TS 38.215 depends on whether RAN1 decides to introduce DL carrier phase difference measurement for NR CPP

**Agreement**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

**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.

**Agreement**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

**Agreement**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.

**Agreement**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
 |

**UE Capabilities for CPP**Based on RAN1’s agreements, the NR DL carrier phase measurement is measured at the same time as legacy measurements from the same DL PRS signals and reported together with the legacy measurements. For UE-assisted CPP, DL RSCP can be reported together with UE Rx – Tx time difference measurement. DL RSCPD can be reported together with RSTD measurement. 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. In addition, RAN1 has agreed to support 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 and UE in RRC\_ INACTIVE state. It is still FFS for UE in RRC\_CONNECTED state without measurement gap.Thus, it is reasonable to propose introduce a new UE capability for supporting the CPP, and under which there will be separate capabilities for different scenarios.**Proposal : Introduce a new UE capability for UE supporting CPP, and additional capabilities for supporting CPP in different scenarios. For example,*** **FG x-1: Supporting CPP.**
* **FG x-1a: Simultaneously reporting RSCPD with RSTD measurement.**
* **FG x-1b: Simultaneously reporting RSCP with UE Rx-Tx time difference measurement.**
* **FG x-1c: UE-based CPP.**
* **FFS: where the capability is per UE, or per FR1/FR2, or per band.**
* **FFS: where to have separate capability for RRC\_CONNECTED and RRC\_INACTIVE modes.**

Common DL PRS Processing Capability for CPPThe Table 5.1.5-1 in TR 38.822 [3] provides the Layer-1 feature list for NR positioning. Among them, FG 13-1 defines the Common DL PRS Processing Capability for UE DL PRS processing for a single positioning frequency layer, which includes the components of: a) Maximum DL PRS bandwidth in MHz; 2) DL PRS buffering capability; 3) DL PRS symbols N in units of ms a UE can process every T ms; and 4) Max number of DL PRS resources that UE can process in a slot. For Rel-18 CPP, CPP only supports a single PFL. Based on RAN1’s agreements, the NR DL carrier phase measurement can be measured at the same time as legacy measurements from the same DL PRS signals and reported together with the legacy measurements. Thus, it is reasonable to propose FG 13-1 Common DL PRS Processing Capability also applies to all DL PRS measurements incuding the carrier phase measurements.**Proposal : Conclude that FG 13-1 Common DL PRS Processing Capability defined in TR 38.822 is applicable also applicable to DL CPP.**DL PRS Resources Capability for CPPIn TR 38.822, UE’s capability for processing the maximum number of DL PRS resources per DL per DL PRS Resource Set and Max number of DL PRS Resources per positioning frequency layer are defined separately for different positioning methods. For example, FG 13-3 defines “the DL PRS Resources for DL-TDOA”, under which FG 13-3a defines “DL PRS Resources for DL-TDOA on a band”, and FG 13-3b defines “DL PRS Resources for DL-TDOA on a band combination”. For Rel-18, RAN1 has reached the agreement to support reporting RSCPD with RSTD measurements and RSCP with the UE Rx-Tx time difference measurements. Therefore, it is reasonable to propose that for a UE that supports RSCPD, its capability of DL PRS Resources for DL-TDOA as indicated by FG 13-3 and FG 13-3a apply to RSCPD. It should be noted that FG 13-3b is not applicable for CPP in Rel-18, since in Rel-18 only single DL PFL is supported. Similarly, for a UE supports RSCP, its capability of FG 13-4 and FG 13-4a for DL PRS Resources for Multi-RTT also apply to RSCP.**Proposal : The following capabilities of a UE for DL-TDOA in a DL PFL also apply to RSCPD if the UE supports reporting RSCPD together with RSTD measurements in the DL PFL:*** **In FG 13-3,**
* **Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE.**
* **Max number of TRPs across all positioning frequency layers per UE**
* **In FG 13-3a**
* **Max number of DL PRS Resources per DL PRS Resource Set**

**Proposal : The following capabilities of a UE for Multi-RTT in a DL PFL also apply to RSCP if the UE supports reporting RSCP together with UE Rx-Tx time difference measurements in the DL PFL:*** **In FG 13-4**
* **Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE.**
* **Max number of TRPs across all positioning frequency layers per UE**
* **In FG 13-4a**
* **Max number of DL PRS Resources per DL PRS Resource Set**

In TR 38.822 [3], there are other additional capabilities are defined for DL PRS processing. These capabilities are not related to specific positioning method, and thus, should be applicable for CPP.* 13-7 Support of SSB from neighbour cell as QCL source of a DL PRS
* 13-7a Support of DL PRS from serving/neighbour cell as QCL source of a DL PRS

**Proposal : For any of the UE capabilities related to DL PRS Processing defined in 38.822, if it is not limited to a specific positioning method (e.g., FG 13-7, 13-7a), it is also applicable to DL PRS Processing for DL CPP.**UL SRS Resources Capability for UL CPPIn TR 38.822, the UE’s capabilities, FG 13-8/13-8x (x=a, b, c, d, e), are defined for SRS resources for positioning, the UE’s capabilities, FG 13-9/13-9x (x=a, b, e, f), are defined for OLPC of SRS resources for positioning, the UE’s capabilities, FG 13-10/13-10x (x= a, b, c, d, e, f), are defined for Spatial relation for SRS for positioning, and the UE’s capabilities, FG 13-19/13-19a are defined for Simultaneous positioning SRS and MIMO SRS transmission. Since there is no change on the transmission of SRS resources for positioning specifically for supporting UL CPP, all of these existing UE’s UL positioning capabilities are applicable for UL CPP. There is no need to add or change these UE UL capabilities specifically for UL CPP.**Proposal : Conclude that existing UE capabilities related to UL SRS Resource for positioning are applicable for NR UL CPP.**UE DL PRS processing capabilities for measurement outside MGIn Rel-17, the following capabilities are introduced for DL PRS processing and reporting of the PRS measurements for DL PRS measurement outside MG. * 27-3-2 DL PRS measurement outside MG and in a PRS processing window
* 27-3-3 DL PRS Processing Capability outside MG - buffering capability

In our view, these capabilities should be applicable when RSCP and RSCPD are measured together with UE Rx-Tx measurements/RSTD and therefore no need to introduce additional capabilities.**Proposal : Conclude that existing UE DL positioning capabilities for DL PRS measurements outside MG are applicable for NR DL CPP.** UE capabilities for low latency measurementIn Rel-17, the following capabilities are introduced for low latency PRS measurements* 27-3-1 M-sample measurements in RRC\_CONNECTED
* 27-7 Multiple measurement instances which can be included in a single measurement report
* 27-10 Support of UL MAC CE based MG activation request for PRS measurements
* 27-10a Low latency MG activation request for PRS measurements

These capabilities should be applicable when RSCP and RSCPD are measured together with UE Rx-Tx measurements/RSTD and therefore no need to introduce additional capabilities.**Proposal : Conclude that existing UE DL positioning capabilities for low latency measurements are applicable for NR DL CPP.** UE DL CPP capabilities in RRC\_INACTIVE stateFG 27-6 defines “DL PRS processing capabilities in RRC inactive state”. FG 27-17 defines “PRS processing in RRC\_INACTIVE” for DL RSTD, DL PRS-RSRP, or UE Rx – Tx time difference measurement. In addition, separate capabilities are defined for the support of PRS measurement in RRC\_INACTIVE state, e.g., FG 27-18a for DL-TDOA and 27-18c for Multi-RTT. Thus, we suggest adding the corresponding capabilities for RSCP and RSCPD measurements. **Proposal : Introduce a new UE capability for the support of PRS measurement in RRC\_INACTIVE state for RSCPD measurements with FG 17-18a as the pre-FG.*** **FFS: details of the capability.**

**Proposal : Introduce a new UE capability for the support of PRS measurement in RRC\_INACTIVE state for RSCP measurements with FG 17-18c as the pre-FG.*** **FFS: details of the capability**

UE UL CPP capabilities in RRC\_INACTIVE stateUE capabilities related to Positioning SRS transmission, OLPC in RRC\_INACTIVE state, special relation for positioning SRS in RRC\_INACTIVE state are defined in FG 27-15/15x (x=a, b. c), FG 27-16/16a, 27-19/19a. We don’t see a need to introduce new UE UL CPP capabilities in RRC\_INACTIVE state for NR UL CPP.**Proposal : Existing UE UL positioning capabilities for UE UL positioning capabilities are applicable for NR CPP in RRC\_INACTIVE state. Thus, no need to introduce new or modify existing UE UL positioning capabilities for NR CPP in RRC\_INACTIVE state.****LPHAP related UE features**In this section, we discuss the UE features related to LPHAP.

|  |
| --- |
| **Agreement**For the spatial relation of an SRS for positioning configuration in multiple cells for UEs in RRC\_INACTIVE state:* + When the spatial relation information is absent in the configuration, the UE may use a *fixed spatial domain transmission filter* for transmissions of the SRS configured by the higher layer parameter SRS-PosResource across multiple SRS resources or it may use a different spatial domain transmission filter across multiple SRS resources;
	+ When the spatial relation information is provided in the configuration, it is applicable across the cells within the SRS positioning validity area. Further study the configuration details.
		- FFS: spatial relation information validity criteria, and whether/how to determine UE fallback behavior if validity criteria for spatial relation of the configured RS is not met.

**Agreement**For the power control of an SRS for positioning configuration in multiple cells for a UE in RRC\_INACTIVE state, when pathloss RS is absent in the configuration, the UE determines the pathloss RS using a RS resource obtained from the SS/PBCH block of the camping cell that the UE uses to obtain MIB as the pathloss RS. |

Based on above agreements, for LPHAP, it seems RAN1 needs to introduce a new UE capability for a UE that supports LPHAP in RRC\_INACTIVE state.For a UE supporting LPHAP in RRC\_INACTIVE state, two cases for the spatial relation of an SRS for positioning configuration, e.g., when the spatial relation information is absent in the configuration and when the spatial relation information is provided in the configuration. Thus, RAN1 may need to further discuss whether the UE is mandatary to support both cases or there is need to introduce separate capabilities. In our view, a UE is required to support both cases, and thus no need to introduce separate capabilities.For the OLPC, the pathloss RS may be absent in the configuration. In this case, the UE is required to determine the pathloss RS using a RS resource obtained from the SS/PBCH block of the camping cell that the UE uses to obtain MIB as the pathloss RS. **Proposal : Introduce a new UE UL positioning capability for UE supporting LPDHP in RRC\_INACTIVE state*** **FFS: details of the capability**

**Bandwidth aggregation for positioning measurements related UE features**In this section, we discuss the UE features related to NR carrier phase positioning based on the following agreements.

|  |
| --- |
| **Agreement**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.

**Agreement*** 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

**Agreement**From RAN1 perspective, support UE performs PRS measurement across multiple aggregated PFLs in RRC\_CONNECTED, RRC\_INACTIVE and RRC\_IDLE state.**Agreement**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

**Agreement**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

**Agreement**Support aperiodic positioning SRS for bandwidth aggregation for UEs in RRC\_CONNECTED state.* FFS the details

**Agreement**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.**Agreement**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

 **Agreement**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

**Agreement**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
 |

UE Capabilities for DL BW aggregation positioningIn DL side, a UE may support PRS measurement across multiple aggregated PFLs in RRC\_CONNECTED, RRC\_INACTIVE and RRC\_IDLE states. Thus, we may consider separate UE capabilities for RRC\_CONNECTED, RRC\_INACTIVE and RRC\_IDLE states.For a UE supporting PRS measurement across multiple aggregated PFLs, the UE may support maximumly two or three PFLs, and the capability may be band or per band combinations dependent, or per UE or per frequency range. These should be considered as the components of the capability.Thus, for DL BW aggregation positioning, we may need to consider the following capabilities:**Proposal : Introduce a new UE capability for UE supporting the DL bandwidth aggregation across two or three PFLs for RRC\_CONNECTED state.*** **FFS: separate capabilities for UE-assisted and UE-based.**
* **FFS: the capability components, e.g., the maximum number of DL PFLs (or per band or per band combinations or per FR1/FR2, or per UE).**

**Proposal : Introduce a new UE capability for UE supporting the DL bandwidth aggregation across two or three PFLs for RRC\_INACTIVE state.*** **FFS: separate capabilities for UE-assisted and UE-based**
* **FFS: the capability components, e.g., the maximum number of DL PFLs (or per band or per band combinations or per FR1/FR2, or per UE)**

**Proposal : Introduce a new UE capability for UE supporting the DL bandwidth aggregation across two or three PFLs for RRC\_IDLE state.*** **FFS: the capability components, e.g., the maximum number of DL PFLs (or per band or per band combinations or per FR1/FR2, or per UE)**

UE Capabilities for UL BW aggregation positioningIn UL side, it was agreed that positioning SRS bandwidth aggregation is supported for UEs in RRC\_CONNECTED and in RRC\_INACTIVE state. For RRC\_CONNECTED mode, it was agreed to support periodic, semi-persistent positioning SRS and aperiodic positioning SRS for bandwidth aggregation for UEs in RRC\_CONNECTED state. we may consider separate UE capabilities for RRC\_CONNECTED and RRC\_INACTIVE states. For each capability, there is a need to further consider the maximum number of carriers, the SRS transmission mode, etc.**Proposal : Introduce a new UE capability for UE supporting the UL bandwidth aggregation across two or three carriers for RRC\_CONNECTED mode.*** **FFS: the capability components, e.g., the maximum number of UL carriers (or per band or per band combinations or per FR1/FR2, or per UE)**
* **FFS: whether to have separate capabilities or components for periodic, semi-persistent SRS and aperiodic positioning SRS**

**Proposal : Introduce a new UE capability for UE supporting the UL bandwidth aggregation across two or three carriers for RRC\_INACTIVE mode.*** **FFS: the capability components, e.g., the maximum number of UL carriers (or per band or per band combinations or per FR1/FR2, or per UE)**
* **FFS: whether to have separate capabilities or components for periodic, semi-persistent SRS and aperiodic positioning SRS**

**RedCap UEs Positioning related UE features**The following agreements had been agreed in RAN1#112 and RAN1#112bis-e related to UE features for RedCap UEs Positioning [1][2].

|  |
| --- |
| **Agreement**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

**Agreement**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, study whether to support one or both of the following options, according to UE capabilities:* Option 1: UL time window where the UE is not expected to receive/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: additional collision rules between the UL SRS with frequency hopping and other UL and DL signals/channels
	+ FFS: details on the collision rules
 |

According to the above 1st agreement, RAN1 had agreed that for RedCap UEs, support at least measurements on DL PRS with Rx frequency hopping using a measurement gap, and the details on RedCap UE processing capabilities for DL PRS with Rx frequency hopping and MG should be further studied. In our view, regarding the UE capabilities to support the RedCap UE measurements on DL PRS with Rx frequency hopping using a measurement gap, the following component R1 should be included:* Component R1 name: RedCap UE can measure DL PRS with Rx frequency hopping using a measurement gap
* Component R1 candidate values: {support, not support}

Proposal : Regarding the UE capabilities to support the RedCap UE measurements on DL PRS with Rx frequency hopping using a measurement gap, the following component R1 should be included:* **Component R1 name: RedCap UE can measure DL PRS with Rx frequency hopping using a measurement gap**
* **Component R1 candidate values: {support, not support}**

According to the above 2nd agreement, RAN1 had agreed that 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, study whether to support one or both of the above two options in the 2nd agreement, according to UE capabilities. In our view, 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, whether to support one or both of the two options should be UE capabilities, and the following component R2 should be included:* Component R2 name: RedCap UE can support the Option 1 and/or Option 2 to handle the collisions between other UL and DL signals/channels and the UL SRS with frequency hopping.
* Component R2 candidate values: {support Option 1, support Option 2, support both Option 1 and Option 2}
	+ Option 1: UL time window where the UE is not expected to receive/transmit other signals/channels and is only expected to transmit frequency hopping SRS for positioning.
	+ Option 2: Additional collision rules between the UL SRS with frequency hopping and other UL and DL signals/channels.

**Proposal : 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, whether to support one or both of the two options should be UE capabilities, and the following component R2 should be included:*** **Component R2 name: RedCap UE can support the Option 1 and/or Option 2 to handle the collisions between other UL and DL signals/channels and the UL SRS with frequency hopping.**
* **Component R2 candidate values: {support Option 1, support Option 2, support both Option 1 and Option 2}**
	+ **Option 1: UL time window where the UE is not expected to receive/transmit other signals/channels and is only expected to transmit frequency hopping SRS for positioning.**
	+ **Option 2: Additional collision rules between the UL SRS with frequency hopping and other UL and DL signals/channels.**
 |
| Intel Corporation [5] |

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| 41. NR\_pos\_enh2 | 41-1-1 | Common SL PRS Processing Capability | 1. Maximum SL PRS bandwidth in MHz, which is supported and reported by UE.

FR1 bands: {5, 10, 20, 40, 50, 80, 100}1. SL PRS buffering capability: Type 1 or Type 2
	1. Type 1 – sub-slot/symbol level buffering
	2. Type 2 – slot level buffering
2. Duration of SL PRS symbols N in units of ms a UE can process every T ms assuming maximum SL PRS bandwidth in MHz, which is supported and reported by UE.

