**3GPP TSG RAN WG1 #100bis-e R1-20xxxxx**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on Email discussion [100b-e-NR-UEFeatures-Positioning-01]

Agenda Item: 7.2.11.8

**Document for:** **Discussion and Decision**

# **Introduction**

This contribution summarizes the following email discussion in AI 7.2.11.8 regarding UE features for NR positioning.

[100b-e-NR-UEFeatures-Positioning-01] Email discussion/approval on reconstructing the feature group structure for NR positioning (20th-24th April) – Hiroki (DCM)

* Reconstruct the features list to align with agreed capability signaling in RAN2
	+ Starting from rapporteur’s updated features list below
	+ In this email discussion, the target is to confirm reconstructed FGs that cover all the feature groups in [R1-2001484](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001484.zip)

|  |  |
| --- | --- |
| 13-1 | NR E-CID DL SSB RRM measurements for NR Positioning |
| 13-2 | NR E-CID DL CSI-RS RRM measurements for NR Positioning |
| 13-3 | Basic DL PRS Processing Capability |
| 13-4 | DL PRS QCL Processing Capability |
| 13-5 | DL PRS Resources for DL AoD |
| 13-6 | DL PRS Measurement Report for DL-AoD |
| 13-7 | DL PRS Resources for DL-TDOA |
| 13-8 | DL PRS RSTD Measurement Report for DL-TDOA |
| 13-9 | SRS Resources for Positioning |
| 13-10 | OLPC for SRS for Positioning |
| 13-11 | Spatial Relation for SRS for Positioning |
| 13-12 | DL PRS Resources for Multi-RTT |
| 13-13 | UE Rx-Tx Measurement Report for Multi-RTT |

# **UE feature table restructuring**

Considering that RAN2 agreed on the following signaling for UE capabilities,

 [[ nr-ECID-ProvideCapabilities-r16 NR-ECID-ProvideCapabilities-r16 OPTIONAL,

 nr-Multi-RTT-ProvideCapabilities-r16 NR-Multi-RTT-ProvideCapabilities-r16 OPTIONAL,

 nr-DL-AoD-ProvideCapabilities-r16 NR-DL-AoD-ProvideCapabilities-r16 OPTIONAL,

 nr-DL-TDOA-ProvideCapabilities-r16 NR-DL-TDOA-ProvideCapabilities-r16 OPTIONAL,

 nr-UL-ProvideCapabilities-r16 NR-UL-ProvideCapabilities-r16 OPTIONAL

 ]]

it is proposed to align RAN1 feature table with the RAN2 WG agreements and continue discussion based on the restructured table provided.

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [3] | vivo | We are fine to align RAN1 feature table with RAN2 UE capabilities signaling structure. |
| [4] | OPPO | For UE feature of NR positioning, adopt the first alternative of table structure (previous formulation), i.e., table structure is formulated based on the UE functions:* UE DL PRS processing capability
* Transmission of SRS for NR positioning
* DL PRS RSRP measurement and reporting
* DL RSTD measurement and reporting
* UE Rx-Tx Time difference measurement and reporting
* DL SSB RRM measurements for NR positioning
* CSI-RS RRM measurements for NR positioning.
 |
| [6] | LG Electronics | We are generally fine with the updated table, which defines the UE features according to DL based positioning, UL based positioning, and DL and UL based positioning. |
| [7] | Intel Corporation | Propose a revision of feature groups as below in this section. |
| [11] | Qualcomm Incorporated | Propose a revision of feature groups as below in this section.Proposal 1: Inside the capability reporting of each positioning method that uses DL PRS (i.e., Multi-RTT, DL-AoD, DL-TDOA) the DL PRS capabilities need to be separated from any reporting capabilities. Similarly, the SRS transmission capabilities need to be separated from any Rx-Tx reporting capabilities.a) DL PRS Capabilitiesb) Transmission of SRS for positioningc) DL PRS RSRP Measurement Reportingd) UE Rx-Tx Measurement Reportinge) DL PRS RSRP Measurement ReportingProposal 2: Even if the DL PRS processing capabilities (N1,N2,T) are reported per positioning method, they correspond to a total PRS processing capabilities of the UE across all methods (assuming the UE supports multiple methods and a concurrent support of multiple methods).Proposal 3: All the following sub-features are reported per band for all positioning methods that are applicable unless explicitly indicated otherwise• DL PRS Capabilities• Transmission of SRS for positioning• DL PRS RSRP Measurement Reporting• UE Rx-Tx Measurement Reporting• DL PRS RSRP Measurement Reporting |
| [12] | Huawei, HiSilicon | Propose a revision of feature groups as below in this section. |
| [13] | Ericsson | Components starting with “support” are either rephrased in an affirmative statement or moved to a separate feature group to become a capability. |

**Based on above, following point should be discussed.**

* **How to organize a restructured feature table. (i.e. How to align RAN1 feature table with the RAN2 WG agreements)**

In [7], revision of feature groups is proposed as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **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)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 13. NR Positioning | 13-1 | NR E-CID DL SSB RRM measurements for NR Positioning | Prerequisite – support of SSB measurements for RRM (SS-RSRP, SS-RSRQ) based on Rel.15 for NR Positioning in Rel.16Configuration and reporting of SSB RRM measurements (SS-RSRP, SS-RSRQ) based on Rel.15 for NR Positioning in Rel.16 | FG 1-1 | No | NA | UE SSB for RRM measurement to facilitate E-CID NR Positining is not supported | Per UE or Per Band | NA | NA | Yes if Per UEN/A if Per Band | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13-2 | NR E-CID DL CSI-RS RRM measurements for NR Positioning | Prerequisite – support CSI-RS for RRM (CSI-RSRP, CSI-RSRQ) based on Rel.15 for NR Positioning in Rel.16Configuration and reporting of CSI-RS for RRM (CSI-RSRP, CSI-RSRQ) for NR Positioning in Rel.16 | FG 1-4 | No | NA | UE CSI-RS for RRM measurements and signalling to facilitate E-CID NR Positining are not supported | Per UE or Per Band | NA | NA | Yes if Per UEN/A if Per Band | Need for location server to know if the feature is supported. | Optional with capability signaling |
|  | 13-3 | Basic DL PRS Processing Capability | 1. Maximum DL PRS bandwidth in MHz, supported by UE. Values = [20, 50, 100, 200, 400] in MHz
2. Duration of DL PRS symbol 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. Values for T = [0.125, 0.25, 0.5, 1, 40, 80, 160, 320, 640, 1280] ms

Notes:* 1. UE is not expected to support DL PRS bandwidth that exceeds the reported DL PRS bandwidth value
	2. UE DL PRS processing capability is defined for a single positioning frequency layer
	3. UE DL PRS processing capability is agnostic to DL PRS comb factor configuration
	4. FFS if UE DL PRS processing capability is agnostic to the configured SCS settings of DL PRS
	5. FFS if reported values of T are the same across bands within a FR or across FRs
	6. FFS cases w/ and w/o configuration of measurement gap
1. Max number of positioning frequency layers supported by UE for DL PRS RSRP measurement report. Values = {1, [2, 3], 4}
 |  | No | NA | UE does not support any of DL PRS measurements | Per band | NA | N/A |  | Need for location server to know if the feature is supported.Separate indication of capability signaling for each component | Optional with capability signaling |
| 13-4 | DL PRS QCL Processing Capability | 1. Support of SSB from serving cell as QCL Type C source of a DL PRS resource from serving cell
2. Support of SSB from neighbor cells as QCL Type C source of a DL PRS resource from neighbor cells
3. Support of SSB from serving cell as QCL Type D source of a DL PRS resource from serving cell
4. Support of SSB from neighbor cells as QCL Type D source of a DL PRS resource from neighbour cells
5. Support of a DL PRS resource from serving cell as QCL Type D source of another DL PRS resource from serving cell
6. Support of a DL PRS resource from neighbour cells as QCL Type D source of another DL PRS resource from neighbour cells
 | 13-3 | No | NA | QCL framework for DL PRS is not supported by UE for a given component | Per Band | NA | N/A |  | Need for location server to know if the feature is supported.Separate indication of capability signaling for each component#3, #4, #5, #6 are not supported for FR1 (i.e. only for FR2) | Optional with capability signaling |
|  | 13-5 | DL PRS Resources for DL AoD | DL PRS Resources for DL PRS RSRP Measurement for DL-AoD1. Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE. Values = {1,2}
2. Max number of DL PRS Resources per DL PRS Resource Set

Values = [1, 4, 8, 16, 32, 64]1. Max number of DL PRS Resources supported by UE across all frequency layers, TRPs and DL PRS Resource Sets. Values = [64, 128, 192, 256, 512, 1024, 2048]
2. Max number of TRPs across all positioning frequency layers per UE. Values = [16, 32, 64, 128, 256]
3. Max number of DL PRS Resources per positioning frequency layer. Values = [32, 64, 128, 256, 512, 1024]
4. [Max number of DL PRS resources per TRP across all frequency layers. Value set: {4,8,16,32,64,128}]
 | 13-3 | No | NA | UE measurements and signalling to facilitate DL-AoD NR Positining are not supported | Per band | NA | NA |  | Need for location server to know if the feature is supported.Separate indication of capability signaling for each component | Optional with capability signaling |
| 13-6 | DL PRS Measurement Report for DL-AoD | UE DL PRS RSRP Measurement Report for DL-AoD1. Max number of DL PRS RSRP measurements on different PRS resources from the same TRP supported by the UE Values = {1, 2, 3, 4, 5, 6, 7, 8}
2. Support of inter-frequency DL PRS RSRP measurement report in RRC\_CONNECTED state
 | 13-3, 13-5 | No | NA | UE measurements and signalling to facilitate DL-AoD NR Positining are not supported | Per band | NA | NA |  | Need for location server to know if the feature is supported.Separate indication of capability signaling for each component | Optional with capability signaling |
| 13-7 | DL PRS Resources for DL-TDOA | DL PRS Resources for DL PRS RSRP & RSTD measurement for DL-TDOA1. Max number of DL PRS Resource Sets per TRP per frequency layer. Values = {1, 2}
2. Max number of DL PRS Resources per DL PRS Resource Set. Values = [1, 4, 8, 16, 32, 64]
3. Max number of DL PRS Resources across all frequency layers, TRPs and DL PRS Resource Sets. Values = [64, 128, 192, 256, 512, 1024, 2048]
4. Max number of TRPs across all positioning frequency layers per UE. Values = [16, 32, 64, 96, 128, 256]
5. Max number of DL PRS Resources per positioning frequency layer. Values = [32, 64, 128, 256, 512, 1024]
6. [Max number of DL PRS resources per TRP across all frequency layers. Value set: {4,8,16,32,64,128}]
 | 13-3 | No | NA | UE measurements and signalling to facilitate DL-TDOA NR Positionign are not supported | Per band | NA | NA |  | Need for location server to know if the feature is supported.Separate indication of capability signaling for each component | Optional with capability signaling |
| 13-8 | DL PRS RSTD Measurement Report for DL-TDOA | DL PRS RSRP and RSTD Measurement Report for DL-TDOA1. Max number of DL RSTD measurements per pair of TRPs. Values = {1, 2, 3, 4}.