T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} msN: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms1. Max number of SL PRS resources that UE can process in a slot

FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHz |  | No | Yes | UE does not support SL positioning | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported.Notes for component 3:A UE reports one combination of (N, T) values per band, where N is a duration of SL PRS symbols in ms processed every T ms for a given maximum bandwidth (B) in MHz supported by UEb. A UE is not expected to support SL PRS bandwidth that exceeds the reported SL PRS bandwidth valuec. A UE’s SL PRS processing capability is agnostic to SL PRS comb factor configurationd.The reporting of (N, T) values for maximum BW in MHz is not dependent on SCS | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-1-2 | Receiving SL-PRS in a shared resource pool | UE can receive SL-PRS in a shared resource pool | 15-1, 41-1-1 | Yes | Yes | Receiving SL-PRS in a shared resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling. [UE indicating support of FG 41-1-1 must indicate either this feature group or feature group 41-1-3 is supported.] |
| 41. NR\_pos\_enh2 | 41-1-3 | Receiving SL-PRS in a dedicated resource pool | 1. UE can receive SL-PRS in a dedicated resource pool

[SL PRS and/or PSCCH]-based RSRP reporting in case of unicast | 15-1, 41-1-1 | Yes | Yes | Receiving SL-PRS in a dedicated resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling. [UE support of FG 41-1-1 must indicate either this feature group or feature group 41-1-2 is supported.] |
| 41. NR\_pos\_enh2 | 41-1-4 | Transmitting SL-PRS scheme 1 in a shared resource pool  | UE can transmit SL-PRS using dynamic scheduling or configured grant type 1 and 2 in NR sidelink positioning scheme 1 scheduled by NR Uu in a shared resource pool  | 15-2, 41-1-2 | Yes | Yes | Transmitting SL-PRS scheme 1 in a shared resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling.  |
| 41. NR\_pos\_enh2 | 41-1-5 | Transmitting SL-PRS scheme 1 in a dedicated resource pool  | 1. UE can transmit SL-PRS using dynamic scheduling or configured grant type 1 and 2 in NR sidelink positioning scheme 1 scheduled by NR Uu in a dedicated resource pool

Support sidelink pathloss based open loop power control | 15-2, 41-1-3 | Yes | Yes | Transmitting SL-PRS scheme 1 in a dedicated resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling.  |
| 41. NR\_pos\_enh2 | 41-1-6 | Transmitting SL-PRS scheme 2 in a shared resource pool  | UE can transmit SL-PRS using NR sidelink positioning scheme 2 configured by NR Uu or preconfiguration in a shared resource pool.  | 15-3, 41-1-2 | Yes | Yes | Transmitting SL-PRS scheme 2 in a shared resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling. [For UE supports NR sidelink positioning in a shared resource pool, UE must indicate this FG is supported.]  |
| 41. NR\_pos\_enh2 | 41-1-7 | Transmitting SL-PRS scheme 2 in a dedicated resource pool  | UE can transmit SL-PRS using NR sidelink positioning scheme 2 configured by NR Uu or preconfiguration in a dedicated resource pool. | 15-3, 41—1-3 | Yes | Yes | Transmitting SL-PRS scheme 2 in a dedicated resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling. [For UE supports NR sidelink positioning in a dedicated resource pool, UE must indicate this FG is supported.]  |
| 41. NR\_pos\_enh2 | 41-1-8 | SL-PRS congestion control in a dedicated resource pool | 1. UE can report CBR measurement to gNB when operating in Mode 1 and mode 2
2. UE can adjust its radio parameters based on CBR measurement and CRlimit.

UE can process CBR and CR within the time it indicates | 41-1-3 and either 41-1-5 or 41-1-7  | Yes | Yes | SL-PRS congestion control in a dedicated resource pool is not supported | Per band | N/A | N/A | N/A |  | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-1-9 | SL PRS Resources for SL-RSTD | TBD on SL PRS resource and resource multiplexing final agreement | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported.Note: if the UE does not indicate this capability for a band, the UE does not support this positioning method in this band. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-1-10 | SL PRS Resources for SL-TDOA | TBD on SL PRS resource and resource multiplexing final agreement | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported.Note: if the UE does not indicate this capability for a band, the UE does not support this positioning method in this band. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-1-11 | SL PRS Resources for SL-AOA | TBD on SL PRS resource and resource multiplexing final agreement | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported.Note: if the UE does not indicate this capability for a band, the UE does not support this positioning method in this band. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-1-12 | SL PRS Resources for Multi-RTT | TBD on SL PRS resource and resource multiplexing final agreement | 41-1-2 and (41-1-4 or 41-1-6) or 41-1-3 and(41-1-5 or 41-1-7) | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported.Note: if the UE does not indicate this capability for a band, the UE does not support this positioning method in this band. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-1-13 | SL PRS measurement report for SL-RSTD | 1. SL-RSTD measurements per pair of UEs (target and reference UE). Values = TBD
2. Support SL PRS-RSRP measurements. Values = {0, 1}
3. Support SL PRS-RSRPP repoting for first path. Values = {0, 1}
4. Support LOS/NLOS indication. Values = {0, 1}.

TBD: LOS/NLOS indicator type/granularity indication | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-1-14 | SL PRS measurement report for SL-TDOA | 1. SL-RTOA measurements per UE. Values = TBD
2. Support SL PRS-RSRP measurements. Values = {0, 1}
3. Support RSRPP repoting for first path. Values = {0, 1}
4. Support LOS/NLOS indication. Values = {0, 1}.

TBD: LOS/NLOS indicator type/granularity indication  | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-1-15 | SL PRS measurement report for SL-AOA | 1. SL-AOA measurements per UE. Values1 = TBD (e.g., # of measurements). Values2 = {Azimuth, Zenith, Azimuth and Zenith}; Values3 = {GCS, LCS};
2. Support SL PRS-RSRP measurements. Values = {0, 1}
3. Support RSRPP repoting for first path. Values = {0, 1}
4. Support LOS/NLOS indication. Values = {0, 1}.

TBD: LOS/NLOS indicator type/granularity indication  | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-1-16 | UE Rx-Tx measurement report for SL Multi-RTT | 1. Max number of UE Rx–Tx time difference measurements corresponding to a single SL PRS Tx resource with each measurement corresponding to a single SL PRS Rx resource.
2. Value for component 1: [{1,2,3,4}]
3. Support RSRP measurements. Values = {0, 1}
4. Support RSRPP repoting for first path. Values = {0, 1}
5. Support LOS/NLOS indication. Values = {0, 1}.

TBD: LOS/NLOS indicator type/granularity indication  | 41-1-2 and (41-1-4 or 41-1-6) or 41-1-3 and(41-1-5 or 41-1-7) | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-1-17 | SL PRS reception in case of TDM-based multiplexing of SL PRS from different UEs in a slot  | SL PRS reception in case of TDM-based multiplexing of SL PRS from different UEs in a slot at least for dedicated resource pools | 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling. |
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| 41. NR\_pos\_enh2 | 41-2-1 | Support DL RSCP reporting based on DL PRS | DL RSCP is reported along with UE Rx-Tx Measurement Report for Multi-RTT | 13-11 | No | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-2-2 | Support of DL RSCPD reporting based on DL PRS | DL RSCPD is reported along with measurement report for DL-RTOA | 13-6 | No | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-2-3 | Support of DL RSCP reporting based on DL PRS in RRC\_INACTIVE | DL RSCP is reported along with UE Rx-Tx Measurement Report for Multi-RTT | 27-18c | No | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-2-4 | Support of DL RSCPD reporting based on DL PRS in RRC\_INACTIVE | DL RSCPD is reported along with measurement report for DL-RTOA | 27-18a | No | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-2-5 | DL PRS processing capabilities for DL RSCP or DL RSCPD measurements | 1. Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz, which is supported and reported by UE | 13-1 |  | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported.Component 1 candidate values:T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} msN: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-2-6 | DL PRS processing capabilities for DL RSCP or DL RSCPD measurements in RRC\_INACTIVE | 1. Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz, which is supported and reported by UE | 27-6 |  | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported.Component 1 candidate values:T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} msN: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms | Optional with capability signaling. |
| 41. NR\_pos\_enh2 | 41-2-7 | Measurements on DL PRS on [indicated] DL RS resources occuring within idnicated time windows | Supported measurements on DL PRS on [indicated] DL RS resources occuring within idnicated time windows. Values = [{RSTD, RSRP, RSRPP, RSCP, RSCPD}] | 13-1 | No | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported.FFS: Conditioning based on reported capabilities for different UE-assisted DL positioning methods | Optional with capability signaling. |
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| 41. NR\_pos\_enh2 | 41-3-1 | Support of SRS for positioning configuration in multiple cells for UEs in RRC\_INACTIVE state | 1. SRS for positioning configuration in multiple cells for UEs in RRC\_INACTIVE state with common configuration of SRSPos resource set and SRSPos resources.
2. SRS for positioning validity area-specific TA timer
3. Spatial relation of an SRS for positioning configuration in multiple cells for UEs in RRC\_INACTIVE state may be present or absent in the configuration.
4. For the power control of an SRS for positioning configuration in multiple cells for a UE in RRC\_INACTIVE state, pathloss RS may be present or absent in the configuration.
5. UL timing - TBD
 | 27-15 | Yes | N/A |  | Per band | N/A | N/A | N/A |  | Optional with capability signalling |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 41. NR\_pos\_enh2 | 41-4-1 | Support of PRS bandwidth aggregation in RRC\_CONNECTED | 1. Support of PRS bandwidth aggregation across multiple PFLs in RRC\_CONNECTED
2. Applicable for DL-TDOA and Multi-RTT positioning methods
 | 13-1 | No |  | PRS bandwidth aggregation across multiple PFLs in RRC\_CONNECTED state is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-2 | Support of PRS bandwidth aggregation in RRC\_INACTIVE | 1. Support of PRS bandwidth aggregation across multiple PFLs in RRC\_INACTIVE
2. Applicable for DL-TDOA and Multi-RTT positioning methods
 | 27-18 | [Yes] |  | PRS bandwidth aggregation across multiple PFLs in RRC\_INACTIVE state is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-3 | Support of PRS bandwidth aggregation in RRC\_IDLE | 1. Support of PRS bandwidth aggregation across multiple PFLs in RRC\_IDLE
2. Applicable for DL-TDOA and Multi-RTT positioning methods
 | TBD | TBD |  | PRS bandwidth aggregation across multiple PFLs in RRC\_IDLE state is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-4 | Support of positioning SRS bandwidth aggregation in RRC\_CONNECTED | 1. Support of positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_CONNECTED
2. Applicable for UL-TDOA and Multi-RTT positioning methods
 | 13-8, 6-2 | Yes |  | Positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_CONNECTED state is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-5 | Support of positioning SRS bandwidth aggregation independent from UL communication CA in RRC\_CONNECTED | 1. Support of positioning SRS bandwidth aggregation in RRC\_CONNECTED that is decoupled from the UE support of communication CA
2. Applicable for UL-TDOA and Multi-RTT positioning methods
 | 13-8 | Yes |  | Positioning SRS bandwidth aggregation in RRC\_CONNECTED state that is decoupled from the UE support of communication CA is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-6 | Support of positioning SRS bandwidth aggregation in RRC\_INACTIVE | 1. Support of positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_INACTIVE
2. Applicable for UL-TDOA and Multi-RTT positioning methods
 | 27-15 | Yes |  | Positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_INACTIVE state is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
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| 41. NR\_pos\_enh2 | 41-5-1 | Support of PRS with Rx frequency hopping for RedCap UEs | 1. Support of PRS with Rx frequency hopping for Redcap UEs
2. For FR1, switching time of [{70us, 140us}] and PRS Rx frequency hopping range up to 100MHz
3. For FR2, switching time of [{35us, 70us, 140us}] and PRS Rx frequency hopping range up to 400MHz
 | 13-1 | Yes |  | PRS with Rx frequency hopping for Redcap UEs is not supported | Per band | N/A | N/A | N/A |  | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-5-2 | Support of positioning SRS with Tx frequency hopping for RedCap UEs | 1. Support of positioning SRS with Tx frequency hopping for Redcap UEs
2. For FR1, switching time of [{70us, 140us}] and positioning SRS Tx frequency hopping range up to 100MHz
3. For FR2, wwitching time of [{35us, 70us, 140us}] and positioning SRS Tx frequency hopping range up to 400MHz
 | 13-8 | Yes |  | Positioning SRS with Tx frequency hopping for Redcap UEs is not supported | Per band | N/A | N/A | N/A |  | Optional with capability signaling |

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| ZTE [6] | **UE feature on sidelink positioning**Regarding UE features on SL positioning, we provide our views as shown below:*Proposal 1: Introduce a new FG 41-1-1 for receiving and processing SL PRS:** *Maximum SL PRS bandwidth: up to 100 MHz in FR1 spectrum*
* *Support SCS values for SL PRS: 15 kHz, 30 kHz, 60 kHz for FR1, and 60 kHz, 120 kHz for FR2*

*Proposal 2: Introduce a new FG 41-1-2 for SL PRS measurement report:** *SL PRS measurement report for SL-TDoA*
* *SL PRS* *measurement report for SL RTT*
* *SL PRS* *measurement report for SL AoA*
* *Support of SL PRS RSRP and SL PRS RSRPP measurement*

*Proposal 3: Introduce a new FG 41-1-3 for SL PRS transmission in resource allocation scheme 1:** *UE can transmit SL PRS/PSCCH using dynamic scheduling or configured grant type 1 and 2 in scheme 1 SL PRS resource allocation scheduled by NR Uu.*
* *UE can monitor DCI format X for SL PRS dynamic scheduling and configured grant type 2*
* *Support downlink pathloss power control*

*Proposal 4: Introduce a new FG 41-1-4 for SL PRS transmission in resource allocation scheme 2:** *UE can transmit SL PRS/PSCCH using scheme 2 SL PRS resource allocation configured by NR Uu or preconfiguration.*
* *UE can perform scheme 2 sensing and resource allocation operations*
* *UE can perform random resource selection*
* *Support downlink pathloss power control when scheme 2 is configured by NR Uu*

*Proposal 5: Introduce a new FG 41-1-5 for SL Positioning congestion control:** *UE can report SL PRS CBR measurement to gNB*
* *UE can adjust its SL PRS transmission parameters based on SL PRS CBR measurement and SL PRS CRlimit*
* *UE can process CBR and CR within the time*

*Proposal 6: Introduce a new FG 41-1-6 for open loop power control and RSRP report:** *Support sidelink pathloss based open loop power control and RSRP report in case of unicast*
	+ *Sidelink pathloss can be calculated based on SL PRS*

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 41-1-1 | SL PRS reception and processing | 1. Maximum SL PRS bandwidth in MHz, which is supported and reported by UE,a) FR1 bands: {5, 10, 20, 40, 50, 80, 100}2. Support SCS values for SL PRSa) FR1: 15 kHz, 30 kHz, 60 kHzb) FR2: 60 kHz, 120 kHz |  | Yes |  | SL PRS reception and processing is not supported | Per UE |  |  |  | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41-1-2 | SL PRS measurement report | 1. Support of SL PRS measurement report for SL-TDOA* Maximum number of SL PRS RTOA per pair of UEs. Values = {1, 2, 3, 4}
* Maximum number of SL PRS RSTD per pair of UEs. Values = {1, 2, 3, 4}

2.Support of SL PRS measurement report for SL RTT* Max number of UE Rx–Tx time difference measurements corresponding to a single SL PRS resource with each measurement corresponding to a single SL PRS resource from another UE. Value for component 1: {1,2,3,4}

3. Support of SL PRS measurement report for SL AoA* Max number of SL AoA measurements on different SL PRS resources from the same UE supported by the UE. Values = {1, 2, 3, 4}

4. Support of SL PRS RSRP and SL PRS RSRPP measurement* Max number of SL PRS RSRP measurements on different SL PRS resources from the same UE supported by the UE. Values = {1, 2, 3, 4, 5, 6, 7, 8}
* Max number of SL PRS RSRPP measurements on different SL PRS resources from the same UE supported by the UE. Values = {1, 2, 3, 4, 5, 6, 7, 8}
 |  | Yes |  | SL PRS measurement report is not supported | Per UE |  |  |  | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41-1-3 | SL PRS transmission in resource allocation scheme 1 | 1. UE can transmit SL PRS/PSCCH using dynamic scheduling or configured grant type 1 and 2 in scheme 1 SL PRS resource allocation scheduled by NR Uu.2. UE can monitor DCI format X for SL PRS dynamic scheduling and configured grant type 23. Support downlink pathloss power control |  | Yes |  | SL PRS transmission in resource allocation scheme 1 is not supported |  |  |  |  |  | Optional with capability signaling |
| 41-1-4 | SL PRS transmission in resource allocation scheme 2 | 1. UE can transmit SL PRS/PSCCH using scheme 2 SL PRS resource allocation configured by NR Uu or preconfiguration2. UE can perform scheme 2 sensing and resource allocation operations3. UE can perform random resource selection4. Support downlink pathloss power control when scheme 2 is configured by NR Uu | 41-1-1 | Yes |  | SL PRS transmission in resource allocation scheme 2 is not supported |  |  |  |  |  | Optional with capability signaling |
| 41-1-5 | SL Positioning congestion control | 1. UE can report SL PRS CBR measurement to gNB2. UE can adjust its SL PRS transmission parameters based on SL PRS CBR measurement and SL PRS CRlimit3. UE can process CBR and CR within the time | 41-1-1 and at least one of 41-1-3 and 41-1-4 | Yes |  | SL Positioning congestion control is not supported |  |  |  |  |  | Optional with capability signaling |
| 41-1-6 | Open loop power control and RSRP report for SL positioning | 1. Support sidelink pathloss based open loop power control and RSRP report in case of unicast, Sidelink pathloss can be calculated based on SL PRS | 41-1-1 and at least one of 41-1-3 and 41-1-4 | Yes |  | Open loop power control and RSRP report for SL positioning is not supported |  |  |  |  |  | Optional with capability signaling |

**UE feature on NR DL and UL carrier phase positioning**For NR DL and UL carrier phase positioning, we provide our views on UE features as below:*Proposal 7: Introduce a new FG 41-2-1 for DL PRS carrier phase measurement in MG:** *Report the PRS processing time {NCPM, TCPM} for carrier phase measurement.*
	+ *Compared with {N, T} for PRS measurement in FG 13-1, more UE processing time is needed for carrier phase measurement. Hence, NCPM ≤ N or TCPM≥ T.*
* *Report the maximum number of DL PRS resources MCPM that UE can process in a slot for carrier phase measurement.*
	+ *Compared with current PRS measurement, more UE memory/complexity is needed for carrier phase measurement, so less resources may be processed. Hence, MCPM ≤ M, where M is maximum number PRS resources for PRS measurement reported by FG 13-1.*

***Proposal 8:*** *Introduce a new FG 41-2-2 for DL PRS carrier phase measurement in RRC inactive state:** *Report the PRS processing time {NCPM, TCPM} for carrier phase measurement.*
	+ *Compared with {N, T} for PRS measurement in FG 13-1, more UE processing time is needed for carrier phase measurement. Hence, NCPM ≤ N or TCPM≥ T.*
* *Report the maximum number of DL PRS resources MCPM that UE can process in a slot for carrier phase measurement.*
	+ *Compared with current PRS measurement, more UE memory/complexity is needed for carrier phase measurement, so less resources may be processed. Hence, MCPM ≤ M, where M is maximum number PRS resources for PRS measurement reported by FG 13-1.*

***Proposal 9:*** *Introduce a new FG 41-2-3 for DL PRS measurement within the indicated time window(s):** *Report the PRS processing capability {N3, TCPM} for DL PRS measurement within the indicated time window(s).*
	+ *FFS: The candidate values of N3.*
* *Report the maximum duration of DL PRS symbols N4 in units of ms in each indicated time window.*
	+ *The maximum duration of DL PRS symbols can be determined based on UE’s capability. FFS: The candidate values of N4.*

***Proposal 10:*** *Introduce a new FG 41-2-4 for UL SRS transmission within the indicated time window(s):** *Report the capability {N3, TSRS} for UL SRS transmission within the indicated time window(s).*
	+ *FFS: The candidate values of N3 and TSRS.*
* *Report the maximum duration of UL SRS symbols N4 in units of ms in each indicated time window.*
	+ *The maximum duration of UL SRS symbols can be determined based on UE’s capability. FFS: The candidate values of N4.*

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| 41-2-1 | DL PRS carrier phase measurement in MG | 1. Duration of DL PRS symbols NCPM in units of ms a UE can process every TCPM ms assuming maximum DL PRS bandwidth in MHz, which is supported and reported by UE.
2. TCPM : {1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
3. NCPM : {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms

**Note1:** NCPM ≤ N or TCPM≥ T, where {N, T} is reported by FG 13-11. Max number of DL PRS resources **MCPM** that UE can process in a slot under it

a) FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHzb) FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz **Note2:** **MCPM** ≤ M, where M is maximum number PRS resources for PRS measurement reported by FG 13-1**Note3**: RSCPD is reported by UE together with RSTD measurement in DL TDOA, RSCP is reported by UE together with UE Rx–Tx time difference measurement in Multi-RTT positioning. | 13-1,13-3, 13-4 | No |  | DL PRS carrier phase measurement in MG is not supported | Per Band | n/a | n/a | n/a | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41-2-2 | DL PRS carrier phase measurement in RRC inactive state | 1. Duration of DL PRS symbols NCPM in units of ms a UE can process every TCPM ms assuming maximum DL PRS bandwidth in MHz, which is supported and reported by UE.
2. TCPM : {1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
3. NCPM : {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms

**Note1:** NCPM ≤ N or TCPM≥ T, where {N, T} is reported by FG 27-61. Max number of DL PRS resources **MCPM** that UE can process in a slot under it

a) FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHzb) FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz **Note2:** **MCPM** ≤ M, where M is maximum number PRS resources for PRS measurement reported by FG 27-6**Note3**: RSCPD is reported by UE together with RSTD measurement in DL TDOA, RSCP is reported by UE together with UE Rx–Tx time difference measurement in Multi-RTT positioning. | 27-6, 27-18a, 27-18c | No |  | DL PRS carrier phase measurement in RRC inactive state is not supported | Per Band | n/a | n/a | n/a | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41-2-3 | Measurement on DL PRS within the indicated time window(s) | 1. Maximum number of indicated time window(s) N3 a UE can process in every TCPM ms, which is supported and reported by UE.
2. TCPM : {1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
3. N3: {1,2,...,N}

FFS: The value of N1. Maximum duration of DL PRS symbols N4 in units of ms in each indicated time window.
2. N4: {1,2,...K} ms

FFS: The value of K | 13-1 | No |  | Measurement on DL PRS within the indicated time window(s)is not supported | Per band | n/a | n/a | n/a | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41-2-4 | Transmission of SRS for positioning within the indicated time window(s) | 1. Maximum number of indicated time window(s) N3 a UE can transmit SRS in every TSRS ms, which is supported and reported by UE.
2. TSRS: {1, 2, ..., T} ms
3. N3: {1,2,...,N}

FFS: The values of T, N1. Maximum duration of UL SRS for positioning symbols N4 in units of ms in each indicated time window.
2. N4: {1,2,...K} ms

FFS: The value of K | 13-8 | Yes |  | Transmission of SRS for positioning within the indicated time window(s)is not supported | Per band | n/a | n/a | n/a | Need for location server to know if the feature is supported. | Optional with capability signaling |

**UE feature on LPHAP**For LPHAP, we provide our views on UE features as below:***Proposal 11:*** *Introduce a new FG 41-3-1 for LPHAP:** *Report whether UE support positioning SRS transmission in RRC\_INACTIVE state within an SRS positioning validity area.*

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| 41-3-1 | Positioning SRS transmission in RRC inactive state within an SRS positioning validity area | 1. Support of positioning SRS transmission in RRC inactive state within an SRS positioning validity area

  | 27-15, 27-15b | Yes |  | Positioning SRS transmission in RRC inactive state within a validity area is not supported | Per UE |  |  |  | Need for location server to know if the feature is supported. | Optional with capability signaling |

**UE feature on bandwidth aggregation for positioning measurements**For PRS bandwidth aggregation, we provide our views on UE features as below:***Proposal 12:*** *Introduce a new FG 41-4-1 for DL PRS processing capability for PRS bandwidth aggregation measurement in MG** *Report the maximum number of aggregated PFLs F.*
	+ *The maximum aggregated bandwidth can be derived from F and the maximum bandwidth reported by legacy FG 13-1.*
* *Report the PRS processing time {NAgg, TAgg} for aggregation.*
	+ *Compared with {N, T} for single PFL, more UE processing time is needed for aggregation measurement. Hence, NAgg ≤ N or TAgg≥ T.*
* *Report the maximum number of DL PRS resources MAgg that UE can process in a slot for PFL aggregation*
	+ *Compared with single PFL measurement, more UE memory/complexity is needed, so less resources may be processed. Hence, MAgg ≤ M, where M is maximum number PRS resources for single PFL measurement reported by FG 13-1*

***Proposal 13:*** *Introduce a new FG 41-4-2 for DL PRS processing capability for PRS bandwidth aggregation measurement in RRC inactive state** *Report the maximum number of aggregated PFLs F.*
	+ *The maximum aggregated bandwidth can be derived from F and the maximum bandwidth reported by legacy FG 13-1.*
* *Report the PRS processing time {NAgg, TAgg} for aggregation.*
	+ *Compared with {N, T} for single PFL, more UE processing time is needed for aggregation measurement. Hence, NAgg ≤ N or TAgg≥ T.*
* *Report the maximum number of DL PRS resources MAgg that UE can process in a slot for PFL aggregation*
	+ *Compared with single PFL measurement, more UE memory/complexity is needed, so less resources may be processed. Hence, MAgg ≤ M, where M is maximum number PRS resources for single PFL measurement reported by FG 27-6*

***Proposal 14:*** *Introduce a new FG 41-4-3 for SRS bandwidth aggregation in RRC\_CONNECTED state** *Report the maximum number of aggregated carriers.*

***Proposal 15:*** *Introduce a new FG 41-4-3 for SRS bandwidth aggregation in RRC\_INACTIVE state** *Report the maximum number of aggregated carriers.*
* *The prerequisite is FG 27-15b since SRS transmission will be outside initial BWP for aggregation*

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| 41-4-1 | DL PRS processing capability for PRS bandwidth aggregation measurement in MG | 1. Maximum number F of PFLs for aggregation, which is supported and reported by UE.

F: {2, 3}, where F < the value reported by FG13-1a   **Note1:** the maximum bandwidth for aggregation is F×B where B is the bandwidth for single PFL reported by FG 13-1; 1. Duration of DL PRS symbols NAgg in units of ms a UE can process every TAgg ms assuming maximum DL PRS bandwidth after F PFLs aggregation in MHz, which is supported and reported by UE.
2. TAgg : {1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
3. NAgg : {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms

**Note2:** NAgg ≤ N or TAgg≥ T, where {N, T} is reported by FG 13-11. Max number of DL PRS resources **MAgg** that UE can process in a slot under it for PFL aggregation measurement

a) FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHzb) FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz **Note3:** **MAgg** ≤ M, where M is maximum number PRS resources for single PFL measurement reported by FG 13-1 | 13-1, 13-1a, 13-3, 13-4 | No |  | DL PRS bandwidth aggregation measurement is not supported in MG | Per BC |  |  |  | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41-4-2 | DL PRS processing capabilities for bandwidth aggregation measurement in RRC inactive state | 1. Maximum number F of PFLs for aggregation, which is supported and reported by UE.

F: {2, 3}, where F < the value reported by FG13-1a   **Note1:** the maximum bandwidth for aggregation is F×B where B is the bandwidth for single PFL reported by FG 13-1 1. Duration of DL PRS symbols NAgg in units of ms a UE can process every TAgg ms assuming maximum DL PRS bandwidth after F PFLs aggregation in MHz, which is supported and reported by UE.
2. TAgg : {1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
3. NAgg : {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms

**Note2:** NAgg ≤ N or TAgg≥ T, where {N, T} is reported by FG 27-61. Max number of DL PRS resources **MAgg** that UE can process in a slot under it for PFL aggregation measurement

a) FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHzb) FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz **Note3:** **MAgg** ≤ M, where M is maximum number PRS resources for single PFL measurement reported by FG 27-6 | 27-6, 13-1a, 27-18a, 27-18c  |  |  | DL PRS bandwidth aggregation measurement is not supported in RRC inactive state |  |  |  |  |  |  |
| 41-4-3 | Simultaneous positioning SRS transmission within a band across multiple contiguous CCs for SRS bandwidth aggregation in RRC\_CONNECTED state | 1. The number of SRS resources for positioning on a symbol across contiguous carriersCandidate values {2, 3} | 13-8 | Yes |  | Positioning SRS bandwidth aggregation is not supported for UE in RRC\_CONNECTED state | Per band |  |  |  |  | Optional with capability signaling |
| 41-4-4 | Simultaneous positioning SRS transmission within a band across multiple contiguous CCs for SRS bandwidth aggregation in RRC\_INACTIVE state  | 1. The number of SRS resources for positioning on a symbol across contiguous carriersCandidate values {2, 3} | 27-15b | Yes |  | Positioning SRS bandwidth aggregation is not supported for UE in RRC\_INACTIVE state | Per band |  |  |  |  | Optional with capability signaling |

**UE feature on positioning for RedCap UEs**Regarding UE features on positioning RedCap UEs, we provide our views as below:*Proposal 16: Introduce a new FG 41-5-1 for DL PRS processing capability of RedCap UE for frequency hopping in MG:** *Report the maximum number of hops*
	+ *The bandwidth of each hop refers to FG 28-1*
* *Report capability of overlapping PRB(s) between adjacent hops or a capability on the maximum equivalent bandwidth after combing all hops*
* *Report the PRS processing time {NFH, TFH} for frequency hopping.*
	+ *Considering there are gap between two hops, duration of DL PRS symbols in ms processed every T ms can be different.*

*Proposal 17: Introduce a new FG 41-5-2 for RedCap UE SRS frequency hopping:** *Report the maximum number of hops*
	+ *The bandwidth of each hop refers to FG 28-1*
* *Report capability of overlapping PRB(s) between adjacent hops or a capability on the maximum equivalent bandwidth after combing all hops*

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| 41-5-1 | DL PRS processing capability of RedCap UE for frequency hopping in MG | 1. Maximum number H of hops for PRS Rx frequency hopping, which is supported and reported by UE.H: {2, 3, 4, 5}  **Note1**: the bandwidth of each hop refers to FG 28-12. Overlapping PRB(s) between adjacent hops or a capability on the maximum equivalent bandwidth after combing all hops3. Duration of DL PRS symbols NFH in units of ms a UE can process every TFH ms assuming maximum DL PRS bandwidth after F PFLs aggregation in MHz, which is supported and reported by UE. | 28-1 | No |  | DL PRS processing capability of RedCap UE for frequency hopping in MG is not supported | Per band |  |  |  | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41-5-2 | RedCap UE SRS frequency hopping | 1. Maximum number H of hops for SRS Tx frequency hopping, which is supported and reported by UE.H: {2, 3, 4, 5}  **Note1**: the bandwidth of each hop refers to FG 28-12. Overlapping PRB(s) between adjacent hops or a capability on the maximum equivalent bandwidth after combing all hops | 28-1 | Yes |  | RedCap UE SRS frequency hopping is not supported | Per band |  |  |  |  | Optional with capability signaling |

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| Apple [7] | **Sidelink positioning** For the objective to specify solutions for support of sidelink positioning (including ranging) in NR systems the following proposal is made: ***Proposal 1******For sidelink positioning the following capabilities should be defined:**** ***Capability for UE support of each of the SL positioning methods being specified***
	+ ***Basic capability support for each of (1) single sided RTT-type operation (2) Double sided RTT-type operation (3) SL-AoA operation, (4) DL-TDOA-like operation (5) UL-TDOA-like operation***
	+ ***Capability for SL-PRS resources for each positioning method e.g. number of resources across SL-BWP, UEs, time domain behavior such as aperiodic, semi-persistent, or periodic, SCSs, comb size***
* ***Capability defining the UE SL PRS Processing Capability in terms of BW, buffering Capability , duration of N symbols it can process in T symbols, # of SL-PRS resources it can process in a defined time duration (N/T)***
* ***Capability defining OLPC for each SL positioning method***

UE-based and LMF-based integrity of RAT-dependent positioning methodsFor the objective to specify the error modelling parameters, signaling, and procedures to support UE-based and LMF-based integrity of RAT-dependent positioning methods the following proposal is made: ***Proposal 2******For integrity of RAT-dependent positioning methods the following capabilities should be defined**** ***A basic capability should be defined indicating UE support for UE-based integrity of RAT-dependent positioning methods***
* ***A basic capability should be defined indicating UE support measurements an signaling for LMF-based integrity of RAT-dependent positioning methods***

**Enhancements for enabling Low Power High Accuracy Positioning (LPHAP)** For the objective to specify enhancements for enabling LPHAP use-case 6 as defined in TS 22.104 the following proposal is made: ***Proposal 3:******For enhancements for enabling LPHAP use-case 6 as defined in TS 22.104 the following CAPABILITYs should be defined**** ***A basic capability indicating support for LPHAP in the RRC\_INACTIVE state***
* ***A basic capability indicating support for extending eDRX cycle beyond 10.24s in RRC\_INACTIVE state***
* ***A basic capability indicating support for SRS configuration enhancements based on SRS positioning validity area to avoid frequent RRC connection for SRS (re)configuration***
* ***A basic capability indication support for DL PRS measurements for a UE in RRC\_IDLE state and reporting of the measurements in RRC\_CONNECTED state***

**Positioning for UEs with Reduced Capabilities (RedCap UEs)**For the objective to specify support of positioning for UEs with Reduced Capabilities (RedCap UEs) the following proposal is made: ***Proposal 4:******For positioning for UEs with Reduced Capabilities (RedCap UEs) the following CAPABILITYs should be defined**** ***A basic capability should be defined for indicate UE support of Frequency Hopping (FH) beyond maximum RedCap UE bandwidth for reception of DL PRS for positioning***
* ***A basic capability should be defined to indicate UE support of Frequency Hopping (FH) beyond maximum RedCap UE bandwidth for transmission of UL SRS for positioning***
* ***A capability with details on RedCap UE processing capabilities for DL PRS with Rx frequency hopping and MG: Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS transmission/total bandwidth in MHz, which is supported and reported by UE***
* ***Capability for SL-PRS: resources for each positioning method e.g. number of resources across SL-BWP, UEs, time domain behavior such as aperiodic, semi-persistent, or periodic, SCSs, comb size (per hop or across multiple hops)***
* ***A capability indicting support for a shorter RF switching time to allow RF retuning between adjacent hops***
* ***A capability on the bandwidth of each hop, the amount of overlap between hops and the number of hops for both PRS and SRS for positioning.***

**Bandwidth Aggregation for Positioning Measurements** For the objective to specify bandwidth aggregation for positioning measurements across up to three intra-band contiguous carriers the following proposal is made: ***Proposal 5:******For bandwidth aggregation for positioning measurements across up to three intra-band contiguous carriers the following capabilities should be defined**** ***a basic capability indicating support for DL PRS bandwidth aggregation. May include maximum # of DL PRS aggregated.***
* ***a basic capability indicating support for UL SRS bandwidth aggregation. May include maximum # of UL SRS aggregated.***
* ***Capability for DL-PRS resources that can be processed over the aggregation e.g. number of resources across aggregated BW, TRPs, time domain behavior such as aperiodic, semi-persistent, or periodic, SCSs, comb size.***
* ***Capability for PFL bandwidth combinations, including maximum number of PFLs, the total aggregated bandwidth.***