Note: This is a max number of DL RSTD measurements per pair of TRPs with each measurement between a different pair of DL PRS resources or DL PRS resource sets. All the RSTD measurements in a single report should have a single reference timing.1. Support of inter-frequency DL RSTD measurement report in RRC\_CONNECTED state
2. Support of DL RSTD measurement quality metric
 | 13-3,13-7 | No | NA | UE measurements and signalling to facilitate DL-TDOA NR Positionign are not supported | Per band | NA | NA |  | Need for location server to know if the feature is supported.Separate indication of capability signaling for each component | Optional with capability signaling |
| 13-9 | SRS Resources for Positioning | SRS resources for positioning based on UTDOA, AoA and Multi-RTT1. Max number of SRS Resource Sets for positioning supported by UE per BWP. Values = {1, 16}. Other values FFS
2. Max number of aperiodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {64}, Other values FFS.
3. Max number of semi-persistent SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {64}, Other values FFS.
4. Max number of periodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {64}, Other values FFS.
 |  | Yes,(SRS for positioning is configured by RRC) | NA | UE signaling to facilitate UL-TDOA, UL-AoA and Multi-RTT NR positioning is not supported | Per Band | NA | NA |  | Need for location server to know if the feature is supported.Separate indication of capability signaling for each component | Optional with capability signaling |
| 13-10 | OLPC for SRS for Positioning | 1. Support of SSB for serving cell DL pathloss estimation and OLPC for SRS for positioning
2. Support of SSB for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning.
3. Support of DL PRS for serving cell DL pathloss estimation and OLPC for SRS for positioning.
4. Support of DL PRS for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning.
5. Max number of pathloss estimates across all SRS resource sets for positioning in addition to the up to four pathloss estimates per serving cell specified for PUSCH/PUCCH/SRS transmission. It is indicated from the following set of values {0, [1], 4, 8, 16}
 | 13-9 | Yes, (SRS for positioning is configured by RRC) | NA |  | Per band | NA | NA |  | Need for location server to know if the feature is supported.Separate indication of capability signaling for each component | Optional with capability signaling |
| 13-11 | Spatial Relation for SRS for Positioning | 1. Support of spatial relation of SRS Resources for positioning with DL PRS Resources from serving cell
2. Support of spatial relation of SRS Resources for positioning with DL PRS Resources from neighbour cells
3. Support of spatial relation of SRS Resources for positioning with SSB from serving cell
4. Support of spatial relation of SRS Resources for positioning with SSB from neighbour cells
5. Support of spatial Relation of SRS Resources for positioning with other SRS resources
6. Max number of active spatial relations including both DL PRS Resources and SSB. Values = [FFS]
 | 13-3,13-9 | Yes, (SRS for positioning is configured by RRC) | NA |  | Per band | NA | NA |  | Need for location server to know if the feature is supported.Separate indication of capability signaling for each componentThis feature is not supported for FR1 (i.e. only for FR2) | Optional with capability signaling |
| 13-12 | DL PRS Resources for Multi-RTT | DL PRS Resources for DL PRS RSRP & UE Rx-Tx measurement for Multi-RTT1. Max number of DL PRS Resource Sets per TRP per frequency layer. Values = {1, 2}
2. Max number of DL PRS Resources per DL PRS Resource Set. Values = [1, 4, 8, 16, 32, 64]
3. Max number of DL PRS Resources across all frequency layers, TRPs and DL PRS Resource Sets. Values = [64, 128, 192, 256, 512, 1024, 2048]
4. Max number of TRPs across all positioning frequency layers per UE. Values = [16, 32, 64, 96, 128, 256]
5. Max number of DL PRS Resources per positioning frequency layer. Values = [32, 64, 128, 256, 512, 1024]
6. [Max number of DL PRS resources per TRP across all frequency layers. Value set: {4,8,16,32,64,128}]
 | 13-3 | Yes | NA | UE measurements and signalling to facilitate Multi-RTT NR Positioning are not supported | Per band | NA | NA |  | Need for location server to know if the feature is supported.Separate indication of capability signaling for each component | Optional with capability signaling |
| 13-13 | UE Rx-Tx Mesurement Report for Multi-RTT | UE Rx-Tx and RSRP Measurement Report for Multi-RTT1. Support of UE Rx-Tx time difference measurement with serving cell
2. Support of UE Rx-Tx time difference measurement with neighbouring cells
3. Support of UE Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing

Note: Covers scenario when DL PRS are processed across different DL PRS frequency layers associated with a given component carrier used for SRS for positioning1. Max number of UE Rx – Tx time difference measurements per TRP DL PRS Resource Set/Resource

Note: A UE can be configured to report multiple Rx–Tx time difference measurements corresponding to a single SRS resource/resource set for positioning with each measurement corresponding to a single DL PRS resource/resource set. The DL PRS resource/resource sets can be in different positioning frequency layers1. Support of UE Rx-Tx time difference measurement quality metric
2. Support of UE Rx-Tx time difference measurements across different component carriers for SRS for positioning.

Note: Covers scenario when SRS for positioning is transmitted in different component carriers than the component carrier to which DL PRS is configured] | 13-9 | Yes | NA | UE measurements and signalling to facilitate Multi-RTT NR Positioning are not supported | Per band | NA | NA |  | Need for location server to know if the feature is supported.Separate indication of capability signaling for each component | Optional with capability signaling |