**NR DL and UL Carrier Phase Positioning for UE-based, UE-assisted, and NG-RAN Node Assisted Positioning** For the objective to specify physical layer measurements and signaling to support NR DL and UL carrier phase positioning for UE-based, UE-assisted, and NG-RAN node assisted positioning the following proposal is made: ***Proposal 6:******For NR DL and UL carrier phase positioning for UE-based, UE-assisted, and NG-RAN node assisted positioning the following capabilities should be defined.**** ***a basic capability indicating support for NR DL carrier phase positioning.***
* ***a basic capability indicating support for NR DL carrier phase positioning.***
* ***UE Capabilities for Carrier Phase Measurement and reporting i.e. can the UE perform a single frequency measurement or multiple frequency measurements within a PFL for CPP reporting.***
* ***PRU Capability and configuration for double differential CPP i.e. can a UE serve as a PRU for CPP based on the accuracy of its position and measurement capabilities.***
* ***for the UE’s positioning processing Capability, the “Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz, which is supported and reported by UE” should be updated especially in the case of joint traditional positioning with CPP due to the additional measurements needed.***
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| Qualcomm Incorporated [8] |

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| NR\_pos\_enh2  | X-SLPRS-1 | Support of SL-PRS reception & processing in shared resource pool | 1. Maximum SL PRS bandwidth in MHz in a shared resource pool for positioning, which is supported and reported by UE for SL-PRS measurement2. SL PRS buffering capabilitya) Type 1 – sub-slot/symbol level bufferingb) Type 2 – slot level buffering3. Duration of SL PRS symbols N in units of ms a UE can process every T ms assuming maximum SL PRS bandwidth in MHz, which is supported and reported by UE4. Max number of SL PRS resources that UE can process in a slot  |  | [TBD] | Yes |  | per FS | n/a | n/a | n/a | Component 1 candidate values:FR1 bands: {5, 10, 20, 40, 50, 80, 100}FR2 bands: {50, 100, 200, 400} Component 2 candidate values: {Type 1, Type 2}Component 3 candidate values:a) T: {1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} msb) N: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} msComponent 4 candidate values:FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHzFR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHzNotes for component 3:a. UE is not expected to support SL PRS bandwidth that exceeds the reported SL PRS bandwidth valueb.UE SL PRS processing capability is agnostic to SL PRS comb factor configurationc.The reporting of (N, T) values for maximum BW in MHz is not dependent on SCSNeed for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-2 | Support of SL-PRS reception & processing in dedicated resource pool | 1. Maximum SL PRS bandwidth in MHz in a dedicated resource pool for positioning, which is supported and reported by UE for SL-PRS measurement2. SL PRS buffering capabilitya) Type 1 – sub-slot/symbol level bufferingb) Type 2 – slot level buffering3. Duration of SL PRS symbols N in units of ms a UE can process every T ms assuming maximum SL PRS bandwidth in MHz, which is supported and reported by UE4. Max number of SL PRS resources that UE can process in a slot 5. Support receiving a single SL-PRS resource in a slot in the allocated BW |  | [TBD] | Yes |  | per FS | n/a | n/a | n/a | Component 1 candidate values:FR1 bands: {5, 10, 20, 40, 50, 80, 100}FR2 bands: {50, 100, 200, 400} Component 2 candidate values: {Type 1, Type 2}Component 3 candidate values:a) T: {1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} msb) N: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} msComponent 4 candidate values:FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHzFR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHzNotes for component 3:a. UE is not expected to support SL PRS bandwidth that exceeds the reported SL PRS bandwidth valueb.UE SL PRS processing capability is agnostic to SL PRS comb factor configurationc.The reporting of (N, T) values for maximum BW in MHz is not dependent on SCSNeed for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-3 | TDM-based multiplexing of SL PRS from different UEs in a dedicated resource pools. | Support of Transmit and receive TDM-based multiplexing of multiple SL PRS resources in a slot in a dedicated resource pools. |  | Yes | Yes |  | per FS | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
|  | X-SLPRS-4 | Comb-based multiplexing of SL-PRS from different UEs in a dedicated resource pool | Support of Transmit and receive comb-based multiplexing of SL PRS from different UEs in a slot in a dedicated resource pools. |  | Yes | Yes |  | Per FS |  |  |  | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-5 | Transmission of SL-PRS in shared resource pool using Scheme 1 RA | 1. Support of SL-PRS transmission in a shared resource pool
2. Max number of SL-PRS Resources
3. Max number of SL-PRS Resources per slot
4. Support downlink pathloss based open loop power control
 |  | Yes | Yes |  | Per band | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-6 | Transmission of SL-PRS in shared resource pool using Scheme 2 RA with full sensing | 1. Support of SL-PRS transmission in a shared resource pool
2. Max number of SL-PRS Resources
3. Max number of SL-PRS Resources per slot
4. Support DL pathloss based open loop power control when configured by NR Uu
 |  | Yes | Yes |  | Per FS | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-7 | Transmission of SL-PRS in shared resource pool using Scheme 2 RA with partial sensing | 1. Support of SL-PRS transmission in a shared resource pool
2. Max number of SL-PRS Resources
3. Max number of SL-PRS Resources per slot
4. Support DL pathloss based open loop power control when configured by NR Uu
 |  | Yes | Yes |  | Per band | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-8 | Transmission of SL-PRS in shared resource pool using Scheme 2 RA with random selection | 1. Support of SL-PRS transmission in a shared resource pool
2. Max number of SL-PRS Resources
3. Max number of SL-PRS Resources per slot
4. Support DL pathloss based open loop power control when configured by NR Uu
 |  | Yes | Yes |  | Per band | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling  |
| NR\_pos\_enh2  | X-SLPRS-9 | Transmission of SL-PRS in dedicated resource pool using Scheme 1 RA | 1. Support of SL-PRS transmission in a shared resource pool
2. Max number of SL-PRS Resources
3. Max number of SL-PRS Resources per slot
4. Support downlink pathloss based open loop power control for SL-PRS resource allocation scheme 1
5. Support DL pathloss based open loop power control when SL-PRS resource allocation scheme 2 is configured by NR Uu
 |  | Yes | Yes |  | Per band | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-10 | Transmission of SL-PRS in dedicated resource pool using Scheme 2 RA with full sensing | 1. Support of SL-PRS transmission in a shared resource pool
2. Max number of SL-PRS Resources
3. Max number of SL-PRS Resources per slot
4. Support DL pathloss based open loop power control when SL-PRS resource allocation scheme 2 is configured by NR Uu
 |  | Yes | Yes |  | Per FS | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-11 | Transmission of SL-PRS in dedicated resource pool using Scheme 2 RA with random selection | 1. Support of SL-PRS transmission in a shared resource pool
2. Max number of SL-PRS Resources
3. Max number of SL-PRS Resources per slot
4. Support DL pathloss based open loop power control when SL-PRS resource allocation scheme 2 is configured by NR Uu
 |  | Yes | Yes |  | Per band | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-12 | SL UE Rx-Tx measurement Report for SL-RTT | 1.Support measuring and reporting SL UE Rx-Tx measurements for a UE |  | No | Yes | SL UE Rx-Tx measurement and report is not supported | Per band | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-13 | SL UE RSTD measurement Report for SL-TDOA | 1.Support measuring and reporting SL RSTD measurements for a pair of UEs |  | No | Yes |  | Per band | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-14 | SL UE Azimuth of arrival measurement Report for SL-AoA | 1.Support measuring and reporting SL UE Azimuth of arrival (AoA) measurements for a UE |  | No | Yes |  | Per band | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-15 | SL UE Zenith of arrival measurement Report for SL-AoA | 1.Support measuring and reporting SL UE Zenoth of arrival (ZoA) measurements for a UE |  | No | Yes |  | Per band | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-16 | Additional path reporting for SL-TDOA measurement report | 1. Support of additional detected path timing reporting for K additional paths for SL-TDOA2. Support of RSRPP reporting for additional paths |  | No | Yes | Additional path reporting for SL-TDOA is not supported | Per band | No | No | No | Component 1 candidate values: {1, 2, 4, 6, 8}Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-17 | Additional path reporting for SL-RTT | 1. Support of additional detected path timing reporting for K additional paths for SL-RTT2. Support of RSRPP reporting for additional paths  |  | No | Yes | Additional path reporting for SL-RTT is not supported | Per band | No | No | No | Component 1 candidate values: {1, 2, 4, 6, 8}Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-18 | LOS/NLOS Indicator reporting | Support reporting LoS/NLoS indicator type  |  | No | Yes | LOS/NLOS Indicator reporting is not supported | Per band | n/a | n/a | n/a | Component 1 candidate values: {hard value, hard+soft value}Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-19 | First path RSRPP reporting in SL for SL-TDOA measurement report | Support of SL-RSRPP reporting for first path for SL-TDOA |  | No | Yes |  | per band | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-20 | First path RSRPP reporting in SL for SL-RTT measurement report | Support of SL-RSRPP reporting for first path for SL-RTT |  | No | Yes |  | per band | n/a | n/a | n/a | Need for location server / server UE to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-21 | SL-PRS congestion control in dedicated RP | 1) UE can report CBR measurement to gNB when operating in Mode 1 and mode 2 2) UE can adjust its radio parameters based on CBR measurement and CRlimit.3) UE can process CBR and CR within the time it indicates |  | Yes | No |  | Per band | n/a | n/a | n/a | Component-3 candidate value set{Congestion process time 1, Congestion process time 2} whereCongestion process time 1: 2, 2, 4, 8 slots for 15, 30, 60, 120 kHz subcarrier spacing.Congestion process time 2: 2, 4, 8, 16 slots for 15, 30, 60, 120 kHz subcarrier spacing | Optional with capability signalling. |
| NR\_pos\_enh2  | X-SLPRS-22 | SL-PRS congestion control in shared RP | 1) UE can report CBR measurement to gNB when operating in Mode 1 and mode 2 2) UE can adjust its radio parameters based on CBR measurement and CRlimit.3) UE can process CBR and CR within the time it indicates |  | Yes | Yes |  | Per band | n/a | n/a | n/a | Component-3 candidate value set{Congestion process time 1, Congestion process time 2} whereCongestion process time 1: 2, 2, 4, 8 slots for 15, 30, 60, 120 kHz subcarrier spacing.Congestion process time 2: 2, 4, 8, 16 slots for 15, 30, 60, 120 kHz subcarrier spacing | Optional with capability signalling. |
| NR\_pos\_enh2  | X-SLPRS-23 | Support of open loop SL power control and RSRP report in shared RP | 1. Support sidelink pathloss based open loop power control for SL-PRS and RSRP reporting
 |  | Yes | Yes |  | Per band | n/a | n/a | n/a |  | Optional with capability signaling |
| NR\_pos\_enh2  | X-SLPRS-24 | Support of open loop SL power control and RSRP report in dedicated RP | 1. Support sidelink pathloss based open loop power control for SL-PRS and RSRP reporting
 |  | Yes | Yes |  | Per band | n/a | n/a | n/a |  | Optional with capability signaling |

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| NR\_pos\_enh2  | X-CPP-1a | DL PRS Carrier Phase measurement in RRC\_CONNECTED within a MG | 1. Support of carrier phase measurements in RRC\_CONNECTED state within a MG | [13-1] | No |  |  | * Per band
 | n/a | n/a | n/a | Need for location server to know if the feature is supportedNote: UE supporting this feature shall support the measurement of at least one RSCP or RSCPD  | Optional with capability signaling |
| NR\_pos\_enh2  | X-CPP-1b | DL PRS Carrier Phase measurement in RRC\_INACTIVE | 1. Support of carrier phase measurements in RRC\_ INACTIVE state | [13-1] | No |  |  | * Per band
 | n/a | n/a | n/a | Need for location server to know if the feature is supportedNote: UE supporting this feature shall support the measurement of at least one RSCP or RSCPD | Optional with capability signaling |
| NR\_pos\_enh2  | X-CPP-2 | DL PRS RSCP measurement report of the first path for RTT | 1. Support of reporting the DL PRS RSCP of the first path for RTT positioning method2. The maximum number of first path PRS RSCP measurements per TRP | [13-1,13-4] | No |  |  | Per band | n/a | n/a | n/a | Need for location server to know if the feature is supportedComponent 2 candidate values: {1, 2, 3, 4} | Optional with capability signaling |
| NR\_pos\_enh2  | X-CPP-3 | DL PRS RSCPD measurement report of the first path for UE-assisted DL-TDOA | 1. Support of measuring and reporting the DL PRS RSCPD of the first path for UE-assisted DL-TDOA positioning method2. The maximum number of first path PRS RSCPD measurements per pair of TRPs | [13-1, 13-3] | No |  |  | Per band | No | Yes | N/A | Need for location server to know if the feature is supportedComponent 2 candidate values: {1, 2, 3, 4} | Optional with capability signaling |
| NR\_pos\_enh2  | X-CPP-4 | Assistance data for UE-based Carrier Phase Positioning | Support the assistance data enhancements for UE-based Carrier Phase Positioning | [13-1] | No |  |  | Per UE | N/A | N/A | N/A | Need for location server to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-CPP-5a | Support of Rx Phase Error Group reporting for carrier phase measurements  | 1. Support of Rx PEG IDs for UE-assisted DL TDOA and/or Multi-RTT positioning2. The maximum number of UE-RxPEG, which is supported and reported by UE for carrier phase measurements for UE assisted DL TDOA and/or Multi-RTT positioning | [13-1, X-CPP-2] | No |  |  | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported Component 2 candidate values: {1, 2, 3, 4, 6, 8, 16, 32} | Optional with capability signaling |
| NR\_pos\_enh2  | X-CPP-5b | Support of Tx Phase Error Group reporting for carrier phase measurements for UL TDOA | 1. Support of UE TxPEG IDs for UL-TDOA 2. The maximum number of UE TxPEG, which is supported and reported by UE for carrier phase measurements for UL-TDOA | [13-1, X-CPP-2] | Yes |  |  | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported Component 2 candidate values: {1, 2, 3, 4, 6, 8, 16, 32} | Optional with capability signaling |
| NR\_pos\_enh2  | X-CPP-5b | Support of Tx Phase Error Group reporting for carrier phase measurements for Multi-RTT | 1. Support of UE TxPEG IDs for Multi-RTT positioning2. The maximum number of UE TxPEG, which is supported and reported by UE for carrier phase measurements for Multi-RTT positioning | [13-1, X-CPP-2] | No |  |  | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported Component 2 candidate values: {1, 2, 3, 4, 6, 8, 16, 32} | Optional with capability signaling |
| NR\_pos\_enh2  | X-CPP-5c | Support of PRS PEG association information for UE-based DL-TDOA | Support of reception of association between PRS and TRP Tx PEG for UE-based positioning |  | No |  |  | Per UE | n/a | n/a | n/a | Need for location server to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-5 | Support of Time Window(s) indication for performing measurement  | Support performing measurements on [indicated] DL PRS resources occurring within indicated time window(s). | [13-1] | No |  |  | Per UE | N/A | N/A | N/A | Need for location server to know if the feature is supported | Optional with capability signaling |

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| NR\_pos\_enh2  | X-LPHAP-1 | Area-specific positioning SRS transmission in RRC\_INACTIVE state for initial UL BWP | Support of area-specific positioning SRS transmission in RRC\_INACTIVE state for initial UL BWP |  |  |  | Area-specific Positioning SRS transmission in RRC\_INACTIVE state for initial UL BWP is not supported | Per band | n/a | n/a | n/a | Need for location server to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-LPHAP-2 | Area-specific Positioning SRS transmission in RRC\_INACTIVE state configured outside initial UL BWP  | Support of Area-specific Positioning SRS transmission in RRC\_INACTIVE state configured outside initial UL BWP  | 27-15 | Yes |  | Area-specific Positioning SRS transmission in RRC\_INACTIVE state configured outside initial UL BWP is not supported | Per band | n/a | n/a | n/a | Need for location server to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-LPHAP-3 | PathLoss estimate maintenance across all cells for area-specific SRS transmission in RRC\_INACTIVE | 1. Max number of pathloss estimates that the UE can simultaneously maintain for all the area-specific SRS resource sets for positioning
	* Candidate values are {1, 4, 8, 16}
 |  | Yes | N/A |  | Per UE | No | No | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| NR\_pos\_enh2  | X-LPHAP-4 | Spatial relation maintenance across all cells for area-specific SRS transmission in RRC\_INACTIVE | 1. Max Number of maintained spatial relations for all the area-specific SRS resource sets for positioning across all serving cells.

Values = {0,1,2,4,8,16} |  | Yes | N/A |  | Per UE | No | No (FR2 only) | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| NR\_pos\_enh2  | X-LPHAP-5 | UE autonomous UL timing determinaton for area-specific SRS for Positioning in RRC\_INACTIVE | Support the UE to autonomously adjust the TA such that the UL timing remains constant with respect to the UL timing before reselecting to the new camping cell, when the DL reference timing difference between the last camping cell and the new camping cell exceeds a threshold. |  | Yes | N/A |  | Per UE | No | No | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| NR\_pos\_enh2  | X-LPHAP-6 | Preconfiguration of multiple SRS for positioning | Maximum number of SRS for Positioning pre-configurations for RRC\_INACTIVE state |  | Yes | N/A |  | Per UE | No | No | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| NR\_pos\_enh2  | X-LPHAP-7 | PRS processing in RRC\_IDLE | Support of PRS processing in RRC\_IDLE | 13-1 | Yes |  | PRS processing in RRC\_INACTIVE is not supported | per band | n/a | n/a | n/a | Note: UE supporting this feature shall support at least one from DL RSTD, DL PRS-RSRP, or UE Rx – Tx time difference measurement | Optional with capability signaling. |
| NR\_pos\_enh2  | X-LPHAP-8 | DL PRS processing capabilities in RRC\_IDLE state | 1. DL PRS buffering capabilitya) Type 1 – sub-slot/symbol level bufferingb) Type 2 – slot level buffering2. Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz, which is supported and reported by UE3. Max number of DL PRS resources that UE can process in a slot  |  | No |  | DL PRS processing in RRC inactive state is not supported | Per band | n/a | n/a | n/a | Component 1 candidate values: {Type 1, Type 2}Component 2 candidate values:T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} msN: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} msComponent 3 candidate values:FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHzFR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHzNeed for location server to know if the feature is supportedNote: Having the PRS processing capabilities in RRC\_Idle state does not imply that LMF is aware of or controlling UE RRC state | Optional with capability signaling |
| NR\_pos\_enh2  | X-LPHAP-9 | Support of PRS measurement in RRC\_IDLE state for DL-TDOA | Support of PRS measurement in RRC\_IDLE state for DL-TDOA - location server | 13-3, 27-6 | No |  | PRS measurement in RRC\_IDLE state for DL-TDOA is not supported | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported.Note: Applicable for both UE-assisted and UE-based DL-TDOANote: PRS capabilities for DL-TDOA measurement and reporting described in FGs in 13-3, 13-3a, 13-3b, 13-6, 13-13 are the same for RRC Inactive.Support of PRS processing measurement in RRC\_IDLE state does not imply that LMF is aware of or controlling UE RRC state | Optional with capability signaling |
| NR\_pos\_enh2  | X-LPHAP-10 | Support of PRS measurement in RRC\_IDLE state for DL-AoD | Support of PRS measurement in RRC\_IDLE state for DL-AoD - location server | 13-2, 27-6 | No |  | PRS measurement in RRC\_IDLE state for DL-AoD is not supported | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported.Note: Applicable for both UE-assisted and UE-based DL-AoDNote: PRS capabilities for DL-AOD measurement and reporting described in FGs 13-2, 13-2a, 13-2b, 13-5, 13-13 are the same for RRC Inactive.Support of PRS processing measurement in RRC\_IDLE state does not imply that LMF is aware of or controlling UE RRC state | Optional with capability signaling |
| NR\_pos\_enh2  | X-LPHAP-11 | Support of PRS measurement in RRC\_IDLE state for Multi-RTT | 1. Support of PRS measurement in RRC\_IDLE state for Multi-RTT - location server | 13-4, 13-11, 27-6 | No |  | PRS measurement in RRC\_IDLE state for Multi-RTT is not supported  | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported.Note: PRS capabilities for Multi-RTT measurement and reporting described in FGs in 13-4, 13-4a, 13-4b, 13-11, 13-11a, 13-14 are the same for RRC InactiveSupport of PRS processing measurement in RRC\_IDLE state does not imply that LMF is aware of or controlling UE RRC state | Optional with capability signaling |

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| NR\_pos\_enh2  | X-Agg-1 | DL PRS processing capabilities for aggregated PRS processing of 2 PFLs in intra-band contiguous within a MG | 1. Maximum DL PRS bandwidth in MHz for each PFL, which is supported and reported by UE.

a) FR1 bands: {5, 10, 20, 40, 50, 80, 100}b) FR2 bands: {50, 100, 200, 400}1. Maximum DL PRS bandwidth in MHz summed across both PFLs, which is supported and reported by UE.

a) FR1 bands: {10, 20, 40, 50, 80, 100, 160, 200}b) FR2 bands: {100, 200, 300, 400, 600, 800}1. DL PRS buffering capability for each PFL: Type 1 or Type 2
2. Type 1 – sub-slot/symbol level buffering
3. Type 2 – slot level buffering
4. Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz for each PFL, which is supported and reported by UE.
5. T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
6. N: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms
7. Max number of DL PRS resources that UE can process in a slot for each PFL:
	1. FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHz
	2. FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz

Note: The above parameters are reported assuming a configured measurement gap and a maximum ratio of measurement gap length (MGL) / measurement gap repetition period (MGRP) of no more than 30%. | [13-1] | No |  | Aggregated PRS processing of 2 PFLs in this band is not supported | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported.Notes for component 4:a.UE reports one combination of (N, T) values per band, where N is a duration of DL PRS symbols in ms processed every T ms for a given maximum bandwidth (B) in MHz in each of the PFLs supported by UEb. UE is not expected to support DL PRS bandwidth that exceeds the reported DL PRS bandwidth value in each PFLd.UE DL PRS processing capability is agnostic to DL PRS comb factor configuratione.The reporting of (N, T) values for maximum BW in MHz is not dependent on SCSNote: if the UE does not indicate this capability for a band, the UE does not support this PRS aggregation in this band.Note for component 5: This is not applicable for 1-symbol PRS | Optional with capability signaling |
| NR\_pos\_enh2  | X-Agg-2 | DL PRS processing capabilities for aggregated PRS processing of 3 PFLs in intra-band contiguous within a MG | 1. Maximum DL PRS bandwidth in MHz for each PFL, which is supported and reported by UE.

a) FR1 bands: {5, 10, 20, 40, 50, 80, 100}b) FR2 bands: {50, 100, 200, 400}1. Maximum DL PRS bandwidth in MHz summed across both PFLs, which is supported and reported by UE.

a) FR1 bands: { 10, 15, 20, 30, 40, 50, 60, 80, 100, 120, 150, 180, 200, 240, 300}b) FR2 bands: { 150, 200, 300, 400, 600, 800, 1000, 1200}1. DL PRS buffering capability for a PFL: Type 1 or Type 2
2. Type 1 – sub-slot/symbol level buffering
3. Type 2 – slot level buffering
4. Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz for each PFL, which is supported and reported by UE.
5. T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
6. N: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms
7. Max number of DL PRS resources that UE can process in a slot for each PFL:
	1. FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHz
	2. FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz

Note: The above parameters are reported assuming a configured measurement gap and a maximum ratio of measurement gap length (MGL) / measurement gap repetition period (MGRP) of no more than 30%. | [13-1, X-Agg-1] | No |  | Aggregated PRS processing of 3 PFLs in this band is not supported | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported.Notes for component 4:a.UE reports one combination of (N, T) values per band, where N is a duration of DL PRS symbols in ms processed every T ms for a given maximum bandwidth (B) in MHz in each of the PFLs supported by UEb. UE is not expected to support DL PRS bandwidth that exceeds the reported DL PRS bandwidth value in each PFLd.UE DL PRS processing capability is agnostic to DL PRS comb factor configuratione.The reporting of (N, T) values for maximum BW in MHz is not dependent on SCSNote: if the UE does not indicate this capability for a band, the UE does not support this PRS aggregation in this band.Note for component 5: This is not applicable for 1-symbol PRS | Optional with capability signaling |
| NR\_pos\_enh2  | X-Agg-3 | Support of UE Rx TEGs for measuring the same aggregated DL PRS resources | The maximum number of different UE-RxTEGs that a UE can support to measure the same DL PRS aggregated PRS resources |  | No |  | Up to 1 RxTEG is used to measure the same aggregated DL PRS resources of a TRP |  per band | n/a | n/a | n/a | The candidate values are {2, 3, 4, 6, 8}Need for location server to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-Agg-4 | Support of UE Rx TEGs for measuring the same aggregated DL PRS resources simultaneously | The maximum number of UE Rx TEGs for measuring the same aggregated DL PRS resources simultaneously | 27-1-4 | No |  | No assumption can be made regarding multiple Rx TEGs measuring the same aggregated DL PRS resources simultaneously | Per band | n/a | n/a | n/a | The candidate values are {1,2,3,4,6,8}Need for location server to know if the feature is supported. | Optional with capability signaling |
| NR\_pos\_enh2  | X-Agg-5 | M-sample aggregated measurements in RRC\_CONNECTED | The capability to support reporting an aggregated measurement based on measuring M=1 or 2 samples (instances) of aggregated DL PRS resources | 13-1 | No |  | If the UE does not provide the capability, the UE is assumed to support M=4 only | per band | n/a | n/a | n/a | Need for location server to know if the feature is supportedNote: this feature is supported for both UE-assisted and UE based positioning | Optional with capability signaling |
| NR\_pos\_enh2  | X-Agg-6 | Aggregated SRS Transmissions of 2 SRS for Positioning in intra-band contiguous CCs in RRC\_Connected state | Support of Aggregated SRS Transmissions of 2 SRS for Positioning in intra-band contiguous CCs. * The UE supports the simultaneous transmission in a coherent manner of 2 SRS resources in 2 intra-band contiguous CCs.

Note: No other signal is expected to be simultaneously transmitted with the 2 aggregated SRS resources in the band | [13-8]c | Yes |  | Aggregated SRS Transmissions of 2 SRS for Positioning in intra-band contiguous CCs in this band is not supported | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported. | Optional with capability signaling |
| NR\_pos\_enh2  | X-Agg-7 | Aggregated SRS Transmissions of 3 SRS for Positioning in intra-band contiguous CCs in RRC\_Connected state | Support of Aggregated SRS Transmissions of 3 SRS for Positioning in intra-band contiguous CCs.* The UE supports the simultaneous transmission in a coherent manner of 3 SRS resources in 3 intra-band contiguous CCs, each SRS resource on one CC.

Note: No other channel is expected to be simultaneously transmitted with the 3 aggregated SRS resources in the band | [13-8] | Yes |  | Aggregated SRS Transmissions of 3 SRS for Positioning in intra-band contiguous CCs in this band is not supported | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported. | Optional with capability signaling |
| NR\_pos\_enh2  | X-Agg-8 | Decoupled SRS for Positioning for aggregation from the UL communication CA in RRC\_Connected state - 1 CC without PUSCH/PUCCH | 1. the maximum SRS bandwidth supported for each SCS that UE supports within a single CC
 | [13-8] | Yes |  | If the UE doesn’t report this feature, it doesn’t support the configuration of decoupled SRS for Positioning from the UL Communication CA | Per band | n/a | n/a | n/a | Component 1 candidate values: 1. FR1 bands: {5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100}
2. FR2 bands: {50, 100, 200, 400}

Note: Support the configuration and transmission of periodic SRS within a CC without PUSCH/PUCCH which can be linked for aggregation with an SRS configured within an UL active BWP of a regular UL communication CC | Optional with capability signaling |
| NR\_pos\_enh2  | X-Agg-9 | Decoupled SRS for Positioning for aggregation from the UL communication CA in RRC\_Connected state - 2 CC without PUSCH/PUCCH | 1. Maximum SRS bandwidth supported for each SCS that UE supports within a single CC
 | [X-Agg-8] | Yes |  |  | Per band | n/a | n/a | n/a | Component 1 candidate values: 1. FR1 bands: {5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100}
2. FR2 bands: {50, 100, 200, 400}

Note: Support the configuration and transmission of periodic SRS within 2 CCs without PUSCH/PUCCH which can be linked for aggregation with an SRS configured within an UL active BWP of a regular UL communication CC | Optional with capability signaling |
| NR\_pos\_enh2  | X-Agg-10 | Guard time between and after for the decoupled SRS for Positioning | 1. Guard time needed before and after the aggregated SRS transmissions for the decoupled SRS for Positioning scenario
 | [X-Agg-8] | Yes |  |  | Per band | n/a | n/a | n/a | Values Up to RAN4 | Optional with capability signaling |
| NR\_pos\_enh2  | X-Agg-11 | Aggregated SRS transmissions for 2 SRS for positioning in a band in RRC\_INACTIVE state configured outside initial UL BWP  | 1. Support of aggregated SRS transmissions for 2 SRS for Positioning in a band in RRC\_INACTIVE state configured outside initial UL BWP
2. TBD additional components based on further agreements
 | [27-15b] | Yes |  |  | Per band | n/a | n/a | n/a | Need for location server to know if the feature is supported | Optional with capability signaling |
| NR\_pos\_enh2  | X-Agg-12 | Aggregated SRS transmissions for 3 SRS for positioning in a band in RRC\_INACTIVE state configured outside initial UL BWP  | 1. Support of aggregated SRS transmissions for 3 SRS for Positioning in a band in RRC\_INACTIVE state configured outside initial UL BWP
2. TBD additional components based on further agreements
 | [27-15b] | Yes |  |  | Per band | n/a | n/a | n/a | Need for location server to know if the feature is supported | Optional with capability signaling |

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| NR\_pos\_enh2  | X-Redcap-1 | Support of DL PRS Hopping and processing within a MG | 1. Maximum PRS BW per hop which is supported and reported by UE

a) FR1 bands: {5, 10, 20}b) FR2 bands: {50, 100}1. One or more Frequency domain overlap(s) between hops which are supported and reported by UE

a) {1 PRB, 2 PRBs, 4 PRBs}1. RF Rx retune times between consecutive hops which is supported and reported by the UE

a) FR1 bands: {70 usec, 140 usec}b) FR2 bands: {35 usec, 70 usec}Note: The UE is expected to support both intra-slot and inter-slot PRS hopping | [13-1] | No |  | DL PRS frequency hopping is not supported | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported.. | Optional with capability signaling |
| NR\_pos\_enh2  | X-Redcap-2 | Support of Tx Frequency Hopping SRS for Positioning resources | 1. Maximum number of SRS BW per hop which is supported and reported by UE
2. FR1 bands: {5, 10, 20}
3. FR2 bands: {50, 100}
4. One or more Frequency domain overlap(s) between hops which are supported and reported by UE
5. {0 RPB, 1 PRB, 2 PRBs, 4 PRBs}
6. RF Tx retune times between consecutive hops which is supported and reported by the UE
7. FR1 bands: {70 usec, 140 usec}
8. FR2 bands: {35 usec, 70 usec, 140 usec}
9. Max number of Tx Frequency Hopping SRS Resource Sets for positioning supported by UE per CC.

Values = {1, 2, 4, 8, 12, 16}.1. Max number of P/SP/AP Tx Frequency Hopping SRS Resources for positioning per CC.

Values = {1,2,4,8,16,32,64}1. Max number of P/SP/AP SRS Resources including the SRS resources for positioning per CC per slot.

Values = {1, 2, 3, 4, 5, 6, 8, 10, 12, 14}1. Max number of periodic SRS Resources for positioning per CC.

 Values = {1,2,4,8,16,32,64}1. Max number of periodic SRS Resources for positioning per CC per slot.

Values = {1,2,3,4,5,6,8,10,12,14}Note: The UE is expected to support intra-slot SRS Tx frequency hopping |  | Yes |  | Tx Frequency Hopping SRS for Positioning is not supported | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported.Note: 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. | Optional with capability signaling |
| NR\_pos\_enh2  | X-Redcap-3 | Support of SRS Tx inter-slot Frequency Hopping for SRS for Positioning | Support of inter-slot repetition configuration for an SRS resource for positioning | [X-Redcap-2] | Yes |  | Inter-slot SRS hopping is not supported | per band | n/a | n/a | n/a | Need for location server to know if the feature is supported. | Optional with capability signaling |