In [11], revision of feature groups is proposed as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **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)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 13a. NR E-CID | 13a-1 | NR E-CID DL SSB RRM measurements for NR Positioning | Prerequisite – support of SSB measurements for RRM (SS-RSRP, SS-RSRQ) based on Rel.15 for NR Positioning in Rel.16Configuration and reporting of SSB RRM measurements (SS-RSRP, SS-RSRQ) based on Rel.15 for NR Positioning in Rel.16Note: No new UE capability is assumed on top of the R15 capabilities. | [FG 1-1] | [No] | NA | **UE signalling to facilitate E-CID NR Positining is not supported** |  | [No] |  |  |  | Optional with capability signaling |
| 13a-2 | NR E-CID DL CSI-RS RRM measurements for NR Positioning | Prerequisite – support CSI-RS for RRM (CSI-RSRP, CSI-RSRQ) based on Rel.15 for NR Positioning in Rel.16Configuration and reporting of CSI-RS for RRM (CSI-RSRP, CSI-RSRQ) for NR Positioning in Rel.16Note: No new UE capability is assumed on top of the R15 capabilities. | [FG 1-4FG1-5] | [No] | NA | **UE CSI-RS for RRM measurements and signalling to facilitate E-CID NR Positining are not supported** |  | [No] |  |  |  | Optional with capability signaling |
| 13b. NR DL AoD | 13b-1 | DL PRS Capabilities  | 1. Duration of DL PRS symbol in units of ms (N1) and number of PRS resources (N2) across all TRPs a UE can process every T ms assuming a maximum DL PRS bandwidth in MHz (Bmax) for a reported SCS, which is supported when measurement gaps are configured.
	* Values for T = {0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
	* Values for N1 = {0.125, 0.25, 0.5, 1, 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, 45, 50} ms
	* Values for N2 = {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64, 96, 128, 256, 512, 1024} resources
	* Values for Bmax = {10, 20, 40, 50, 80, 100, 200, 400} MHz
	* For each SCS, the UE reports
		+ a single Bmax
		+ One or both of the following two:
			- one (N1,N2,T) for T = “slot duration” with $N1\leq T$
			- one (N1,N2,T) for T > “slot duration” with $N1\leq T$
2. Duration of DL PRS symbol in units of ms (N1) and number of PRS resources (N2) across all TRPs a UE can process every T ms assuming a maximum DL PRS bandwidth in MHz (Bmax) for a reported SCS, which is supported when measurement gaps are not configured.
	* Values for T={0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
	* Values for N1 = {0.125, 0.25, 0.5, 1, 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, 45, 50} ms
	* Values for N2 = {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64, 96, 128, 256, 512, 1024} resources
	* Values for Bmax = {10, 20, 40, 50, 80, 100, 200, 400} MHz
	* For each SCS, the UE reports
		+ a single Bmax
		+ One or both of the following two:
			- one (N1,N2,T) for T = “slot duration” with $N1\leq T$
			- one (N1,N2,T) for T > “slot duration” with $N1\leq T$
	* When a UE does not report this UE DL PRS processing capability, the UE does not support DL PRS processing without measurement gaps
3. Max number of positioning frequency layers supported by UE. Values = {1, 2, 3, 4}
4. Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE. Values = {1,2}
5. Max number of DL PRS Resources per DL PRS Resource Set a UE can be configured . Values = [1, 4, 8, 16, 32, 64]
6. Max number of DL PRS Resources supported by UE across all frequency layers, TRPs and DL PRS Resource Sets. Values = [64, 128, 192, 256, 512, 1024, 2048]
7. Max number of TRPs across all positioning frequency layers per UE. Values = [16, 32, 64, 128, 256]
8. Max number of DL PRS Resources per positioning frequency layer. Values = [32, 64, 128, 256, 512, 1024]
9. Max number of DL PRS resources per TRP across all frequency layers. Value set: {4,8,16,32,64,128}
10. Support of inter-frequency DL PRS measurement in RRC\_CONNECTED state
11. Support of SSB from serving cell as QCL Type C source of a DL PRS resource from serving cell
12. Support of SSB from neighbor cells as QCL Type C source of a DL PRS resource from neighbor cells
13. Support of SSB from serving cell as QCL Type D source of a DL PRS resource from serving cell
14. Support of SSB from neighbor cells as QCL Type D source of a DL PRS resource from neighbour cells
15. Support of a DL PRS resource from serving cell as QCL Type D source of another DL PRS resource from serving cell
16. Support of a DL PRS resource from neighbour cells as QCL Type D source of another DL PRS resource from neighbour cells
 |  | [No] | NA | **UE measurements to facilitate DL-AoD NR Positioning is not supported** | **Per Band** |  |  |  |  | Optional with capability signaling |
|  | 13b-2 | DL PRS RSRP Measurement Reporting  | 1. Max number of DL PRS RSRP measurements on different PRS resources from the same TRP supported by the UE Values = {1, 2, 3, 4, 5, 6, 7, 8}
2. Support of inter-frequency DL PRS RSRP measurement report in RRC\_CONNECTED state
 | 13b-1 |  | NA | **UE reporting to facilitate DL-AoD NR Positioning is not supported** | **Per Band** |  |  |  |  | Optional with capability signaling |
|  | 13b-3 | Concurrent support of DL-TDOA, AoD, multi-RTT Positioning Methods  | Indication of concurrent configuration of a list of the DL-TDOA, AoD, multi-RTT Positioning methods* Up to 8 strings with values {000, …, 111}
* Note: A 3-bit string in which each bit corresponds to the concurrent support of the DL-TDOA, AoD, multi-RTT respectively, where 0 means “no support” and 1 means “support”
 |  |  |  | **The UE does not support concurrent configuration of the corresponding method** | **Per UE** |  |  |  |  | Optional with capability signalling |
|  | 13b-4 | Concurrent support of DL-TDOA, AoD, multi-RTT Positioning Methods per supported CA Band Combination | For each supported CA Band Combination in the BandCombinationList, indication of concurrent configuration of a list of the DL-TDOA, AoD, multi-RTT Positioning methods* Up to 8 strings with values {000, …, 111}
* Note: A 3-bit string in which each bit corresponds to the concurrent support of the DL-TDOA, AoD, multi-RTT respectively, where 0 means “no support” and 1 means “support”
 | 13b-3 |  |  | **The UE does not support concurrent configuration of the corresponding method for the configured CA band configuration**  | **Per band combo** |  |  |  |  | Optional with capability signalling |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 13c. NR DL-TDOA | 13c-1 | DL PRS Capabilities | 1. Duration of DL PRS symbol in units of ms (N1) and number of PRS resources (N2) across all TRPs a UE can process every T ms assuming a maximum DL PRS bandwidth in MHz (Bmax) for a reported SCS, which is supported when measurement gaps are configured.
	* Values for T = {0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
	* Values for N1 = {0.125, 0.25, 0.5, 1, 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, 45, 50} ms
	* Values for N2 = {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64, 96, 128, 256, 512, 1024} resources
	* Values for Bmax = {10, 20, 40, 50, 80, 100, 200, 400} MHz
	* For each SCS, the UE reports
		+ a single Bmax
		+ One or both of the following two:
			- one (N1,N2,T) for T = “slot duration” with $N1\leq T$
			- one (N1,N2,T) for T > “slot duration” with $N1\leq T$
2. Duration of DL PRS symbol in units of ms (N1) and number of PRS resources (N2) across all TRPs a UE can process every T ms assuming a maximum DL PRS bandwidth in MHz (Bmax) for a reported SCS, which is supported when measurement gaps are not configured.
	* Values for T={0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
	* Values for N1 = {0.125, 0.25, 0.5, 1, 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, 45, 50} ms
	* Values for N2 = {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64, 96, 128, 256, 512, 1024} resources
	* Values for Bmax = {10, 20, 40, 50, 80, 100, 200, 400} MHz
	* For each SCS, the UE reports
		+ a single Bmax
		+ One or both of the following two:
			- one (N1,N2,T) for T = “slot duration” with $N1\leq T$
			- one (N1,N2,T) for T > “slot duration” with $N1\leq T$
	* When a UE does not report this UE DL PRS processing capability, the UE does not support DL PRS processing without measurement gaps
3. Max number of positioning frequency layers supported by UE. Values = {1, 2, 3, 4}
4. Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE. Values = {1,2}
5. Max number of DL PRS Resources per DL PRS Resource Set a UE can be configured . Values = [1, 4, 8, 16, 32, 64]
6. Max number of DL PRS Resources supported by UE across all frequency layers, TRPs and DL PRS Resource Sets. Values = [64, 128, 192, 256, 512, 1024, 2048]
7. Max number of TRPs across all positioning frequency layers per UE. Values = [16, 32, 64, 128, 256]
8. Max number of DL PRS Resources per positioning frequency layer. Values = [32, 64, 128, 256, 512, 1024]
9. Max number of DL PRS resources per TRP across all frequency layers. Value set: {4,8,16,32,64,128}
10. Support of inter-frequency DL PRS measurement in RRC\_CONNECTED state
11. Support of SSB from serving cell as QCL Type C source of a DL PRS resource from serving cell
12. Support of SSB from neighbor cells as QCL Type C source of a DL PRS resource from neighbor cells
13. Support of SSB from serving cell as QCL Type D source of a DL PRS resource from serving cell
14. Support of SSB from neighbor cells as QCL Type D source of a DL PRS resource from neighbour cells
15. Support of a DL PRS resource from serving cell as QCL Type D source of another DL PRS resource from serving cell
16. Support of a DL PRS resource from neighbour cells as QCL Type D source of another DL PRS resource from neighbour cells
 |  |  | NA | **UE measurements to facilitate DL-TDOA NR Positionign is not supported** | **Per Band** |  |  |  |  | Optional with capability signaling |
|  | 13c-2 | DL PRS RSTD Measurement Reporting  | 1. Max number of DL RSTD measurements per pair of TRPs. Values = {1, 2, 3, 4}.
	* Note: This is a max number of DL RSTD measurements per pair of TRPs with each measurement between a different pair of DL PRS resources or DL PRS resource sets. All the RSTD measurements in a single report should have a single reference timing.
2. Support of inter-frequency DL RSTD measurement report in RRC\_CONNECTED state
 | 13c-1 | [No] | NA | **UE reporting of RSTD measurements to facilitate DL-TDOA NR Positionign is not supported** | **Per Band** | [No] |  |  |  | Optional with capability signaling |
|  | 13c-3 | DL PRS RSRP Measurement Reporting  | 1. Max number of DL PRS RSRP measurements on different PRS resources from the same TRP supported by the UE Values = {1, 2, 3, 4, 5, 6, 7, 8}
2. Support of inter-frequency DL PRS RSRP measurement report in RRC\_CONNECTED state
 | 13c-1, 13c-2 | [No] | NA | **UE reporting of RSRP measurement to facilitate DL-TDOA NR Positioning is not supported** | **Per Band** |  |  |  |  | Optional with capability signaling |
|  | 13c-3 | Concurrent support of DL-TDOA, AoD, multi-RTT Positioning Methods  | Indication of concurrent configuration of a list of the DL-TDOA, AoD, multi-RTT Positioning methods* Up to 8 strings with values {000, …, 111}
* Note: A 3-bit string in which each bit corresponds to the concurrent support of the DL-TDOA, AoD, multi-RTT respectively, where 0 means “no support” and 1 means “support”
 |  |  |  | **The UE does not support concurrent configuration of the corresponding method** | **Per UE** |  |  |  |  | Optional with capability signalling |
|  | 13c-4 | Concurrent support of DL-TDOA, AoD, multi-RTT Positioning Methods per supported CA Band Combination | For each supported CA Band Combination in the BandCombinationList, indication of concurrent configuration of a list of the DL-TDOA, AoD, multi-RTT Positioning methods* Up to 8 strings with values {000, …, 111}
* Note: A 3-bit string in which each bit corresponds to the concurrent support of the DL-TDOA, AoD, multi-RTT respectively, where 0 means “no support” and 1 means “support”
 | 13c-3 |  |  | **The UE does not support concurrent configuration of the corresponding method for the configured CA band configuration**  | **Per band combo** |  |  |  |  | Optional with capability signalling |
| 13d. UL Positioning | 13d-1 | Transmission of SRS for positioning | 1. Max number of SRS Resource Sets for positioning supported by UE per BWP. Values = {1, 2, 4, 8, 16}.
2. Max number of aperiodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {1,2,4,8,16,32,64}
3. Max number of semi-persistent SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {1,2,4,8,16,32,64}
4. Max number of periodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {1,2,4,8,16,32,64}
5. Max number of aperiodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP per slot. Values = {1,2,3,4,5,6,8,10,12,14}
6. Max number of semi-persistent SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP per slot. Values = {1,2,3,4,5,6,8,10,12,14}
7. Max number of periodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP per slot. Values = {1,2,3,4,5,6,8,10,12,14}
8. Support of SSB for serving cell DL pathloss estimation and OLPC for SRS for positioning.
9. Support of SSB for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning.
10. Support of DL PRS for serving cell DL pathloss estimation and OLPC for SRS for positioning.
11. Support of DL PRS for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning.
12. Max number of pathloss estimates across all SRS resource sets for positioning in addition to the up to four pathloss estimates per serving cell specified for PUSCH/PUCCH/SRS transmission. It is indicated from the following set of values {0, 1, 4, 8, 16}
13. Spatial relation of SRS Resources for positioning with DL PRS Resources from serving cell
14. Spatial relation of SRS Resources for positioning with DL PRS Resources from neighbour cells
15. Spatial relation of SRS Resources for positioning with SSB from serving cell
16. Spatial relation of SRS Resources for positioning with SSB from neighbour cells
17. Spatial Relation of SRS Resources for positioning with other SRS resources
18. Max number of active spatial relations including both DL PRS Resources and SSB. Values = {1,2,4,8,14}
 |  | Yes | NA | **SRS for positioning transmission to facilitate UL positioning is not supported** |  | [No] |  |  |  | Optional with capability signaling |
| 13e. NR Multi-RTT | 13e-1 | Transmission of SRS for positioning | 1. Max number of SRS Resource Sets for positioning supported by UE per BWP. Values = {1, 2, 4, 8, 16}.
2. Max number of aperiodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {1,2,4,8,16,32,64}
3. Max number of semi-persistent SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {1,2,4,8,16,32,64}
4. Max number of periodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {1,2,4,8,16,32,64}
5. Max number of aperiodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP per slot. Values = {1,2,3,4,5,6,8,10,12,14}
6. Max number of semi-persistent SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP per slot. Values = {1,2,3,4,5,6,8,10,12,14}
7. Max number of periodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP per slot. Values = {1,2,3,4,5,6,8,10,12,14}
8. Support of SSB for serving cell DL pathloss estimation and OLPC for SRS for positioning.
9. Support of SSB for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning.
10. Support of DL PRS for serving cell DL pathloss estimation and OLPC for SRS for positioning.
11. Support of DL PRS for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning.
12. Max number of pathloss estimates across all SRS resource sets for positioning in addition to the up to four pathloss estimates per serving cell specified for PUSCH/PUCCH/SRS transmission. It is indicated from the following set of values {0, 1, 4, 8, 16}
13. Spatial relation of SRS Resources for positioning with DL PRS Resources from serving cell
14. Spatial relation of SRS Resources for positioning with DL PRS Resources from neighbour cells
15. Spatial relation of SRS Resources for positioning with SSB from serving cell
16. Spatial relation of SRS Resources for positioning with SSB from neighbour cells
17. Spatial Relation of SRS Resources for positioning with other SRS resources
18. Max number of active spatial relations including both DL PRS Resources and SSB. Values = {1,2,4,8,14}
 |  | Yes | NA | **SRS for positioning transmission to facilitate Multi-RTT positioning is not supported** |  | [No] |  |  |  | Optional with capability signaling |
|  | 13e-2 | DL PRS Capabilities | 1. Duration of DL PRS symbol in units of ms (N1) and number of PRS resources (N2) across all TRPs a UE can process every T ms assuming a maximum DL PRS bandwidth in MHz (Bmax) for a reported SCS, which is supported when measurement gaps are configured.
* Values for T = {0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
* Values for N1 = {0.125, 0.25, 0.5, 1, 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, 45, 50} ms
* Values for N2 = {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64, 96, 128, 256, 512, 1024} resources
* Values for Bmax = {10, 20, 40, 50, 80, 100, 200, 400} MHz
* For each SCS, the UE reports
	+ a single Bmax
	+ One or both of the following two:
		- one (N1,N2,T) for T = “slot duration” with $N1\leq T$
		- one (N1,N2,T) for T > “slot duration” with $N1\leq T$
1. Duration of DL PRS symbol in units of ms (N1) and number of PRS resources (N2) across all TRPs a UE can process every T ms assuming a maximum DL PRS bandwidth in MHz (Bmax) for a reported SCS, which is supported when measurement gaps are not configured.
* Values for T={0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
* Values for N1 = {0.125, 0.25, 0.5, 1, 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, 45, 50} ms
* Values for N2 = {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64, 96, 128, 256, 512, 1024} resources
* Values for Bmax = {10, 20, 40, 50, 80, 100, 200, 400} MHz
* For each SCS, the UE reports
	+ a single Bmax
	+ One or both of the following two:
		- one (N1,N2,T) for T = “slot duration” with $N1\leq T$
		- one (N1,N2,T) for T > “slot duration” with $N1\leq T$
* When a UE does not report this UE DL PRS processing capability, the UE does not support DL PRS processing without measurement gaps
1. Max number of positioning frequency layers supported by UE. Values = {1, 2, 3, 4}
2. Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE. Values = {1,2}
3. Max number of DL PRS Resources per DL PRS Resource Set a UE can be configured . Values = [1, 4, 8, 16, 32, 64]
4. Max number of DL PRS Resources supported by UE across all frequency layers, TRPs and DL PRS Resource Sets. Values = [64, 128, 192, 256, 512, 1024, 2048]
5. Max number of TRPs across all positioning frequency layers per UE. Values = [16, 32, 64, 128, 256]
6. Max number of DL PRS Resources per positioning frequency layer. Values = [32, 64, 128, 256, 512, 1024]
7. Max number of DL PRS resources per TRP across all frequency layers. Value set: {4,8,16,32,64,128}
8. Support of inter-frequency DL PRS measurement in RRC\_CONNECTED state
9. Support of SSB from serving cell as QCL Type C source of a DL PRS resource from serving cell
10. Support of SSB from neighbor cells as QCL Type C source of a DL PRS resource from neighbor cells
11. Support of SSB from serving cell as QCL Type D source of a DL PRS resource from serving cell
12. Support of SSB from neighbor cells as QCL Type D source of a DL PRS resource from neighbour cells
13. Support of a DL PRS resource from serving cell as QCL Type D source of another DL PRS resource from serving cell
14. Support of a DL PRS resource from neighbour cells as QCL Type D source of another DL PRS resource from neighbour cells
 | 13e-1 |  | NA | **UE measurements and signalling to facilitate Multi-RTT NR Positioning are not supported** | **Per Band** |  |  |  |  | Optional with capability signaling |
|  | 13e-3 | UE Rx-Tx Measurement Reporting | 1. 1. Support of UE Rx-Tx time difference measurement with serving cell
2. 2. Support of UE Rx-Tx time difference measurement with neighbouring cells
3. Support of UE Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing

Note: Covers scenario when DL PRS are processed across different DL PRS frequency layers associated with a given component carrier used for SRS for positioning1. Max number of UE Rx – Tx time difference measurements per TRP DL PRS Resource Set/Resource

Note: A UE can be configured to report multiple Rx–Tx time difference measurements corresponding to a single SRS resource/resource set for positioning with each measurement corresponding to a single DL PRS resource/resource set. The DL PRS resource/resource sets can be in different positioning frequency layers **if supported by the UE**1. Support of UE Rx-Tx time difference measurement quality metric
2. Support of UE Rx-Tx time difference measurements across different component carriers for SRS for positioning.

Note: Covers scenario when SRS for positioning is transmitted in different component carriers than the component carrier to which DL PRS is configured | 13e-1, 13e-2  | No | NA | **UE measurements and signalling to facilitate Multi-RTT NR Positioning are not supported** | **Per Band** | [No] |  |  |  | Optional with capability signaling |
|  | 13e-3 | Concurrent support of DL-TDOA, AoD, multi-RTT Positioning Methods  | Indication of concurrent configuration of a list of the DL-TDOA, AoD, multi-RTT Positioning methods* Up to 8 strings with values {000, …, 111}
* Note: A 3-bit string in which each bit corresponds to the concurrent support of the DL-TDOA, AoD, multi-RTT respectively, where 0 means “no support” and 1 means “support”
 |  |  |  | **The UE does not support concurrent configuration of the corresponding method** | **Per UE** |  |  |  |  | Optional with capability signalling |
|  | 13e-4 | Concurrent support of DL-TDOA, AoD, multi-RTT Positioning Methods per supported CA Band Combination | For each supported CA Band Combination in the BandCombinationList, indication of concurrent configuration of a list of the DL-TDOA, AoD, multi-RTT Positioning methods* Up to 8 strings with values {000, …, 111}
* Note: A 3-bit string in which each bit corresponds to the concurrent support of the DL-TDOA, AoD, multi-RTT respectively, where 0 means “no support” and 1 means “support”
 | 13e-3 |  |  | The UE does not support concurrent configuration of the corresponding method for the configured CA band configuration  | Per band combo |  |  |  |  | Optional with capability signalling |