 |
| OPPO [9] |

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| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs.** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Note** |
| Y. NR\_pos\_enh2 | Y-1 | Receiving NR sidelink positioning reference signal in shared resource pool | 1) UE can receive NR PSCCH, 2nd SCI conveyed by PSSCH, and SL PRS in a resource pool shared with SL communication.2) UE can attempt to receive SL PRS over Y= NRB non-overlapping RBs per slot.3) UE can receive SL PRS using 30 kHz subcarrier spacing with normal CP in FR1, 120 kHz subcarrier spacing with normal CP FR24) Maximum SL PRS bandwidth in MHz, which is supported and reported by UE.a) [FR1 bands: {5, 10, 20, 40, 50, 80, 100}]b) [FR2 bands: {50, 100, 200, 400}]5) Duration of SL PRS symbols N in units of ms a UE can process every T ms assuming maximum SL PRS bandwidth in MHz, which is supported and reported by UE.a) [T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms]b) [N: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms]6) [Max number of SL PRS resources that UE can process in a slot under it]a) [FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHz]b) [FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz] | 15-1, 15-4 | NA | Yes | Per band | This is the basic FG for NR sidelink positioning |
| Y. NR\_pos\_enh2 | Y-2 | Receiving NR sidelink positioning reference signal in dedicated resource pool | 1) UE can receive NR PSCCH and SL PRS in a resource pool dedicated for SL PRS.2) UE can attempt to receive SL PRS over Y= NRB non-overlapping RBs per slot.3) UE can receive SL PRS using 30 kHz subcarrier spacing with normal CP in FR1, 120 kHz subcarrier spacing with normal CP FR24) Maximum SL PRS bandwidth in MHz, which is supported and reported by UE.a) [FR1 bands: {5, 10, 20, 40, 50, 80, 100}]b) [FR2 bands: {50, 100, 200, 400}]5) Duration of SL PRS symbols N in units of ms a UE can process every T ms assuming maximum SL PRS bandwidth in MHz, which is supported and reported by UE.a) [T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms]b) [N: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms]6) Max number of SL PRS resources that UE can process in a slot under ita) [FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHz]b) [FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120kHz] | 15-1, 15-4 | NA | Yes | Per band | This is the basic FG for NR sidelink positioning |
|  | Y-3 | Transmitting NR sidelink positioning reference signal Scheme 1 in shared resource pool | 1) UE can transmit PSCCH, PSSCH with 2nd SCI, and SL PRS using dynamic scheduling or configured grant type 1 and 2 in Scheme 1 resource allocation.2) UE can monitor DCI format [3\_0] for dynamic scheduling and configured grant type 2 for SL PRS on the same carrier as sidelink.3) UE can transmit SL PRS using 30 kHz and normal CP subcarrier spacing in FR1, 120 kHz subcarrier spacing with normal CP FR24) Support downlink pathloss based open loop power control | 15-2, 15-4 | Yes | Yes | Per band | [This is the basic FG for NR sidelink positioning] |
|  | Y-4 | Transmitting NR sidelink positioning reference signal Scheme 2 in shared resource pool | 1) UE can transmit PSCCH, PSSCH with 2nd SCI, and SL PRS with comb size {1, 2, 4, [6] } using Scheme 2 resource allocation configured by NR Uu or preconfiguration. Up to [8] sidelink processes are supported. 2) UE can perform scheme 2 sensing and resource allocation operations in shared resource pool.3) UE can perform random resource selection in shared resource pool.4) UE can transmit SL PRS using 30 kHz and normal CP subcarrier spacing in FR1, 120 kHz subcarrier spacing with normal CP FR25) Support downlink pathloss based open loop power control | 15-1, 15-4, Y-1 | NA | Yes | Per band | [This is the basic FG for NR sidelink positioning] |
|  | Y-5 | Transmitting NR sidelink positioning reference signal Scheme 1 in dedicated resource pool | 1) UE can transmit PSCCH, and SL PRS with comb size {2, 4, 6, [12] } in SL PRS resource using dynamic scheduling or configured grant type 1 and 2 in NR sidelink mode 1 scheduled by NR Uu. Up to [8] configured grants can be configured for a UE. 2) UE can monitor DCI format [3\_0] for dynamic scheduling and configured grant type 2 for SL PRS on the same carrier as sidelink.3) UE can transmit SL PRS using 30 kHz and normal CP subcarrier spacing in FR1, 120 kHz subcarrier spacing with normal CP FR24) Support downlink pathloss based open loop power control | 15-2, 15-4 | Yes | Yes | Per band | [This is the basic FG for NR sidelink positioning] |
|  | Y-6 | Transmitting NR sidelink positioning reference signal Scheme 2 in dedicated resource pool | 1) UE can transmit PSCCH, and SL PRS with comb size {2, 4, 6, [12] } using Scheme 2 resource allocation configured by NR Uu or preconfiguration. Up to [8] sidelink processes are supported. 2) UE can perform scheme 2 sensing and resource allocation operations in dedicated resource pool.3) UE can perform random resource selection in dedicated resource pool.4) UE can transmit SL PRS using 30 kHz and normal CP subcarrier spacing in FR1, 120 kHz subcarrier spacing with normal CP FR25) Support downlink pathloss based open loop power control | 15-1, 15-4, Y-2 | NA | Yes | Per band | [This is the basic FG for NR sidelink positioning] |
|  | Y-7 | SL PRS Measurement Report for SL-TDOA | 1. SL RSTD measurements and reports per pair of anchor UEs. Values = [{1, 2, 3, 4}]2. Support SL PRS-RSRP measurements and report. Values = {0, 1} | At least one of Y-1 and Y-2 | Yes | Yes | Per band | Optional with capability signaling |
|  | Y-8 | SL PRS Measurement Report for RTT-type SL positioning | 1. Support Rx-Tx time difference measurement and report.2. Support SL PRS-RSRP measurements and report. Values = {0, 1} | At least one of Y-1 and Y-2 | Yes | Yes | Per band | Optional with capability signaling |
|  | Y-9 | SL PRS Measurement Report for AoA | 1. Support SL-PRS based Azimuth of arrival (AoA) and zenith of arrival (ZoA) measurement and report with or without translation of the LCS to GCS for. | At least one of Y-1 and Y-2 | Yes | Yes | Per band | Optional with capability signaling |
|  | Y-10 | Congestion control for SL PRS in dedicated resource pool | 1) UE can report CBR measurement to gNB when operating in Scheme 1 and Scheme 22) UE can adjust its radio parameters based on CBR measurement and CRlimit.3) UE can process CBR and CR within the time it indicates | 15-5, and at least one of Y-5 and Y-6 | Yes | Yes | Per band | [This is the basic FG for NR sidelink positioning] |
|  | Y-11 | Support of open loop SL power control and RSRP report in dedicated resource pool | 1) Support sidelink pathloss based open loop power control and RSRP report in case of unicast in dedicated resource pool | 15-23, and at least one of Y-5 and Y-6 | Yes | Yes | Per band | [This is the basic FG for NR sidelink positioning] |
|  | Y-12 | Support of UE-based sidelink positioning and ranging  | 1. Support measurement on SL PRS for UE based sidelink positioning and ranging. | At least one of Y-1 and Y-2 | Yes | Yes | Per band | Optional with capability signaling |

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| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs.** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Note** |
| Y. NR\_pos\_enh2 | Y-1 | Support DL reference carrier phase difference measurement for DL-TDOA method | 1.Support of DL refrence carrier phase difference measurement along with RSTD measurement. |  |  |  |  |  |
|  | Y-1-1 | DL PRS processing capability for DL reference carrier phase difference measurement for DL-TDOA | 1.Maximum number of DL PRS resources within a give time duration for support of DL reference carrier phase difference measurement2.(N,T) maximum number of DL PRS resource for DL refernce carrier phase difference measurement within given time duration. |  |  |  |  |  |
|  | Y-2 | Support DL reference carrier phase measurement for Multi-RTT | 1.Support of DL refrence carrier phase measurement along with UE Rx-Tx time difference. |  |  |  |  |  |
|  | Y-2-1 | DL PRS processing capability for DL reference carrier phase measurement for multi-RTT | 1.Maximum number of DL PRS resources within a give time duration for support of DL reference carrier phase measurement2.(N,T) maximum number of DL PRS resource for DL reference carrier phase measurement within given time duration. |  |  |  |  |  |
|  | Y-3 | Support DL reference carrier phase measurement for UE-based positioning | 1.Support of DL reference carrier phase measurement for UE-based positioning. |  |  |  |  |  |

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| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs.** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Note** |
| Y. NR\_pos\_enh2 | Y-1 | SRS for positioning pre-configuration for UEs in RRC\_INACTIVE state in validity region | 1. Support of SRS for positioning transmission in RRC\_INACTIVE state for multiple cells2. Maximum number of pre-configured cells for SRS for positioning in RRC\_INACTIVE state |  | Yes | No | 1) Per UE |  |
|  | Y-1-1 | UE autonomous UL timing determinaton for SRS for positioning in RRC\_INACTIVE | 1. Support of UE autonomous UL timing determinaton for SRS for positioning in RRC\_INACTIVE | Y-1 | Yes | No | 1) Per UE |  |
|  | Y-1-2 | Spatial relation information across multiple cells for SRS for positioning in RRC\_INACTIVE | 1. Support of spatial relation information for multiple cells for SRS for positioning in RRC\_INACTIVE2. Maximum number of candidate spatial relation information Values = [1, 2, 4, 8] | Y-1 | Yes | No | 2) Per Band |  |
|  | Y-1-3 | PL RS across multiple cells for SRS for positioning in RRC\_INACTIVE | 1. Support of PL RS for multiple cells for SRS for positioning in RRC\_INACTIVE2. Maximum number of candidate PL RSValues = [1, 2, 4, 8] | Y-1 | Yes | No | 2) Per Band |  |

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| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs.** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Note** |
| Y. NR\_pos\_enh2 | Y-1 | DL PRS processing capability for PRS bandwidth aggregation measurement | 1. Maximum number of PFLs involved in bandwidth aggregation2. Maximum total PRS bandwidth of aggregated DL PRS resource 3. (N, T) the maximum number of DL PRS resources across all involved PFLs within time duration T.  |  |  |  |  |  |
|  | Y-2 | Support bandwidth aggregation of DL PRS in multiple PFLs for DL-TDOA | 1.Support of DL PRS bandwidth aggregation for DL-TDOA2. Maximum number of PFLs for DL PRS bandwith aggregaiton |  |  |  |  |  |
|  | Y-3 | Support bandwidth aggregation of DL PRS in multiple PFLs for multi-RTT | 1.Support of DL PRS bandwidth aggregation for Multi-RTT2. Maximum number of PFLs for DL PRS bandwith aggregaiton |  |  |  |  |  |
|  | Y-4-1 | Support SRS for positioning for bandwidth aggregation | 1.Support of SRS for positioning for bandwidth aggregation2.The maximum number of carriers for bandwidth aggregation of SRS for positioning3.Maximum number of SRS resource sets for positioning that can be configured for bandwidth aggregation4.Maximum number of SRS resources for positioning across all CCs that can be configured for bandwidth aggregation |  |  |  |  |  |
|  | Y-4-2 | Support aperiodic SRS for positioning for bandwidth aggregation | 1.Support of aperiodic SRS for positioning for bandwitdth aggregation2. The minimum latency between triggering DCI and the transmission of SRS for positioning for bandwitdth3.The maximum number of carriers for bandwidth aggregation of aperiodic SRS for positioning4.Maximum number of aperiodic SRS resource sets for positioning that can be configured for bandwidth aggregation5.Maximum number of aperiodic SRS resources for positioning across all CCs that can be configured for bandwidth aggregation |  |  |  |  |  |
|  | Y-4-3 | Support semi-persistent SRS for positioning for bandwidth aggregation | 1.Support of semi-persistent SRS for positioning for bandwitdth aggregation2. The maximum number of carriers for bandwidth aggregation of semi-persistent SRS for positioning4.Maximum number of semi-persistent SRS resource sets for positioning that can be configured for bandwidth aggregation5.Maximum number of semi-persistent SRS resources for positioning across all CCs that can be configured for bandwidth aggregation |  |  |  |  |  |
|  | Y-4-4 | Support same power prioritization for aggregated SRS resources for positioning | 1.Support of applying same power prioritization for SRS resources for positioning for bandwidth aggregation |  |  |  |  | If not supported, legacy power prioritization rule is applied. |

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| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs.** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Note** |
| Y. NR\_pos\_enh2 | Y-1 | PRS with Rx frequency hopping for RedCap UEs | 1. Support of RedCap UEs Rx frequency hopping for PRS reception2. Maximum of PRS bandwidth (in MHz) per hopFR1: {5, 10, 20}FR2: {50, 100}3. Switch times for PRS between consecutive hopsFR1: {70us, 140us}FR2: {35us, 70us, 140us} |  | Yes | No | 2) Per Band |  |
|  | Y-2 | SRS for positioning frequency hopping for RedCap UEs | 1. Support of RedCap UEs Tx frequency hopping for SRS for positioning2. Maximum of SRS for positioning bandwidth (in MHz) per hopFR1: {5, 10, 20}FR2: {50, 100}3. Switch times for SRS for positioning between consecutive hopsFR1: {70us, 140us}FR2: {35us, 70us, 140us} |  | Yes | No | 2) Per Band |  |

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| Nokia/Nokia Shanghai Bell [10] | RAN1 related work on the WI can be divided to several sub-categories based on the WI objectives and sub-objectives:* Sidelink positioning
	+ SL PRS RSRP measurement and reporting
	+ SL PRS RSRPP measurement and reporting
	+ SL PRS based RTOA measurement and reporting
	+ SL PRS based RSTD measurement and reporting
	+ SL PRS based AOA/ZOA measurement and reporting
	+ SL PRS based Rx-Tx time difference measurement and reporting
	+ [SL PRS triggering, too early to say if this is a capability or a basic component]
	+ [SL PRS resource allocation, too early to say if this is a capability or a basic component]
* NR DL and UL carrier phase positioning
	+ UE-based DL carrier phase positioning support
	+ UE-assisted DL carrier phase positioning support
	+ Support for LMF request for DL PRS measurements
	+ PRU support
* LPHAP (Low Power High Accuracy Positioning)
	+ Support for SRS validity area
* Bandwidth aggregation for positioning measurements
	+ Support for PRS based measurements with bandwidth-aggregated PRS for DL PRS RSTD measurement
	+ Support for PRS based measurements with bandwidth-aggregated PRS for UE Rx-Tx time difference measurement
	+ Support for SRS bandwidth aggregation in RRC CONNECTED and INACTIVE
* Positioning for RedCap UEs
	+ Support for PRS with Rx frequency hopping with measurement gaps
	+ Support for SRS with Tx frequency hopping with switching gaps

Similarly to previous releases, this is expected to result in families of rather independent FGs, without strong relationship among them, with pre-requisites defined case-by-case. One basic structure for upcoming discussions is as presented in Table 1 below, which follows a similar structure as that for Rel-16 positioning WI.

|  |  |  |  |
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| **Index** | **Feature group** | **Components** | **Notes** |
| 41-1-1 | Common SL PRS Processing Capability  | 1. Maximum SL PRS bandwidth
2. FFS others
 | Basic FG for positioning techniques based on SL PRS measurements |
| 41-1-1a | SL PRS transmission capability | FFS  | Basic FG for positioning techniques based on SL PRS measurementsFFS if different FGs needed for mode 1 and mode 2 |
| 41-1-2 | SL PRS measurement report for RTOA | FFS | Pre-requisite: FG 41-1-1 |
| 41-1-3 | SL PRS measurement report for RSTD | FFS | Pre-requisite: FG 41-1-1 |
| 41-1-4 | SL PRS measurement report for AoD/ZoA | FFS | Pre-requisite: FG 41-1-1 |
| 41-1-5 | SL PRS measurement report for Rx-Tx time difference | FFS | Pre-requisite: FG 41-1-1 |
| 41-1-6 | SL PRS RSRP measurement and reporting | FFS | Pre-requisite: FG 41-1-1 |
| 41-1-7 | SL PRS RSRPP measurement and reporting | FFS | Pre-requisite: FG 41-1-1 |
| 41-2-1 | UE-based DL carrier phase positioning support with RSTD | FFS  | Pre-requisite: FG 13-6 |
| 41-2-1 | UE-based DL carrier phase positioning support with UE Rx-Tx time difference | FFS | Pre-requisite: FG 13-11 |
| 41-2-3 | UE-assisted DL carrier phase positioning support | FFS |  |
| 41-2-6 | Support for LMF request for DL PRS measurements | Support of RSCPD request with RSTD 1. Support of RSCP request with UE Rx-Tx time difference measurement
 |  |
| 41-2-7 | PRU UE  | Support of reporting UE location. Support of different measurements: {RSCP, RSCPD, RSTD, UE Rx-Tx}1. FFS: Support of SRS for positioning transmission?
 |  |
| 41-3-1 | Support for SRS validity area for LPHAP | Support of spatial relation information Support of path-loss reference RS Support of validity area-specific TA timer |  |
| 41-4-1 | Support for PRS based measuremtents with bandwidth-aggregated PRS | Support of simultaneous reception of multiple PRS resources across multiple PFLsSupport of the maximum number of PFLs to be aggregated1. [ Support of additional (N,T) ]
 |  |
| 41-4-2 | Support for SRS bandwidth aggregation in RRC CONNECTED state | 1. Support the maximum number of CCs to guarantee the phase coherency for the simultaneous transmission of SRS resources.
 |  |
| 41-4-2 | Support for SRS bandwidth aggregation in RRC INACTIVE state | 1. Support the maximum number of CCs to guarantee the phase coherency for the simultaneous transmission of SRS resources.
 | Pre-requisite: FG 27-15 |
| 41-5-1 | Support for PRS with Rx frequency hopping with measurement gaps | the different types of measurements that are supported via Rx hopping. Switching times FR1: {70, 140} us, FR2: {35, 70, 140} us [NOTE this is from RAN4 LS]3. Frequency overlap between hops. Candidate values {1 PRB, 4 PRBs}  | Pre-requisite: FG 13-1 (Common DL PRS Processing Capability), one\_of {28-1 (Rel-17 RedCap), 48-x ( Rel-18 RedCap PR1), 48-y (Rel-18 RedCap PR1 + BW3)} |
| 41-5-2 | Support for SRS with Tx frequency hopping with switching gaps | Switching times FR1: {70, 140} us, FR2: {35, 70, 140} us [NOTE this is from RAN4 LS]Frequency overlap between hops. Candidate values {0, 1 PRB, 4 PRBs}1. Support of SRS configuration separate from UL BWP
 | Pre-requisite: FG 13-8 (SRS Resources for Positioning), one\_of {28-1 (Rel-17 RedCap), 48-x ( Rel-18 RedCap PR1), 48-y (Rel-18 RedCap PR1 + BW3)} |

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# Discussion Items during RAN1 #113 — First Checkpoint

After review of contributions submitted to RAN1 #113 in this agenda item, the following topics were identified by the moderator for discussion during RAN1 #113.

**General comments**

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| --- | --- |
| Company | Comments/Questions/Suggestions |
|  |  |

# Issue 1: Sidelink Positioning

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FGs as baseline for sidelink positioning**

* **All details FFS**

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| 41. NR\_pos\_enh2 | 41-1-1 | Common SL PRS Processing Capability | 1. Maximum SL PRS bandwidth in MHz, which is supported and reported by UE.FR1 bands: {5, 10, 20, 40, 50, 80, 100}2. SL PRS buffering capability: Type 1 or Type 2* 1. Type 1 – sub-slot/symbol level buffering
	2. Type 2 – slot level buffering

3. Duration of SL PRS symbols N in units of ms a UE can process every T ms assuming maximum SL PRS bandwidth in MHz, which is supported and reported by UE.T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} msN: {0.125, 0.25, 0.5, 1, 2, 4, 6, 8, 12, 16, 20, 25, 30, 32, 35, 40, 45, 50} ms4. Max number of SL PRS resources that UE can process in a slotFR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHz |  | No | Yes | UE does not support SL positioning | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported.Notes for component 3:A UE reports one combination of (N, T) values per band, where N is a duration of SL PRS symbols in ms processed every T ms for a given maximum bandwidth (B) in MHz supported by UEb. A UE is not expected to support SL PRS bandwidth that exceeds the reported SL PRS bandwidth valuec. A UE’s SL PRS processing capability is agnostic to SL PRS comb factor configurationd.The reporting of (N, T) values for maximum BW in MHz is not dependent on SCS | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-2 | Receiving SL-PRS in a shared resource pool | UE can receive SL-PRS in a shared resource pool | 15-1, 41-1-1 | Yes | Yes | Receiving SL-PRS in a shared resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-3 | Receiving SL-PRS in a dedicated resource pool | 1. UE can receive SL-PRS in a dedicated resource pool[SL PRS and/or PSCCH]-based RSRP reporting in case of unicast | 15-1, 41-1-1 | Yes | Yes | Receiving SL-PRS in a dedicated resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-4 | Transmitting SL-PRS scheme 1 in a shared resource pool  | UE can transmit SL-PRS using dynamic scheduling or configured grant type 1 and 2 in NR sidelink positioning scheme 1 scheduled by NR Uu in a shared resource pool  | 15-2, 41-1-2 | Yes | Yes | Transmitting SL-PRS scheme 1 in a shared resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-5 | Transmitting SL-PRS scheme 1 in a dedicated resource pool  | 1. UE can transmit SL-PRS using dynamic scheduling or configured grant type 1 and 2 in NR sidelink positioning scheme 1 scheduled by NR Uu in a dedicated resource poolSupport sidelink pathloss based open loop power control | 15-2, 41-1-3 | Yes | Yes | Transmitting SL-PRS scheme 1 in a dedicated resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-6 | Transmitting SL-PRS scheme 2 in a shared resource pool  | UE can transmit SL-PRS using NR sidelink positioning scheme 2 configured by NR Uu or preconfiguration in a shared resource pool.  | 15-3, 41-1-2 | Yes | Yes | Transmitting SL-PRS scheme 2 in a shared resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-7 | Transmitting SL-PRS scheme 2 in a dedicated resource pool  | UE can transmit SL-PRS using NR sidelink positioning scheme 2 configured by NR Uu or preconfiguration in a dedicated resource pool. | 15-3, 41—1-3 | Yes | Yes | Transmitting SL-PRS scheme 2 in a dedicated resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-8 | SL-PRS congestion control in a dedicated resource pool | 1. UE can report CBR measurement to gNB when operating in Mode 1 and mode 2 2. UE can adjust its radio parameters based on CBR measurement and CRlimit.UE can process CBR and CR within the time it indicates | 41-1-3 and either 41-1-5 or 41-1-7  | Yes | Yes | SL-PRS congestion control in a dedicated resource pool is not supported | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-9 | SL PRS Resources for SL-RSTD | TBD on SL PRS resource and resource multiplexing final agreement | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-10 | SL PRS Resources for SL-TDOA | TBD on SL PRS resource and resource multiplexing final agreement | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-11 | SL PRS Resources for SL-AOA | TBD on SL PRS resource and resource multiplexing final agreement | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-12 | SL PRS Resources for Multi-RTT | TBD on SL PRS resource and resource multiplexing final agreement | 41-1-2 and (41-1-4 or 41-1-6) or 41-1-3 and(41-1-5 or 41-1-7) | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-13 | SL PRS measurement report for SL-RSTD | 1. SL-RSTD measurements per pair of UEs (target and reference UE). Values = TBD2. Support SL PRS-RSRP measurements. Values = {0, 1}3. Support SL PRS-RSRPP repoting for first path. Values = {0, 1}4. Support LOS/NLOS indication. Values = {0, 1}. TBD: LOS/NLOS indicator type/granularity indication | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-14 | SL PRS measurement report for SL-TDOA | 1. SL-RTOA measurements per UE. Values = TBD2. Support SL PRS-RSRP measurements. Values = {0, 1}3. Support RSRPP repoting for first path. Values = {0, 1}4. Support LOS/NLOS indication. Values = {0, 1}.TBD: LOS/NLOS indicator type/granularity indication  | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-15 | SL PRS measurement report for SL-AOA | 1. SL-AOA measurements per UE. Values1 = TBD (e.g., # of measurements). Values2 = {Azimuth, Zenith, Azimuth and Zenith}; Values3 = {GCS, LCS}; 2. Support SL PRS-RSRP measurements. Values = {0, 1}3. Support RSRPP repoting for first path. Values = {0, 1}4. Support LOS/NLOS indication. Values = {0, 1}.TBD: LOS/NLOS indicator type/granularity indication  | 41-1-2 or 41-1-3 | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-1-16 | UE Rx-Tx measurement report for SL Multi-RTT | 1. Max number of UE Rx–Tx time difference measurements corresponding to a single SL PRS Tx resource with each measurement corresponding to a single SL PRS Rx resource.2. Value for component 1: [{1,2,3,4}]3. Support RSRP measurements. Values = {0, 1}4. Support RSRPP repoting for first path. Values = {0, 1}5. Support LOS/NLOS indication. Values = {0, 1}. TBD: LOS/NLOS indicator type/granularity indication  | 41-1-2 and (41-1-4 or 41-1-6) or 41-1-3 and(41-1-5 or 41-1-7) | No | Yes |  | Per band | N/A | N/A | N/A | Need for location server or server UE to know if the feature is supported. | Optional with capability signaling |

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| Company | Comments/Questions/Suggestions |
| Qualcomm | FG 41-1-8 mentions that the UE reports a CBR processing time, but does not provide values for the processing time. Our understanding is that all these details will be discussed in subsequent rounds.RAN1 agreed support random selection, partial sensing, and full sensing in a shared resource as well as random selection and full sensing in a dedicated resource pool. In sidelink communications, these features are listed separate and the same is needed for SL positioning.Two more FGs are needed, one for TDM-based multiplexing of SL-PRS from different UEs in the same slot and one for comb-based multiplexing. Both these features significantly increase UE implementation complexity and are are necessary in many deployment scenarios. Therefore, we think it is important to separate these two capabilities. The following two agreements also require FGs for reporting the additional paths and the LoS/NLoS indicator**Agreement**Support SL-based RSTD, Rx-Tx time difference, RToA, AoA, RSRPP measurement and report for the first path and optionally additional path.* No specification impact for how to set the additional path measurements
* From RAN1 perspective, no performance requirements are expected to be defined for the additional-path measurements in Rel-18.

**Agreement**LoS/NLoS indicator can be included in a sidelink positioning measurement report, considering different reporting targets (LMF and UE).* LOS/NLOS indicator specified in Rel-17 positioning is reused as much as possible.
* No specification impact for how to set this indicator.
* From RAN1 perspective, no performance requirements are expected to be defined for setting indicator in Rel-18.
 |
| Futurewei | In Proposal 4, FL suggests that FG UE for inter-UE coordination and congestion control can be further introduced wait for the process of detailed design, however 41-1-8 the congestion control is introdus while the IUC is omitted. We would prefer that IUC and congestion control be treated together, and therefore propose that IUC FG to be added to the table.For FG 41-1-16 we prefer to add [ indication of SL-PRS Tx/Rx timing change] is supported together with UE Rx-Tx measurement support.For FG 41-1-6 and FG 41-1-7 we prefer that the exact configuration to be FFS as the transmission configuration can be from upper layers (LMF, UE) |
| CATT | For FG 41-1-12 and 41-1-16, about the name of “UE Rx-Tx measurement report for SL Multi-RTT”, we prefer to change the wording of “SL Multi-RTT” into “”RTT-type solutions using SL”, according to the related descriptions about the supported SL positioning methods in the R18 Pos WID as follows. * + Specify measurements to support RTT-type solutions using SL, SL-AoA, and SL-TDOA [RAN1, RAN2].

In fact, the “”RTT-type solutions using SL” includes single-side RTT and double-side RTT, and it may be SL single-RTT instead of SL multi-RTT.The updated name of FG 41-1-12 should be : SL PRS Resources for RTT-type solutions using SL ~~Multi-RTT.~~The updated name of FG 41-1-16 should be : UE Rx-Tx measurement report for RTT-type solutions using SL ~~Multi-RTT.~~ |
| Huawei, HiSilicon | We agree with Futurewei, and IUC and congestion control should be treated in the same way.For 41-1-1, except for the bandwidth, we currently do not support introducing 41-1-1, at least it should be further discussed. SL-positioning could be different from Uu positioning, and UE should be anyway processing SCI prior to SL-PRS reception.For 41-1-4, for SL-PRS Tx in shared RP, we do not think we should have split FGs for scheme 1 and scheme 2. Having a single SL-PRS Tx in shared RP should be sufficient as long as UE reports the support of mode 1 and mode 2 for data respectively.For 41-1-8, for component 1, the mode 1 and mode 2 should be changed to scheme-1 and shcmeme-2.For 41-1-13 to 16 related measurement FGs, we prefer to currently focus on measurement itself. Whether it needs to be associated with a positioning method should be discussed further. |
| ZTE | 41-1-9 to 41-1-12 are not needed or should be combined since the resources are only for transmit or received which can be common for positioning methods. |
| Samsung | We think that 41-1-3 can be mandatory if 41-1-1 is supported.Depeding on the slot structure, 41-1-4 and 41-1-5 could be merged to a single capability (UE supports transmitting SL-PRS scheme 1). Then whether it is in dedicated, shared, resource pools or both can be obtained by combining 41-1-2 with 41-1-3. And same comments apply for 41-1-6 and 41-1-7.If 41-1-8 is capability, then it should be mandatory, otherwise SL positioning performance can be severely impacted. |
| Apple | We think that there should be more granularity in the support on the different types of SL positioning methods i.e. ***Basic capability support for each of (1) single sided RTT-type operation (2) Double sided RTT-type operation (3) SL-AoA operation, (4) DL-TDOA-like operation (5) UL-TDOA-like operation*** ***This is based on the following agreements in the SI***AgreementFor SL-TDOA, DL-TDOA-like operation and UL-TDOA-like operation should be introduced.* A UE is not required to support both DL-TDOA-like operation and UL-TDOA-like operation

AgreementWith regards to the RTT-type solutions using SL, both single-sided and double-sided RTT methods should be introduced* Strive to minimize the changes needed on top of the specification support for single-sided RTT, if any, for the introduction of double-sided RTT.
* Note: a UE should be able to support single-sided RTT without having to support double-sided RTT

***On OLPC, wonder why this is combined in 41-1-5 rather than a separate FG like Uu positioning (13-9) and SL (15-23). Also, may need to have OLPC for the shared case once the design is finalized.*** |
| vivo | For 41-1-8, the CBR has not been discussed, we think details can be determined after the discussion in the agenda 9.5.1.3. For FG 41-1-9~12, considering there is no conclusion on separate method-based configuration/report or unify configuration/report for different positioning methods, it is not suitable to directly reuse the FGs of DL PRS resources capabilities of different methods for ‘SL-PRS resource capabilities’.,So, we prefer ro change 41-1-9 as follows and remove 41-1-10~41-1~12

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| 41. NR\_pos\_enh2 | 41-1-9 | SL PRS Resources for SL measurement |

For FG 41-1-13~16, we also prefer to focus on measurements instead of positioning methods. ,So, we prefer ro change 41-1-13 as follows and remove 41-1-14~41-16

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| 41. NR\_pos\_enh2 | 41-1-13 | SL PRS measurement report for SL positioning |

In addition, we think ARP related capabilities should be included as a new FG with the following example.FG 41-1-x, per ARP measurement and report for SL measurementFG-41-1X, ARP information provision of UE for sidelink positioning Component 1: ARP location information provision of assistance information for sidelink positioning   Besides, the comb-based and TDMed-based multiplexing in a slot are introduced for SL-PRS in the dedicated resource pool, one more FG is needed for TDM-based multiplexing and comb-based multiplexing of SL-PRS from different UEs in the same slot.  |
| OPPO | Following 2 FGs should be included: “Support of open loop SL power control and RSRP report in dedicated resource pool” and “Support of UE-based sidelink positioning and ranging”.We prefer to merge the components of FG 41-1-1 into 41-1-2 an 41-1-3, as the commo processiong capabilities are for SL PRS reception only, not relavent to SL PRS transmitting.No agreement so far supports introducing FG 41-1-9~41-1-12. |

# Issue 2: Carrier Phase Positioning

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FGs as baseline for carrier phase positioning**

* **All details FFS**

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| 41. NR\_pos\_enh2 | 41-2-1 | DL RSCP reporting based on DL PRS | DL RSCP is reported along with UE Rx-Tx Measurement Report for Multi-RTT | 13-11 | No | N/A | DL RSCP reporting based on DL PRS is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-2-2 | DL RSCPD reporting based on DL PRS | DL RSCPD is reported along with measurement report for DL-RTOA | 13-6 | No | N/A | DL RSCPD reporting based on DL PRS is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-2-3 | DL RSCP reporting based on DL PRS in RRC\_INACTIVE | DL RSCP is reported along with UE Rx-Tx Measurement Report for Multi-RTT | 27-18c | No | N/A | DL RSCP reporting based on DL PRS in RRC\_INACTIVE is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-2-4 | DL RSCPD reporting based on DL PRS in RRC\_INACTIVE | DL RSCPD is reported along with measurement report for DL-RTOA | 27-18a | No | N/A | DL RSCPD reporting based on DL PRS in RRC\_INACTIVE is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-2-5 | DL PRS processing capabilities for DL RSCP or DL RSCPD measurements | 1. Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz, which is supported and reported by UE | 13-1 | No | N/A | DL PRS processing capabilities for DL RSCP or DL RSCPD measurements is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-2-6 | DL PRS processing capabilities for DL RSCP or DL RSCPD measurements in RRC\_INACTIVE | 1. Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz, which is supported and reported by UE | 27-6 | No | N/A | DL PRS processing capabilities for DL RSCP or DL RSCPD measurements in RRC\_INACTIVE is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-2-7 | Measurement on DL PRS within the indicated time window(s) | Supported measurements on DL PRS on [indicated] DL RS resources occuring within idnicated time windows.  | 13-1 | No | N/A | Measurement on DL PRS within the indicated time window(s) is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-2-8 | Transmission of SRS for positioning within the indicated time window(s) | Support of transmission of SRS for positioning within the indicated time window(s) |  | No | N/A | Transmission of SRS for positioning within the indicated time window(s) is not supported | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |

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| Company | Comments/Questions/Suggestions |
| Qualcomm | The first features seem to focus on the ‘reporting capability” but we think there needs to be a “measurement capability” similar to what we did for legacy measurements. This will be reported for a UE doing UE-based for example: * “Support of carrier phase measurements in RRC\_CONNECTED state within a MG” and
* “DL PRS Carrier Phase measurement in RRC\_INACTIVE”.

Similarly, for UE-based, there will be assistance data enhancements, and a corresponding capability is needed: “Assistance data for UE-based Carrier Phase Positioning” |
| CATT | FG 41-2-2: Typo “DL RSCPD is reported along with measurement report for DL-RTOA”, where “DL-RTOA” should be “DL-TDOA”FG 41-2-3: Make the high-lighted change to the description “DL RSCP is reported along with UE Rx-Tx Measurement Report for Multi-RTT in RRC\_INACTIVE”.FG 41-2-4: Make the high-lighted change to the description “DL RSCPD is reported along with measurement report for DL-TDOA in RRC\_INACTIVE”FG 41-2-5: We are not sure there is need to have a separate DL PRS processing capabilities for CPP. All legacy DL positioning methods have the same DL PRS common processing capabilities. This should apply to CPP.FG 41-2-6: We are not sure there is need to have a separate DL PRS processing capabilities for CPP in RRC\_INACTIVE. All legacy DL positioning methods have the same DL PRS common processing capabilities. This should apply to CPP. |
| Qualcomm | To CATT: If a UE is doing UE-based CPP, it will not support the reporting capabilities, but it has to support some CPP capability. Can you suggest which one that will be?  |
| Huawei, HiSilicon | We prefer not to introduce 41-2-5 or 41-2-6. As of now, the RSCP/RSCPD measurement is quite like Rel-17 RSRPP measurement and reporting, and we do not prefer to introduce separate processing capabilities.For 41-2-8, we do not support this. The transmission of SRS is managed by gNB configuration. |
| ZTE | 41-2-1 and 41-2-2 should be combined, the prerequisite is legacy RTT and TDOA since carrier phase method now is not a standalone method. We think 41-2-5 and 41-2-6 are needed since UE needs to extra operations to abstract the phase and need implementation extra cost.  |
| Intel | **To Qualcomm:** the FGs to cover the measurement capabilities are expected to be covered by FGs 41-2-5 and 41-2-6. 1. We can add a note for each of these FGs to the effect: “A UE that does not report support of this FG is summeded to not support DL RSCP or DL RSCPD measurements”. 2. Further, we could reorder the FG indexing and promote FGs 41-2-5 and 41-2-6 at the beginning of the list and add FG 41-2-5 as pre-requisite for FGs 41-2-1, 41-2-2 and add FG 41-2-6 as pre-requisite for FGs 41-2-3 and 41-2-4.Also, we agree with Huawei that FG 41-2-8 is not necessary.  |
| Samsung | QC’s comment makes sense to keep homogeneity on how the positioning methods are signaled by UE capability.We also prefer adding the measurement capability. |
| Apple | On making a decision for single vs multi-frequency measurements, this needs to be captured as a capabilityIs there a need to differentiate a PRU and a normal UE based on capabilities ? |
| vivo | For DL PRS processing capability of CPP, in our view, the processing of PRS should include the processing of the entire channel and include the processing of the phase, PRS processing separate processing capability FG41-2-5/6 may not be introduced.Also, we agree with Huawei and intel that FG 41-2-8 is not necessary since the indicated time window for UL transmission should be invisible to UE |