In [12], revision of feature groups is proposed as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 (V2X WI only)”.** | **Consequence if the feature is not supported by the UE** | **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)** | **Need of FDD/TDD differentiation** | **Need of FR1/FR2 differentiation** | **Capability interpretation for mixture of FDD/TDD and/or FR1/FR2** | **Note** | **Mandatory/Optional** |
| 13. Common NR DL PRS processing | 13-0 | FFS Basic PRS processing | FFS whether or not to introduce basic FG. |  |  |  |  |  |  |  |  |  |  |
| 13-1 | PRS processing capability | 1. Maximum DL PRS bandwidth in MHz, supported by UE. Values = [20, 50, 100, 200, 400] in MHz
2. Duration of DL PRS symbol 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. Values for T = [0.125, 0.25, 0.5, 1, 40, 80, 160, 320, 640, 1280] ms
 | FFS 13-0 | Yes |  | Network does not know how to provide the assistance data to the UE | 2) Per band | No | Yes | NA | 1. UE is not expected to support DL PRS bandwidth that exceeds the reported DL PRS bandwidth value
2. UE DL PRS processing capability is defined for a single positioning frequency layer
3. UE DL PRS processing capability is agnostic to DL PRS comb factor configuration
4. FFS if UE DL PRS processing capability is agnostic to the configured SCS settings of DL PRS
5. FFS if reported values of T are the same across bands within a FR or across FRs
6. FFS cases w/ and w/o configuration of measurement gap
 | Optional with capability signalling#1: {5MHz, 20MHz, 50MHz, 100MHz} for FR1 bands, {50MHz, 100MHz, 200MHz, 400MHz} for FR2 bands#2: N = {0.5, 1, 2, 4, 5, 6, 8, 10, 15, 20, 40} msT = {1, 2, 5, 10, 20, 40, 80, 160, 320, 640, 1280[, equalToN]} ms |
| 13a. NR E-CID | 13a-1 | NR E-CID DL SSB RRM measurements for NR Positioning | Configuration and reporting of SSB RRM measurements (SS-RSRP, SS-RSRQ) based on Rel.15 for NR Positioning in Rel.16 | [FG 1-1] | Yes |  | LMF may not trigger RRM measurement report in E-CID based on SSB | 1) Per UE | No | No | NA | Note: No new UE capability is assumed on top of the R15 capabilities. | Optional with capability signalling{supported, notSupported} |
| 13a-2 | NR E-CID DL CSI-RS RRM measurements for NR Positioning | Configuration and reporting of CSI-RS for RRM (CSI-RSRP, CSI-RSRQ) for NR Positioning in Rel.16 | [FG 1-4FG 1-5] | Yes |  | LMF may not trigger RRM measurement report in E-CID based on CSI-RS | 1) Per UE | No | No | NA | Note: No new UE capability is assumed on top of the R15 capabilities. | Optional with capability signalling{supported, notSupported} |
| 13b. NR DL-AoD | 13b-0 | FFS Basic DL-AoD positioning | FFS whether or not to introduce basic FG. |  |  |  |  |  |  |  |  |  |  |
| 13b-1 | PRS configuration | 1. Max number of positioning frequency layers supported by UE for DL PRS measurement report. Values = {1, [2, 3], 4}
2. Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE for DL PRS measurement report. Values = {1,2}
3. Max number of DL PRS Resources per DL PRS Resource Set a UE can be configured for DL PRS measurement report. Values = [1, 4, 8, 16, 32, 64]
4. Max number of DL PRS Resources supported by UE for DL PRS measurement report across all frequency layers, TRPs and DL PRS Resource Sets. Values = [64, 128, 192, 256, 512, 1024, 2048]
5. Max number of TRPs across all positioning frequency layers per UE for DL PRS measurement report. Values = [16, 32, 64, 128, 256]
6. Max number of DL PRS Resources per positioning frequency layer for DL PRS measurement report. Values = [32, 64, 128, 256, 512, 1024]
7. [Max number of DL PRS resources per TRP across all frequency layers. Value set: {4,8,16,32,64,128}]
 | FFS 13b-0 | Yes |  | Network does not know how to provide the assistance data | 1) Per UE | No | Yes | FFS |  | Optional with capability signalling#1: {1,2,3,4} for FR1 and FR2#2: {1,2} for both FR1 and FR2#3: {2, 8} for FR1, {8, 64} for FR2.#4: {6, 24, 128, 512} for FR1, {24, 96, 512, 2048} for FR2.#5: {3, 12, 64, 256} for FR1 and FR2.#6: {6, 24, 128} for FR1, and {24, 96, 512} for FR2#7: FFS |
| 13b-2 | Multiple RSRP report | Max number of DL PRS RSRP measurements on different PRS resources from the same TRP supported by the UE Values = {1, 2, 3, 4, 5, 6, 7, 8} | FFS 13b-0 | No |  | At most 2 RSRP measurements per TRP will be requested. | 1) Per UE | No | No | NA |  | Optional with capability signalling{2,4,8} |
| 13b-3 | Inter-frequency measurement | Support of inter-frequency DL PRS RSRP measurement report in RRC\_CONNECTED state | FFS 13b-0 | No |  | Only intra-frequency RSRP measurement is supported. | 1) Per UE | No | No | NA |  | Optional with capability signalling{supported, notSupported} |
| 13b-4 | PRS QCL support | 1. [Support of SSB from serving cell as QCL Type C source of a DL PRS resource from serving cell]
2. [Support of SSB from neighbour cells as QCL Type C source of a DL PRS resource from neighbour cells]
3. [Support of SSB from serving cell as QCL Type D source of a DL PRS resource from serving cell]
4. [Support of SSB from neighbour cells as QCL Type D source of a DL PRS resource from neighbour cells]
5. [Support of a DL PRS resource from serving cell as QCL Type D source of another DL PRS resource from serving cell]
6. [Support of a DL PRS resource from neighbour cells as QCL Type D source of another DL PRS resource from neighbour cells]
 | FFS 13b-0 | No |  | LMF may or may not configure QCL information with PRS. | 1) Per UE | No | No | NA | This feature group is not needed from our perspective. | Optional with capability signalling{supported, notSupported} |
| 13c. NR DL-TDOA | 13c-0 | FFS Basic DL-TDOA positioning | FFS whether or not to introduce basic FG. |  |  |  |  |  |  |  |  |  |  |
| 13c-1 | PRS configuration | 1. Max number of positioning frequency layers supported by UE for DL PRS measurement report. Values = {1, [2, 3], 4}
2. Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE for DL PRS measurement report. Values = {1,2}
3. Max number of DL PRS Resources per DL PRS Resource Set a UE can be configured for DL PRS measurement report. Values = [1, 4, 8, 16, 32, 64]
4. Max number of DL PRS Resources supported by UE for DL PRS measurement report across all frequency layers, TRPs and DL PRS Resource Sets. Values = [64, 128, 192, 256, 512, 1024, 2048]
5. Max number of TRPs across all positioning frequency layers per UE for DL PRS measurement report. Values = [16, 32, 64, 128, 256]
6. Max number of DL PRS Resources per positioning frequency layer for DL PRS measurement report. Values = [32, 64, 128, 256, 512, 1024]
7. [Max number of DL PRS resources per TRP across all frequency layers. Value set: {4,8,16,32,64,128}]
 | FFS 13c-0 | Yes |  | Network does not know how to provide the assistance data | 1) Per UE | No | Yes | FFS |  | Optional with capability signalling#1: {1,2,3,4} for FR1 and FR2#2: {1,2} for both FR1 and FR2#3: {1, 8} for FR1, {8, 64} for FR2.#4: {3, 24, 128, 512} for FR1, {24, 96, 512, 2048} for FR2.#5: {3, 12, 64, 256} for FR1 and FR2.#6: {3, 24, 128} for FR1, and {24, 96, 512} for FR2#7: FFS |
| 13c-2 | Multiple RSTD report | Max number of DL RSTD measurements per pair of TRPs. Values = {1, 2, 3, 4}. | FFS 13c-0 | No |  | Single RSTD measurement per TRP pair will be requested. | 1) Per UE | No | No | NA | Note: This is a max number of DL RSTD measurements per pair of TRPs with each measurement between a different pair of DL PRS resources or DL PRS resource sets. All the RSTD measurements in a single report should have a single reference timing. | Optional with capability signalling{1,2,3,4} |
| 13c-3 | Inter-frequency measurement | Support of inter-frequency DL RSTD/DL PRS RSRP measurement report in RRC\_CONNECTED state | FFS 13c-0 | No |  | Only intra-frequency RSTD/RSRP measurement is supported. | 1) Per UE | No | No | NA |  | Optional with capability signalling{supported, notSupported} |
| 13c-4 | PRS QCL support | 1. [Support of SSB from serving cell as QCL Type C source of a DL PRS resource from serving cell]
2. [Support of SSB from neighbour cells as QCL Type C source of a DL PRS resource from neighbour cells]
3. [Support of SSB from serving cell as QCL Type D source of a DL PRS resource from serving cell]
4. [Support of SSB from neighbour cells as QCL Type D source of a DL PRS resource from neighbour cells]
5. [Support of a DL PRS resource from serving cell as QCL Type D source of another DL PRS resource from serving cell]
6. [Support of a DL PRS resource from neighbour cells as QCL Type D source of another DL PRS resource from neighbour cells]
 | FFS 13c-0 | No |  | LMF may or may not configure QCL information with PRS. | 1) Per UE | No | No | NA | This feature group is not needed from our perspective. | Optional with capability signalling{supported, notSupported} |
| 13c-5 | Quality report | [Support of DL RSTD measurement quality metric] | FFS 13c-0 | No |  | UE will not provide RSTD quality in the measurement report | 1) Per UE | No | No | NA | This feature group is not needed from our perspective. | Optional with capability signalling{supported, notSupported} |
| 13d. NR Multi-RTT | 13d-0 | FFS Basic Multi-RTT positioning | FFS whether or not to introduce basic FG. |  |  |  |  |  |  |  |  |  |  |
| 13d-1 | PRS configuration | 1. Max number of positioning frequency layers supported by UE for DL PRS measurement report. Values = {1, [2, 3], 4}
2. Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE for DL PRS measurement report. Values = {1,2}
3. Max number of DL PRS Resources per DL PRS Resource Set a UE can be configured for DL PRS measurement report. Values = [1, 4, 8, 16, 32, 64]
4. Max number of DL PRS Resources supported by UE for DL PRS measurement report across all frequency layers, TRPs and DL PRS Resource Sets. Values = [64, 128, 192, 256, 512, 1024, 2048]
5. Max number of TRPs across all positioning frequency layers per UE for DL PRS measurement report. Values = [16, 32, 64, 128, 256]
6. Max number of DL PRS Resources per positioning frequency layer for DL PRS measurement report. Values = [32, 64, 128, 256, 512, 1024]
7. [Max number of DL PRS resources per TRP across all frequency layers. Value set: {4,8,16,32,64,128}]
 |  | Yes |  | Network does not know how to provide the assistance data | 1) Per UE | No | Yes | FFS |  | Optional with capability signalling#1: {1,2,3,4} for FR1 and FR2#2: {1,2} for both FR1 and FR2#3: {1, 8} for FR1, {8, 64} for FR2.#4: {3, 24, 128, 512} for FR1, {24, 96, 512, 2048} for FR2.#5: {3, 12, 64, 256} for FR1 and FR2.#6: {3, 24, 128} for FR1, and {24, 96, 512} for FR2#7: FFS |
| 13d-2 | Multiple UE Rx – Tx time difference report | Max number of UE Rx – Tx time difference measurements per TRP DL PRS Resource Set/Resource | FFS 13d-0 | No |  | Single UE Rx – Tx time difference measurement per TRP will be requested. | 1) Per UE | No | No | NA |  | Optional with capability signalling{1,2,3,4} |
| 13d-3 | Intra/Inter-frequency measurement | 1. Support of UE Rx – Tx time difference measurement with serving cell
2. Support of UE Rx – Tx time difference measurement with neighbouring cells
3. Support of UE Rx – Tx time difference measurements across different positioning frequency layers for DL PRS processing
4. [Support of UE Rx-Tx time difference measurements across different component carriers for SRS for positioning.
 | FFS 13d-0 | No |  | Only UE Rx – Tx time difference measurement with serving cell is supported.PRS and SRS are from the same cell. | 1) Per UE | No | No | NA | #3: Note: Covers scenario when DL PRS are processed across different DL PRS frequency layers associated with a given component carrier used for SRS for positioning#4: Note: Covers scenario when SRS for positioning is transmitted in different component carriers than the component carrier to which DL PRS is configured] | Optional with capability signalling{supported, notSupported} |
| 13d-4 | PRS QCL support | 1. [Support of SSB from serving cell as QCL Type C source of a DL PRS resource from serving cell]
2. [Support of SSB from neighbour cells as QCL Type C source of a DL PRS resource from neighbour cells]
3. [Support of SSB from serving cell as QCL Type D source of a DL PRS resource from serving cell]
4. [Support of SSB from neighbour cells as QCL Type D source of a DL PRS resource from neighbour cells]
5. [Support of a DL PRS resource from serving cell as QCL Type D source of another DL PRS resource from serving cell]
6. [Support of a DL PRS resource from neighbour cells as QCL Type D source of another DL PRS resource from neighbour cells]
 | FFS 13d-0 | No |  | LMF may or may not configure QCL information with PRS. | 1) Per UE | No | No | NA | This feature group is not needed from our perspective. | Optional with capability signalling{supported, notSupported} |
| 13d-5 | Quality report | [Support of UE Rx – Tx time difference measurement quality metric] | FFS 13d-0 | No |  | UE will not provide UE Rx – Tx time difference quality in the measurement report | 1) Per UE | No | No | NA | This feature group is not needed from our perspective. | Optional with capability signalling{supported, notSupported} |
| 13d-6 | SRS configuration | 1. Max number of SRS Resource Sets for positioning supported by UE per BWP. Values = {1, 16}. Other values FFS
2. Max number of aperiodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {64}, Other values FFS.
3. Max number of semi-persistent SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {64}, Other values FFS.
4. Max number of periodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {64}, Other values FFS.
 | FFS 13d-0 | Yes |  | LMF will not know how to request SRS configuration from the serving gNB.Serving gNB will not know how to configure SRS. | 1) Per UE | No | Yes | NA | Support of AP SRS is still under discussion in RAN2. | Optional with capability signalling.#1: {1,2,4} for FR1, and {1,4,16} for FR2.#2: {0,1,2,4} for FR1, and {0,4,16,64} for FR2.#3: {0,1,2,4} for FR1, and {0,4,16,64} for FR2#4: {1,2,4} for FR1 and {4,16,64} for FR2. |
| 13d-7 | Open loop power control | 1. Support of SSB for serving cell DL pathloss estimation and OLPC for SRS for positioning.
2. Support of SSB for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning.
3. Support of DL PRS for serving cell DL pathloss estimation and OLPC for SRS for positioning.
4. Support of DL PRS for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning.
 | FFS 13d-0 | No |  | SRS pathloss will only be based on the Rel-15 reference signal from the serving cell. | 1) Per UE | No | Yes | NA |  | Optional with capability signalling.{supported, notSupported} |
| 13d-8 | Number of pathloss estimates | Max number of pathloss estimates across all SRS resource sets for positioning in addition to the up to four pathloss estimates per serving cell specified for PUSCH/PUCCH/SRS transmission. It is indicated from the following set of values {0, [1], 4, 8, 16} | FFS 13d-0, 13d-7 | No |  | SRS pathloss will only be based on the DL reference signal from the serving cell. | 2) Per band | No | Yes | NA |  | Optional with capability signalling.{0,4,8,16} |
| 13d-9 | SRS Tx beamforming | 1. Support of spatial relation of SRS Resources for positioning with DL PRS Resources from serving cell
2. Support of spatial relation of SRS Resources for positioning with DL PRS Resources from neighbour cells
3. Support of spatial relation of SRS Resources for positioning with SSB from serving cell
4. Support of spatial relation of SRS Resources for positioning with SSB from neighbour cells
5. Support of spatial Relation of SRS Resources for positioning with other SRS resources
 | FFS 13d-0 | No |  | SRS spatial relation will only be based on the Rel-15 reference signal from the serving cell. | 1) Per UE | No | Yes | NA |  | Optional with capability signalling.{supported, notSupported} |
| 13d-10 | Number of spatial relations | [Max number of active spatial relations including both DL PRS Resources and SSB. Values = [FFS]] | FFS 13d-0, 13d-9 | No |  | The spatial relation of SRS for positioning will only be based spatial relations for Rel-15 SRS/PUSCH/PUCCH. | 2) Per band | No | Yes | NA |  | Optional with capability signalling{0,4,8,16} |
| 13e. SRS for positioning | 13e-0 | FFS Basic SRS for positioning | FFS whether or not to introduce basic FG. |  |  |  |  |  |  |  |  |  |  |
| 13e-1 | SRS configuration | 1. Max number of SRS Resource Sets for positioning supported by UE per BWP. Values = {1, 16}. Other values FFS
2. Max number of aperiodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {64}, Other values FFS.
3. Max number of semi-persistent SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {64}, Other values FFS.
4. Max number of periodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {64}, Other values FFS.
 | FFS 13e-0 | Yes |  | Serving gNB will not know how to configure SRS. | 1) Per UE | No | Yes | NA | Support of AP SRS is still under discussion in RAN2. | Optional with capability signalling.#1: {1,2,4} for FR1, and {1,4,16} for FR2.#2: {0,1,2,4} for FR1, and {0,4,16,64} for FR2.#3: {0,1,2,4} for FR1, and {0,4,16,64} for FR2#4: {1,2,4} for FR1 and {4,16,64} for FR2. |
| 13e-2 | Open loop power control | 1. Support of SSB for serving cell DL pathloss estimation and OLPC for SRS for positioning.
2. Support of SSB for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning.
3. Support of DL PRS for serving cell DL pathloss estimation and OLPC for SRS for positioning.
4. Support of DL PRS for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning.
 | FFS 13e-0 | No |  | SRS pathloss will only be based on the Rel-15 reference signal from the serving cell. | 1) Per UE | No | Yes | NA |  | Optional with capability signalling.{supported, notSupported} |
| 13e-3 | Number of pathloss estimates | Max number of pathloss estimates across all SRS resource sets for positioning in addition to the up to four pathloss estimates per serving cell specified for PUSCH/PUCCH/SRS transmission. It is indicated from the following set of values {0, [1], 4, 8, 16} | FFS 13e-0, 13e-2 | No |  | SRS pathloss will only be based on the DL reference signal from the serving cell. | 2) Per band | No | Yes | NA |  | Optional with capability signalling.{0,4,8,16} |
| 13e-4 | SRS Tx beamforming | 1. Support of spatial relation of SRS Resources for positioning with DL PRS Resources from serving cell
2. Support of spatial relation of SRS Resources for positioning with DL PRS Resources from neighbour cells
3. Support of spatial relation of SRS Resources for positioning with SSB from serving cell
4. Support of spatial relation of SRS Resources for positioning with SSB from neighbour cells
5. Support of spatial Relation of SRS Resources for positioning with other SRS resources
 | FFS 13e-0 | No |  | SRS spatial relation will only be based on the Rel-15 reference signal from the serving cell. | 1) Per UE | No | Yes | NA |  | Optional with capability signalling.{supported, notSupported} |
| 13e-5 | Number of spatial relations | [Max number of active spatial relations including both DL PRS Resources and SSB. Values = [FFS]] | FFS 13e-0, 13e-4 | No |  | The spatial relation of SRS for positioning will only be based spatial relations for Rel-15 SRS/PUSCH/PUCCH. | 2) Per band | No | Yes | NA |  | Optional with capability signalling{0,4,8,16} |