# Issue 3: LPHAP

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FGs as baseline for LPHAP**

* **All details FFS**

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| 41. NR\_pos\_enh2 | 41-3-1 | SRS for positioning configuration in multiple cells for UEs in RRC\_INACTIVE state | SRS for positioning configuration in multiple cells for UEs in RRC\_INACTIVE state with common configuration of SRSPos resource set and SRSPos resources | 27-15 | Yes | N/A | SRS for positioning configuration in multiple cells for UEs in RRC\_INACTIVE state is not supported | Per band | N/A | N/A | N/A |  | Optional with capability signalling |
| 41. NR\_pos\_enh2 | 41-3-2 | PRS measurement in RRC\_IDLE | Support PRS measurement in RRC\_IDLE |  | Yes | N/A | PRS measurement in RRC\_IDLE is not supported | Per band | N/A | N/A | N/A |  | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
| Qualcomm | * We suggest 41-3-1 to be split in 2 similar to Rel-17 RRC inactive SRS capabilities: “RRC\_INACTIVE state for initial UL BWP” and “RRC\_INACTIVE state configured outside initial UL BWP”
* We also think it is essential to have a separate maximum number of the maximum simultaneous RS for pathloss reference and spatial relation: “PathLoss estimate maintenance across all cells for area-specific SRS transmission in RRC\_INACTIVE” & “Spatial relation maintenance across all cells for area-specific SRS transmission in RRC\_INACTIVE”
* For PRS in RRC Idle, the UE should be able to report the new PRS processing capabilities “DL PRS processing capabilities in RRC\_IDLE state”
* Similar to RRC inactive PRS processing, we need oto have: “Support of PRS measurement in RRC\_IDLE state for DL-TDOA”, “Support of PRS measurement in RRC\_IDLE state for Multi-RTT”, “Support of PRS measurement in RRC\_IDLE state for DL-AoD”
 |
| Huawei, HiSilicon | Reply to QC:On FG 41-3-1, we do not see the need to split into inside initial UL BWP and outside initial BWP. This feature should be jointly considered with FG 27-15 and FG 27-15b. Likewise we do not need to introduce SP-SRS for validity area as well. Otherwise the UE capability signaling will explode.On FG 41-2-3, we prefer to reuse the RRC\_INACTIVE state capability. It is not clear to us why they would be different, assuming there is no gap or PPW anyway. We do not prefer to explicity include the support of PRS measurement for RTT in RRC\_INACTIVE state, but it is not working for RRC\_INACTIVE state and UE is not switching within RRC states between Rx and Tx. |
| ZTE | On FG 41-3-1, share the same view as Huawei. The prerequiste can be Rel-17 FGs for initial BWP and outside BWP. |
| Intel | We share same views as Huawei on both the points. We do not need to split 41-3-1 for the cases inside and outside initial UL BWP – these can be referred to existing FGs 27-15 and 27-15b. Also, we do not see a justification that the RRC\_INACTIVE state capability cannot be reused for 41-3-2.  |
| Samsung | We share the same view as Qualcomm and think that the PRS processing capability needs to be added (per BC optional). The values for maximum aggregated DL PRS bandwidth could be different for FR1 and FR2. |
| Apple | We agree with QC and Samsung on the need for a new PRS processing capability and to separate it per positioning method. |
| vivo | Regarding the UE feature for PRS measurement in RRC\_IDLE, we think most UE features in RRC\_INACTIVE can be reused, such as FG27-6, FG27-17, FG27-18a/b, except for the FG of Rx-Tx measurement which is also related to SRS transmission in IDLE. |
| OPPO | On FG 41-3-1, we are fine with it. And we don’t think it is necessary to split it into two parts, one for initial UL BWP and the other one for outside of the initial UL BWP. On FG 41-3-2, we also prefer to reuse UE capability of RRC\_INACTIVE, since this whole feature is considered for UEs in RRC\_INACTIVE state.  |

# Issue 4: Bandwidth Aggregation

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FGs as baseline for bandwidth aggregation**

* **All details FFS**

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| 41. NR\_pos\_enh2 | 41-4-1 | Support of PRS bandwidth aggregation in RRC\_CONNECTED — DL-TDOA | Support of PRS bandwidth aggregation across multiple PFLs in RRC\_CONNECTED for DL-TDOA positioning methods | 13-1 | No | N/A | PRS bandwidth aggregation across multiple PFLs in RRC\_CONNECTED state is not supported for DL-TDOA positioning methods | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-1 | Support of PRS bandwidth aggregation in RRC\_CONNECTED — Multi-RTT | Support of PRS bandwidth aggregation across multiple PFLs in RRC\_CONNECTED for Multi-RTT positioning methods | 13-1 | No | N/A | PRS bandwidth aggregation across multiple PFLs in RRC\_CONNECTED state is not supported for Multi-RTT positioning methods | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-2 | Support of PRS bandwidth aggregation in RRC\_ INACTIVE — DL-TDOA | Support of PRS bandwidth aggregation across multiple PFLs in RRC\_ INACTIVE for DL-TDOA positioning methods | 27-18 | [Yes] | N/A | PRS bandwidth aggregation across multiple PFLs in RRC\_INACTIVE state is not supported for DL-TDOA positioning methods | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
|  |  | Support of PRS bandwidth aggregation in RRC\_ INACTIVE — Multi-RTT | Support of PRS bandwidth aggregation across multiple PFLs in RRC\_ INACTIVE for Multi-RTT positioning methods | 27-18 | [Yes] | N/A | PRS bandwidth aggregation across multiple PFLs in RRC\_INACTIVE state is not supported for Multi-RTT positioning methods | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-3 | Support of PRS bandwidth aggregation in RRC\_IDLE — DL-TDOA | Support of PRS bandwidth aggregation across multiple PFLs in RRC\_IDLE for DL-TDOA positioning methods | FFS | FFS | N/A | PRS bandwidth aggregation across multiple PFLs in RRC\_IDLE state is not supported for DL-TDOA positioning methods | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-3 | Support of PRS bandwidth aggregation in RRC\_IDLE — Multi-RTT | Support of PRS bandwidth aggregation across multiple PFLs in RRC\_IDLE for Multi-RTT positioning methods | FFS | FFS | N/A | PRS bandwidth aggregation across multiple PFLs in RRC\_IDLE state is not supported for Multi-RTT positioning methods | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-4 | Support of positioning SRS bandwidth aggregation in RRC\_CONNECTED — DL-TDOA | Support of positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_CONNECTED for DL-TDOA positioning methods | 13-8, 6-2 | Yes | N/A | Positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_CONNECTED state is not supported for DL-TDOA positioning | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-4 | Support of positioning SRS bandwidth aggregation in RRC\_CONNECTED — Multi-RTT | Support of positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_CONNECTED for Multi-RTT positioning methods | 13-8, 6-2 | Yes | N/A | Positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_CONNECTED state is not supported for Multi-RTT positioning methods | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-5 | Support of positioning SRS bandwidth aggregation independent from UL communication CA in RRC\_CONNECTED — DL-TDOA | Support of positioning SRS bandwidth aggregation in RRC\_CONNECTED that is decoupled from the UE support of communication CA for DL-TDOA positioning methods | 13-8 | Yes | N/A | Positioning SRS bandwidth aggregation in RRC\_CONNECTED state that is decoupled from the UE support of communication CA is not supported for DL-TDOA positioning | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-5 | Support of positioning SRS bandwidth aggregation independent from UL communication CA in RRC\_CONNECTED — Multi-RTT | Support of positioning SRS bandwidth aggregation in RRC\_CONNECTED that is decoupled from the UE support of communication CA for Multi-RTT positioning methods | 13-8 | Yes | N/A | Positioning SRS bandwidth aggregation in RRC\_CONNECTED state that is decoupled from the UE support of communication CA is not supported for Multi-RTT positioning methods | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-6 | Support of positioning SRS bandwidth aggregation in RRC\_INACTIVE — DL-TDOA | Support of positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_INACTIVE for DL-TDOA positioning methods | 27-15 | Yes | N/A | Positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_INACTIVE state is not supported for DL-TDOA positioning | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-4-6 | Support of positioning SRS bandwidth aggregation in RRC\_INACTIVE — Multi-RTT | Support of positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_INACTIVE for Multi-RTT positioning methods | 27-15 | Yes | N/A | Positioning SRS bandwidth aggregation across intra-band contiguous carriers in RRC\_INACTIVE state is not supported for Multi-RTT positioning methods | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |

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| Company | Comments/Questions/Suggestions |
| Qualcomm | The “PRS processing capabilities” are missing, which are the most important FGs for PRS processing. A UE should be able to report* Maximum DL PRS bandwidth in MHz for each PFL, which is supported and reported by UE.
* Maximum DL PRS bandwidth in MHz summed across both PFLs, which is supported and reported by UE.
* DL PRS buffering capability for a PFL: Type 1 or Type 2
* Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz for each PFL, which is supported and reported by UE.
* Max number of DL PRS resources that UE can process in a slot for each PFL:

The above needs to be different for the case of aggregating 2 PFLs and 3 PFLs. Similarly for SRS. We don’t see how a single FG that says “Support BW aggregation” is useful. We suggest to add these FGs as baseline for discussion: * “DL PRS processing capabilities for aggregated PRS processing of 2 PFLs in intra-band contiguous within a MG”
* DL PRS processing capabilities for aggregated PRS processing of 3 PFLs in intra-band contiguous within a MG

With regards to UL, we believe that there should be different FG for the aggregation of 2 CCs or 3 CCs. Is the assumption that the UE will report as a component in the corresponding FG whether it supports 2 or 3 CCs aggregation?  |
| CATT | Typo: FG 41-4-4/5/6: Change DL-TDOA to UL-TDOA.  |
| Huawei, HiSilicon | For FG 41-4-4 to FG 41-4-6, we do not need separate FGs for DL-TDOA (typo?) and Multi-RTT.Regarding SRS BW aggregation for basic mode and decoupled mode, we prefer to combine them by having a separate BW class indication. |
| ZTE | For DL, One FG is sufficient for each of RRC\_CONNECTED sate, RRC\_INACTIVE state, RRC\_idle state, i.e. it is unnecessary to have two FGs for TDOA and RTT since the prerequiste can be the legacy TDOA and RTT.For UL, it is only for SRS transmission. It is also unnecessary to separate FGs for TDOA and RTT.The PRS processing capabilities are missing which should be separate FGs for RRC\_CONNECTED sate, RRC\_INACTIVE state.  |
| Intel | We are open to deifning separate capabilities for PRS and SRS BW aggregation for up to 2 vs. 3 PFLs and 2 vs. 3 UL CCs respectively. However, we are not convinced that capabilities like DL PRS processing or buffering capabilities need to be separately reported for PRS aggregation – PRS aggregation is limited to PFLs within a band, and accordingly, e.g., the capabilities from FG 13-1 can be reused. Similarly, agree with Huawei and ZTE that we do not need to split FGs for TDOA and RTT – certainly not for UL. |
| Apple | There needs to be c***apabilities for DL-PRS resources that can be processed / UL SRSs transmitted over the aggregation e.g. number of resources across aggregated BW, TRPs, time domain behavior such as aperiodic, semi-persistent, or periodic, SCSs******On the BW aggregation, we think that a UE should be able to indicate if it can support up to 3 aggregations or only 2***  |
| vivo | Firstly, we are OK to introduce 2 FGs corresponding to PRS processing capability of 2 PFLs and 3 PFLs respectively. And whether PRS processing capability is within MG or PPW, we can wait for the progress in AI 9.5.Then, for FG 41-4-3, we have concerns that due to SRS transmission in RRC\_IDLE is not supported, how to support Rx-Tx time difference measurement in RRC\_IDLE. Maybe we can discuss this feature after Rx-Tx time difference in RRC\_IDLE is clearly supported.. |

# Issue 5: RedCap Positioning

After review of contributions submitted to RAN1 #113 in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FGs as baseline for RedCap positioning**

* **All components FFS**

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| 41. NR\_pos\_enh2 | 41-5-1 | Support of PRS with Rx frequency hopping for RedCap UEs | 1. Support of PRS with Rx frequency hopping for Redcap UEs2. [For FR1, switching time of [{70us, 140us}] and PRS Rx frequency hopping range up to 100MHz]3 [For FR2, switching time of [{35us, 70us, 140us}] and PRS Rx frequency hopping range up to 400MHz]4. [Frequency overlap between hops. Candidate values {1 PRB, 4 PRBs}] | 13-1 | Yes | N/A | PRS with Rx frequency hopping for Redcap UEs is not supported | Per band | N/A | N/A | N/A |  | Optional with capability signaling |
| 41. NR\_pos\_enh2 | 41-5-2 | Support of positioning SRS with Tx frequency hopping for RedCap UEs | 1. Support of positioning SRS with Tx frequency hopping for Redcap UEs2. [For FR1, switching time of [{70us, 140us}] and positioning SRS Tx frequency hopping range up to 100MHz]3. [For FR2, switching time of [{35us, 70us, 140us}] and positioning SRS Tx frequency hopping range up to 400MHz]4. [Frequency overlap between hops. Candidate values {0, 1 PRB, 4 PRBs}]5. [Support of SRS configuration separate from UL BWP] | 13-8 | Yes | N/A | Positioning SRS with Tx frequency hopping for Redcap UEs is not supported | Per band | N/A | N/A | N/A |  | Optional with capability signaling |

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| Company | Comments/Questions/Suggestions |
| Qualcomm | We believe that the main capability on DL PRS Frequency hopping should include a “PRS processing capability” that includes: * Maximum PRS BW per hop which is supported and reported by UE
* Maximum DL PRS bandwidth across all hops.
* Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz across all hops, which is supported and reported by UE
* Max number of DL PRS resources that UE can process in a slot

We are OK to put it in brackets, but we should have an FG with such information, or add those components in the main 41-5-1 FG. Second, we also think that a UE can support multiple supportable overlap options and it should not appear as if only 1 overlap value is supported. * One or more Frequency domain overlap(s) between hops which are supported and reported by UE

 |
| Futurewei | The fourth item in both 41-5-1 and 41-5-2, that is the candidate values the frequency overlap between hops should exclude the guard bands on either side of the channel when the number of PRBs is greater than 0. It does not serve any purpose if the overlapping frequency is covering the guard bands.  |
| CATT | For 41-5-1, about Component 4, we prefer to add the new value of “0” into the candidate values of frequency overlap between hops. Therefore, the updated candidate values should be {0, 1 PRB, 4 PRBs}. |
| Huawei, HiSilicon | We think FG 41-5-1 should be RAN4 to decide. |
| ZTE | We support the two FGs. The details should be further discussed. For DL, 1. Maximum number H of hops for PRS Rx frequency hopping, which is supported and reported by UE.H: {2, 3, 4, 5}  **Note1**: the bandwidth of each hop refers to FG 28-12. Overlapping PRB(s) between adjacent hops or a capability on the maximum equivalent bandwidth after combing all hops3. Duration of DL PRS symbols NFH in units of ms a UE can process every TFH ms assuming maximum DL PRS bandwidth after F PFLs aggregation in MHz, which is supported and reported by UE.For UL1. Maximum number H of hops for SRS Tx frequency hopping, which is supported and reported by UE.H: {2, 3, 4, 5}  **Note1**: the bandwidth of each hop refers to FG 28-12. Overlapping PRB(s) between adjacent hops or a capability on the maximum equivalent bandwidth after combing all hops |
| Intel | To QC’s comment, we are not convinced that the DL PRS processing capabilities from FG 13-1 cannot be used for FG 41-5-1. The reduction in UE complexity is primarily coming from the BW reduction already on a “per-FH basis”, and thus, it is not clear if we need to define new PRS processing capabilities for PRS Rx w/ FH.  |
| Samsung | PRS processing capability is needed. |
| Apple | * A capability with details on RedCap UE processing capabilities for DL PRS with Rx frequency hopping and MG: Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS transmission/total bandwidth in MHz, which is supported and reported by UE
* A capability indicting support for a shorter RF switching time to allow RF retuning between adjacent hops. This may be dependent on the RAN4 reply
 |
| vivo | For 41-5-1 component 1, we prefer to add ‘within a MG’, since PPW-based Rx hopping is not supported. 1. Support of PRS with Rx frequency hopping within a MG for Redcap UEsFor 41-5-1, another component of ‘ support of Rx frequency hopping within a DL PRS resource’ should be added based on existing agreement.**Agreement(RAN1#112)**

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| 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
 |

For 41-5-1, regarding other detailed components such as PRS processing capability, overlap, etc., we can wait for the progress in AI 9.5.5 or handled by RAN4.Then, due to the following agreements, we think FG for Rx hopping measurement report should be introduced, such asFG 41-5-x Support of DL Rx hopping measurement reportComponent 1 A single measurement based on receiving multiple hops of the DL PRSComponent 2 One [or more] measurements where each measurement is associated with one received hop

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| **Agreement(RAN1#112bis)**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 [or more] measurements where each 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 |

For FG41-5-2 component 1, we think it should be updated due to the following agreement1. Support of positioning SRS with Tx frequency hopping within one SRS for positioning resource for Redcap UEs

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| **Agreement (RAN1#112bis)**For RedCap UEs, SRS for positioning Tx frequency hopping is configured within one SRS for positioning resource. |

 |
| OPPO | On both FG 41-5-1 and FG 41-5-2, we are fine with these two groups and open for more discussion on components.  |

# Discussion Items during RAN1 #113 — Second Checkpoint

Based on the comments/questions/suggestions received by the first checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 3 will not be considered]***

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Discussion Items during RAN1 #113 — Third Checkpoint

Based on the comments/questions/suggestions received by the second checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 4 will not be considered]***

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Summary of Final Proposals for Agreements

This Section summarizes the final proposals for agreement in RAN1 #113 by email. There are no tables for comments.

***[All comments must be directly made on the RAN1 email reflector]***

Companies can continue to update their comments in the previous Sections, however, these are no longer monitored by the moderator. Any such comments will be for archival purposes only and will not influence the outcome of this email discussion. Any objection to any of the proposals in this Section must be voiced directly on the RAN1 email reflector.

**Possible Agreement: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Conclusion

After further discussion on the RAN1 email reflector the following was agreed as part of this email discussion:

# References

1. R1-2304227, Initial RAN1 UE features list for Rel-18 NR after RAN1#112bis-e, Moderators (AT&T, NTT DOCOMO, INC.)
2. R1-2304508, Discussion on Rel-18 positioning UE features, vivo
3. R1-2304666, UE features for expanded and improved NR positioning, Huawei/HiSilicon
4. R1-2304720, Discussion on UE features for expanded and improved NR positioning, CATT
5. R1-2304835, UE features for Rel-18 positioning, Intel Corporation
6. R1-2304934, Discussion on UE feature for Rel-18 NR positioning, ZTE
7. R1-2305276, Vieww on UE features for expanded and improved NR positioning, Apple
8. R1-2305368, UE features on Expanded and improved NR Positioning, Qualcomm Incorporated
9. R1-2305469, Discussion on UE features for expanded and improved NR positioning, OPPO
10. R1-2305719, Initial views on UE features for expanded and improved NR positioning, Nokia/Nokia Shanghai Bell