## 2.1 Discussion 1

**Companies are encouraged to provide views on** **how to reconstruct the features list to align with agreed capability signaling in RAN2.**

* **Starting from rapporteur’s updated features list below**
* **The target is to confirm reconstructed FGs that cover all the feature groups in R1-2001484**

|  |  |
| --- | --- |
| **13-1** | **NR E-CID DL SSB RRM measurements for NR Positioning** |
| **13-2** | **NR E-CID DL CSI-RS RRM measurements for NR Positioning** |
| **13-3** | **Basic DL PRS Processing Capability** |
| **13-4** | **DL PRS QCL Processing Capability** |
| **13-5** | **DL PRS Resources for DL AoD** |
| **13-6** | **DL PRS Measurement Report for DL-AoD** |
| **13-7** | **DL PRS Resources for DL-TDOA** |
| **13-8** | **DL PRS RSTD Measurement Report for DL-TDOA** |
| **13-9** | **SRS Resources for Positioning** |
| **13-10** | **OLPC for SRS for Positioning** |
| **13-11** | **Spatial Relation for SRS for Positioning** |
| **13-12** | **DL PRS Resources for Multi-RTT** |
| **13-13** | **UE Rx-Tx Measurement Report for Multi-RTT** |

**First, companies are encouraged to provide views on whether or not to apply above updated structure from rapporteur.**

 **Applying above rapporteur’s updated structure supported by:**

 **Objected by: Huawei/HiSilicon, Qualcomm**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We have the following concerns regarding the structure, and reasons are provided* 13-3: “Basic” should be changed to “Common”, as we think that DL PRS processing capability is something common among positioning methods. “Basic” should not be used as it gives a wrong impression that it is a basic FG, which is not.
* 13-4: The motivation of introduce this FG with the listed components is unclear. It is also related to an issue that is not discussed in this meeting on whether UE should perform SSB measurement for the sole purpose of positioning, or UE should reuse the RRM measurement of the source SSB. In addition, we do not think PRS-PRS QCL indication needs to be a capability, as one motivation to introduce that is to facilitate DL-AoD, but now we have the assistance data and/or location request customized for DL-AoD. Therefore, we suggest to change the FG name to “Reuse of RRM measurement for DL PRS QCL processing”.
* 13-6/13-8/13-13: The capability of number of measurements for TRP (UE Rx – Tx time difference) or a TRP pair (DL RSTD) are mixed with the capability of supporting intra-frequency measurements on neighboring TRPs and supporting inter-frequency measurements under the so-called “XXX Measurement Report for YYY”, which should be separate FGs. We are OK if it is commonly understood that they are temporarily placed under the same FG, which may be further split following Rel-15 convention.
* 13-10/13-11: The capability of number of pathloss estimates/active spatial relations are mixed with support of SSB/PRS as the pathloss reference and spatial relations. We are OK if it is commonly understood that they are temporarily placed under the same FG, which may be further split following Rel-15 convention.
* Whether a basic FG is defined for the features DL-AoD, DL-TDOA, Multi-RTT, or SRS for positioning is another issue, which cannot be precluded now. This is because in our understanding, 13-1 can be regarded as the basic FG for E-CID positioning, which is the minimum FG to support NR E-CID reporting via LPP, but we do not have that for other features.

In summary, we propose the following change.

|  |  |
| --- | --- |
| **13-1** | **NR E-CID DL SSB RRM measurements for NR Positioning** |
| **13-2** | **NR E-CID DL CSI-RS RRM measurements for NR Positioning** |
| **13-3** | **Common DL PRS Processing Capability** |
| **13-4** | **Reuse of RRM measurement for DL PRS QCL Processing**  |
| **13-5** | **DL PRS Resources for DL AoD** |
| **13-6** | **DL PRS Measurement Report for DL-AoD** |
| **13-7** | **DL PRS Resources for DL-TDOA** |
| **13-8** | **DL PRS RSTD Measurement Report for DL-TDOA** |
| **13-9** | **SRS Resources for Positioning** |
| **13-10** | **OLPC for SRS for Positioning** |
| **13-11** | **Spatial Relation for SRS for Positioning** |
| **13-12** | **DL PRS Resources for Multi-RTT** |
| **13-13** | **UE Rx-Tx Measurement Report for Multi-RTT** |
| **13-u** | **Inter-frequency measurement for DL-AoD** |
| **13-v** | **Inter-frequency measurement for DL-TDOA** |
| **13-w** | **Intra-frequency measurement for neighbouring TRPs for Multi-RTT** |
| **13-x** | **Inter-frequency measurement for Multi-RTT** |
| **13-y** | **Pathloss estimates maintaining capability** |
| **13-z** | **Spatial relation estimates maintaining capability** |

Note: Whether to introduce basic FG is a separate issue. |
| Qualcomm | Our reply below is under the assumption that whenever we have 2 sub-features (e.g., “Support X” & “Support Y”) for which we prefer to have a separate capability bit, then these 2 should be in different rows. Therefore, several additional rows need to be added in the restructuring (some of these were effectively components inside a FG in our previous proposal, but based in RAN2 input, we would like to clarify it earlier than later): 1. We prefer to call it “Common DL PRS processing Capability” rather than “Basic” as pointed out also by HW/HiSi
2. Introduce 2 FGs for Measurement report for OTDOA & MRTT, one for RSRP and one for TDOA/Rx-Tx, especially because the understanding is that this FG would contain how many RSRPs can be reported. For OTDOA/MRTT, a UE does not need to report as many RSRPs as for AoD (or even may not support any RSRP reporting), and it may also be doing a different beam management procedure.
	* **DL PRS RSRP Measurement Report for DL-TDOA**
	* **DL PRS RSRP Measurement Report for Multi-RTT**
3. Introduce separate FGs for inter-frequency measurement support for AoD/TDOA/MRTT respectively:
	* **Inter-frequency measurements for DL-AoD**
	* **Inter-frequency measurements for DL-TDOA**
	* **Inter-frequency measurements for Multi-RTT**
4. Introduce separate FG for the following AP/SP and SRS Carrier switching from basic FG of SRS for positioning:
	* **Support of Aperiodic SRS for positioning**

Agreement:The Rel-15 aperiodic SRS framework is supported for SRS for positioning. Transmission of aperiodic SRS for positioning is a UE capability. There is no impact on DCI design.* + **Support of Semi-persistent SRS for positioning**
	+ **Support for SRS for positioning with Carrier Switching.**
1. Split “DL PRS QCL Processing capability” into 2 FGs:
	* **Support of SSB from neighbor cell as QCL source of a DL PRS**
	* **Support of a DL PRS from neighbor cell as QCL source of a DL PRS**
2. Introduce separate FG for the following:
	* **Support Rx-Tx measurement reporting with DL PRS and SRS in different CCs**
		+ Note: Covers scenario when SRS for positioning is transmitted in different component carriers than the component carrier to which DL PRS is configured
3. Introduce separate FG for the following:
	* **Support of UE Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing**
		+ Note: Covers scenario when DL PRS are processed across different DL PRS frequency layers associated with a given component carrier used for SRS for positioning
4. Separate the following 2 capabilities from the “OLPC for SRS for Positioning”:
	* **Support of OLPC for SRS for positioning from serving cell**
	* **Support of OLPC for SRS for positioning from neighbor cell**
5. Separate the following 2 capabilities from the “Spatial Relation for SRS for Positioning”:
	* **Support of Spatial relation for SRS for positioning from serving cell**
	* **Support of Spatial relation for SRS for positioning from neighbor cell**

|  |  |
| --- | --- |
|  | **NR E-CID DL SSB RRM measurements for NR Positioning** |
|  | **NR E-CID DL CSI-RS RRM measurements for NR Positioning** |
|  | **Common DL PRS Processing Capability** |
|  | **Support of SSB from neighbor cell as QCL source of a DL PRS** |
|  | **Support of DL PRS from neighbor cell as QCL source of a DL PRS** |
|  | **DL PRS Resources for DL AoD** |
|  | **DL PRS Measurement Report for DL-AoD** |
|  | **Inter-frequency measurements for DL-AoD** |
|  | **DL PRS Resources for DL-TDOA** |
|  | **DL PRS RSTD Measurement Report for DL-TDOA** |
|  | **DL PRS RSRP Measurement Report for DL-TDOA** |
|  | **Inter-frequency measurements for DL-TDOA** |
|  | **SRS Resources for Positioning** |
|  | **Support of Aperiodic SRS Resources for positioning** |
|  | **Support of Semi-persistent SRS Resources for positioning** |
|  | **Support of SRS for positioning with Carrier Switching** |
|  | **Support of OLPC for SRS for positioning from serving cell** |
|  | **Support of OLPC for SRS for positioning from neighbor cell** |
|  | **Support of Spatial relation for SRS for positioning from serving cell** |
|  | **Support of Spatial relation for SRS for positioning from neighbor cell** |
|  | **DL PRS Resources for Multi-RTT** |
|  | **UE Rx-Tx Measurement Report for Multi-RTT** |
|  | **Support Rx-Tx measurement reporting with DL PRS and SRS in different CCs for Multi-RTT** |
|  | **Support of Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing for Mult-RTT** |
|  | **DL PRS RSRP Measurement Report for Multi-RTT** |

 |
| CATT | 1. 13-3: Share the same view as HW/HiSi. We also prefer to call it “Common DL PRS processing Capability” rather than “Basic”.
2. 13-4: Share the same view as HW/HiSi that UE may not be required to perform SSB measurement for the sole purpose of positioning. This may be clarified with a note for this capability.
3. In general, we prefer the structure for the feature list provided by QC, for which we have the following comments:
	* For “Support of SRS for positioning with Carrier Switching”, our understanding is that RAN1 has not discussed the “Support of SRS for positioning with Carrier Switching” in previous meetings. We are wondering what the expected behavior is for a UE with such a capability, and what the difference is with the UE that supports the capability o SRS with Carrier Switching, but not this capability.
	* “Support of OLPC for SRS for positioning from serving cell”: Should this be a mandatory feature for UE? Not sure if we can have a UE without this capability.
 |
| ZTE | 1. We are generally fine with the feature list poropose by QC:
* We have similar concerns as commented by CATT.
* Regarding “Support of Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing for Multi-RTT” and “Support Rx-Tx measurement reporting with DL PRS and SRS in different CCs”, from our understanding, if we support intra and inter frequency measurement for Multi-RTT, the above cases will naturally be supported.
1. 13-4: We know the intention of Huawei’s update, but we have agreed that the topic will postpone to next meeting, so it’s better to put it into a bracket.
 |
| Qualcomm2 | It seems there are 3 comments from CATT, ZTE that may be good to clarify:1. SRS for positioning with carrier switching
2. Our understanding of inter-frequency M-RTT and its relation to “Support of Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing for Multi-RTT” and “Support Rx-Tx measurement reporting with DL PRS and SRS in different CCs”
3. “Support of OLPC for SRS for positioning from serving cell”: Should this be a mandatory feature for UE

Please find replies from our side in the 3 issues:**Issue 1:**1. As a reply to CATT and ZTE, regarding the “SRS for positioning with Carrier switching”. First, the understading from this agreement, that Aperiodic SRS for positioning triggering with Carrier switching is supported,

Agreement:The Rel-15 aperiodic SRS framework is supported for SRS for positioning. Transmission of aperiodic SRS for positioning is a UE capability. There is no impact on DCI design.and this is why also in 38.212 Table 7.3.1.1.2-24, the following has been added with regards to Type-B:

|  |
| --- |
| Triggered aperiodic SRS resource set(s) for DCI format 2\_3 configured with higher layer parameter *srs-TPC-PDCCH-Group* set to 'typeA' |
| No aperiodic SRS resource set triggered |
| SRS resource set(s) configured with higher layer parameter *usage* in *SRS-ResourceSet* set to '*antennaSwitching*' and *resourceType* in *SRS-ResourceSet* set to 'aperiodic' for a 1st set of serving cells configured by higher layers, or SRS resource set(s) configured by *[SRS-ResourceSetForPositioning]* and *resourceType* in *[SRS-ResourceSetForPositioning]* set to 'aperiodic' for a 1st set of serving cells configured by higher layers |
| SRS resource set(s) configured with higher layer parameter *usage* in *SRS-ResourceSet* set to '*antennaSwitching*' and *resourceType* in *SRS-ResourceSet* set to 'aperiodic' for a 2nd set of serving cells configured by higher layers, or SRS resource set(s) configured by *[SRS-ResourceSetForPositioning]* and *resourceType* in *[SRS-ResourceSetForPositioning]* set to 'aperiodic' for a 2nd set of serving cells configured by higher layers |
| SRS resource set(s) configured with higher layer parameter *usage* in *SRS-ResourceSet* set to '*antennaSwitching*' and *resourceType* in *SRS-ResourceSet* set to 'aperiodic' for a 3rd set of serving cells configured by higher layers, or SRS resource set(s) configured by *[SRS-ResourceSetForPositioning]* and *resourceType* in *[SRS-ResourceSetForPositioning]* set to 'aperiodic' for a 3rd set of serving cells configured by higher layers |

So, the feature has been added in the specification. So, we have 2 alternatives here:* Alt. 1: Assume that when the UE supports SRS for carrier switching + Aperiodic SRS for Positioning -> The network understands the UE supports Aperiodic SRS with Carrier switching
* Alt. 2: Have separate UE capability.

We prefer the second option, because we do not consider a good practice to connect the different aspects, as for example, we prefer have a different capability bit for Aperiodic SRS for positioning (and not implicity assume that whenever AP-SRS is supported, then also Ap-SRS for positioning is supported). **Issue 2:*** To ZTE: With regards to “inter frequency measurement for Multi-RTT”, there has been some understanding that it corresponds to PRS reception from different frequency layers, and not about SRS transmission in different CCs. This was discussed during the main session also.
* Maybe you mean that “Support of Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing for Multi-RTT” is the same as inter-frequency Multi-RTT?
	+ This is why there is no Inter-frequency Multi-RTT in the list.

What if it is written as:**Support of Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing for Mult-RTT (Inter-frequency Multi-RTT)**This row: “Support Rx-Tx measurement reporting with DL PRS and SRS in different CCs”, is about SRS transmission in different CCs, that is the UE may receive just a PRS in one layer, and transmit in multiple. This is not considered “inter-frequency measurement” from our side.**Issue 3:*** To CATT: “Support of OLPC for SRS for positioning from serving cell”, yes this is fine by us to include this as part as mandatory feature within a an SRS. So, we could remove a capability bit for this

Based on the above comments, please find the following updates:

|  |  |
| --- | --- |
|  | **NR E-CID DL SSB RRM measurements for NR Positioning** |
|  | **NR E-CID DL CSI-RS RRM measurements for NR Positioning** |
|  | **Common DL PRS Processing Capability** |
|  | **Support of SSB from neighbor cell as QCL source of a DL PRS** |
|  | **Support of DL PRS from neighbor cell as QCL source of a DL PRS** |
|  | **DL PRS Resources for DL AoD** |
|  | **DL PRS Measurement Report for DL-AoD** |
|  | **Inter-frequency measurements for DL-AoD** |
|  | **DL PRS Resources for DL-TDOA** |
|  | **DL PRS RSTD Measurement Report for DL-TDOA** |
|  | **DL PRS RSRP Measurement Report for DL-TDOA** |
|  | **Inter-frequency measurements for DL-TDOA** |
|  | **SRS Resources for Positioning** |
|  | **Support of Aperiodic SRS Resources for positioning** |
|  | **Support of Semi-persistent SRS Resources for positioning** |
|  | **Support of SRS for positioning with Carrier Switching** |
|  | **Support of OLPC for SRS for positioning from neighbor cell** |
|  | **Support of Spatial relation for SRS for positioning from serving cell** |
|  | **Support of Spatial relation for SRS for positioning from neighbor cell** |
|  | **DL PRS Resources for Multi-RTT** |
|  | **UE Rx-Tx Measurement Report for Multi-RTT** |
|  | **Support Rx-Tx measurement reporting with DL PRS and SRS in different CCs for Multi-RTT** |
|  | **Support of Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing for Mult-RTT (Inter-frequency Multi-RTT )** |
|  | **DL PRS RSRP Measurement Report for Multi-RTT** |

 |
| CATT | Thanks QC for the responses to our comments. Further discussion on Issue 1 “SRS for positioning with carrier switching”:* 1. For RAN1’s previous agreement on aperiodic SRS for positioning, it indicates “There is no impact on DCI design”. If we want to support different capability bits for SRS, and for SRS for positioning,

I assume we may not be to use the same DCI to trigger the carrier switching for SRS, and the carrier switching for SRS for positioning, or there will be impact on DCI design. Do we have the same understanding?* 1. For SRS carrier switching is for CLPC, as shown in the following in TS 38.212, it is mainly used for CLPC. Given that SRS for positioning uses OLPC, it is unclear to us when and why the network to specifically support carrier switching for SRS for positioning.

|  |
| --- |
| TS 38.212:*If the UE is configured with higher layer parameter srs-TPC-PDCCH-Group = typeA for an UL without PUCCH and PUSCH or an UL on which the SRS power control is not tied with PUSCH power control, one block is configured for the UE by higher layers, with the following fields defined for the block:**- SRS request – 0 or 2 bits. The presence of this field is according to the definition in Clause 11.4 of [5, TS38.213]. If present, this field is interpreted as defined by Table 7.3.1.1.2-24.**- TPC command number 1, TPC command number 2, ..., TPC command number N, where each TPC command applies to a respective UL carrier provided by higher layer parameter cc-IndexInOneCC-Set* |

 |

**On Tuesday UE feature session for NR positioning, following proposal was made. Companies can provide feedback on the necessity of each row below.**

Proposal:

Use following feature group structure for further discussion

|  |
| --- |
| [NR E-CID DL SSB RRM measurements for NR Positioning] |
| NR E-CID DL CSI-RS RRM measurements for NR Positioning |
| [Common] DL PRS Processing Capability |
| [Support of SSB from neighbor cell as QCL source of a DL PRS] |
| [Support of DL PRS from neighbor cell as QCL source of a DL PRS] |
| DL PRS Resources for DL AoD |
| DL PRS Measurement Report for DL-AoD |
| [Inter-frequency measurements for DL-AoD] |
| DL PRS Resources for DL-TDOA |
| DL PRS RSTD Measurement Report for DL-TDOA |
| [DL PRS RSRP Measurement Report for DL-TDOA] |
| [Inter-frequency measurements for DL-TDOA] |
| SRS Resources for Positioning |
| [Support of Aperiodic SRS Resources for positioning] |
| [Support of Semi-persistent SRS Resources for positioning] |
| [Support of SRS for positioning with Carrier Switching] |
| [Support of OLPC for SRS for positioning from neighbor cell] |
| [Support of Spatial relation for SRS for positioning from serving cell] |
| [Support of Spatial relation for SRS for positioning from neighbor cell] |
| DL PRS Resources for Multi-RTT |
| UE Rx-Tx Measurement Report for Multi-RTT |
| [Support Rx-Tx measurement reporting with DL PRS and SRS in different CCs for Multi-RTT] |
| [Support of Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing for Mult-RTT (Inter-frequency Multi-RTT )] |
| [DL PRS RSRP Measurement Report for Multi-RTT] |

## **[NR E-CID DL SSB RRM measurements for NR Positioning]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We support this FG, and it can be the basic FG of NR E-CID positioning, which means UE should not support only CSI-RS RRM reporting for E-CID.We would also like to clarify that agreeing with this, we do not need separate capability bits for SS-RSRP and SS-RSRQ. |

## **NR E-CID DL CSI-RS RRM measurements for NR Positioning**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We support this FG, and it can be the additional optional FG of NR E-CID.We would also like to clarify that agreeing with this, we do not need separate capability bits for CSI-RSRP and CSI-RSRQ. |

## **[Common] DL PRS Processing Capability**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We support the name “Common DL PRS processing capability”. Components at least include the supported maximum bandwidth, and the UE (N, T) or (N, N2, T) assuming the maximum bandwidth subject to discussion in another email thread. Other components can be FFS.The reporting type should be per band. |

## **[Support of SSB from neighbor cell as QCL source of a DL PRS]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | To us, we do not see the need to introduce this capability, unless it is change to “Support of reusing SSB measurement from RRM to assist PRS reception via QCL indication. In the current form, there is no difference between supporting this FG and not supporting this FG. |

## **[Support of DL PRS from neighbor cell as QCL source of a DL PRS]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | To us, we do not see the need to introduce this capability. PRS-PRS QCL mainly serves as the indication from physical layer to request UE to use the fixed Rx beam to receive PRS for DL-AoD, but now we have customized DL-AoD related assistance data and measurement request/report, and thus this QCL-D indication is less needed from signaling point of view, let alone the UE capability. |

## **DL PRS Resources for DL AoD**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We assume the components are related to the values X1, X3-X7. Generally those values should be reported per UE, but some of them have FR1/FR2 differentiation (e.g. number of PRS resources in a resource set), some of them does not (e.g. number of positioning frequency layers). Some values needs interpretation in case of FR1-FR2 mixed operation.In summary, we are not sure whether they can be put under a single FG. If they can, we support this FG. Otherwise, we may need to split this FG. |

## **DL PRS Measurement Report for DL-AoD**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We support this FG. |

## **[Inter-frequency measurements for DL-AoD]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We support this FG.We may need to clarify that intra-frequency measurement for DL-AoD would be considered as the mandatory capability (basic FG) for DL-AoD. |

## **DL PRS Resources for DL-TDOA**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We assume the components are related to the values X1, X3-X7. Generally those values should be reported per UE, but some of them have FR1/FR2 differentiation (e.g. number of PRS resources in a resource set), some of them does not (e.g. number of positioning frequency layers). Some values needs interpretation in case of FR1-FR2 mixed operation.In summary, we are not sure whether they can be put under a single FG. If they can, we support this FG. Otherwise, we may need to split this FG. |

## **DL PRS RSTD Measurement Report for DL-TDOA**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | Our initial understanding would be that there should not be separate FGs for RSTD measurement and RSRP measurement for DL-TDOA positioning. UE should support both, and the number of measurements should also be the same.In case it is really necessary to split the two, we can accept this FG. If it is split from RSRP measurement, is it assumed that DL RSTD measurement should be mandatory for DL-TDOA (basic FG)? |

## **[DL PRS RSRP Measurement Report for DL-TDOA]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | Our initial understanding would be that there should not be separate FGs for RSTD measurement and RSRP measurement for DL-TDOA positioning. UE should support both, and the number of measurements should also be the same.In case it is really necessary to split the two, we can accept this FG.If it is split from DL RSTD measurement, is it assumed that RSRP measurement should be optional for DL-TDOA? |

## **[Inter-frequency measurements for DL-TDOA]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We support this FG.We may need to clarify that intra-frequency measurement for DL-TDOA would be considered as the mandatory capability (basic FG) for DL-TDOA. |

## **SRS Resources for Positioning**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We assume the components are related to the number of SRS resource sets and the total number of SRS resource for each time domain behavior.If so, we support this FG. |

## **[Support of Aperiodic SRS Resources for positioning]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We support this FG, if RAN3 decides it is feasible. |

## **[Support of Semi-persistent SRS Resources for positioning]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We support this FG. |

## **[Support of SRS for positioning with Carrier Switching]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We would like to clarify whether this is related to aperiodic carrier switching by DCI format 2\_3 or periodic/semi-persistent SRS carrier switching without TPC command, but may result in UL interruption. |

## **[Support of OLPC for SRS for positioning from neighbor cell]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | Using “support of” means that the capability bit would be single bit based on our understanding.The result would be if UE support its, UE should support both OLPC for SRS based on SSB and DL PRS from neighbouring cell. Another result would be that there is no way to put the components for number of pathloss estimates which we agreed to be a UE capability.We suggest to add another FG: PL estimate maintenance to cover the components of number of PL estimates.Also is it correct understanding that OLPC for SRS for positioning based on CSI-RS/SSB/PRS from the serving cell is mandatory (in basic FG) for SRS for positioning? |

## **[Support of Spatial relation for SRS for positioning from serving cell]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We would like to ask for clarification that by setting the bit UE indicates it supports CSI-RS/SSB/PRS from the serving cell and another SRS. |

## **[Support of Spatial relation for SRS for positioning from neighbor cell]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We would like to ask for clarification that by setting the bit UE indicates it supports SSB/PRS from the neighbouring cell. We would also ask for clarification that SRS-SRS spatial relation indication is not considered as for neighbouring cell. |

## **DL PRS Resources for Multi-RTT**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We assume the components are related to the values X1, X3-X7. Generally those values should be reported per UE, but some of them have FR1/FR2 differentiation (e.g. number of PRS resources in a resource set), some of them does not (e.g. number of positioning frequency layers). Some values needs interpretation in case of FR1-FR2 mixed operation.In summary, we are not sure whether they can be put under a single FG. If they can, we support this FG. Otherwise, we may need to split this FG. |

## **UE Rx-Tx Measurement Report for Multi-RTT**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | Our initial understanding would be that there should not be separate FGs for UE Rx – Tx time difference measurement and RSRP measurement for multi-RTT positioning. UE should support both, and the number of measurements should also be the same.In case it is really necessary to split the two, we can accept this FG. If it is split from RSRP measurement, is it assumed that UE Rx – Tx time difference measurement should be mandatory for Multi-RTT (basic FG)? |

## **[Support Rx-Tx measurement reporting with DL PRS and SRS in different CCs for Multi-RTT]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We do not understand the wording, DL PRS can have no CC, as it can be inter-frequency. A DL PRS should not paired with SRS from multiple CC, which we think is common understanding that we do not define multiple UE Rx – Tx time difference based on a single DL PRS and multiple SRS.Why do we need this capability? |

## **[Support of Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing for Mult-RTT (Inter-frequency Multi-RTT )]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | In our understanding, measurements across different positioning frequency layers does not have to be inter-frequency measurement, and if we reuse inter-frequency measurement from Rel-15, it simply means that PRS from neighbouring cells have the same bandwidth and centered aligned with the PRS from the serving cell.In case multiple positioning frequency layers are all on each CC, there would be no inter-frequency measurement at all.Therefore, we suggest to revise the wording to Inter-frequency measurement for Multi-RTT. |

## **[DL PRS RSRP Measurement Report for Multi-RTT]**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | Our initial understanding would be that there should not be separate FGs for UE Rx – Tx time difference measurement and RSRP measurement for multi-RTT positioning. UE should support both, and the number of measurements should also be the same.In case it is really necessary to split the two, we can accept this FG.If it is split from UE Rx – Tx time difference measurement, is it assumed that RSRP measurement should be optional for multi-RTT? |

## **Additional comment**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | Is it correct understanding the following basic FG should be introducedFG-xx: Basic DL-TDOA, including at least support of intra-frequency DL RSTD measurementFG-xx: Basic DL-AoD, including at least support of intra-frequency DL PRS-RSRP measurementFG-xx: Basic Multi-RTT, including at least support of intra-frequency UE Rx – Tx time difference measurementFG-xx: Basic SRS for positioning, including at least support of periodic SRS, and support of OLPC from the serving cell |

# **Conclusion**

TBD

# **References**

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[3] R1-2001723 Discussion on UE features for Rel-16 NR positioning vivo

[4] R1-2001739 Discussion on UE features for NR Positioning OPPO

[5] R1-2001831 Views on Rel-16 UE features for NR positioning MediaTek Inc.

[6] R1-2001956 Discussion on UE features for NR positioning LG Electronics

[7] R1-2002022 Input to discussion on UE features for NR Positioning Intel Corporation

[8] R1-2002073 Discussion of UE features for NR positioning CATT

[9] R1-2002156 UE features for NR positioning Samsung

[10] R1-2002479 On UE features for NR Positioning Nokia, Nokia Shanghai Bell

[11] R1-2002569 Discussion on NR Positionign UE features Qualcomm Incorporated

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