**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.Reply to Ericsson: We would interpret this FG as capability of supportingNR E-CID positioning. Whether it needs to be signaling can be discussed, but we are not sure whether this can be without capability signaling now.For Rel-15 UE that support LPP, if LMF request its NR E-CID capability, we think the UE would simply ignore the request anyway. |
| Ericsson | We would like to understand the need for this feature group. The underlying capability is already reported by the UE to the network since release 15. If so, couldn’t the network relay the capability to the location server when establishing the cell E-CID toward the location server. |
| Qualcomm | We support this FG. LPP signaling to the LMF would be needed.  |
| CATT | We share the similar view as Ericsson. Our understanding is that if an UE informs the LMF that it support NR E-CID, the UE should have the capability to support using SSB RRM measurements for NR E-CID. We don’t see the need to have separate LPP signaling to LMF for this capability. |
| Intel | Support for the LPP reasons |
| Futurewei | Same questions as those raised by Ericsson and CATT i.e. whether it is SSB or CSI-RS RRM, they are known to the network. |
| Nokia/NSB | We support this FG and share a similar view as HW.  |
| Samsung | Same questions as Ericsson. |
| LG | Support this FG. We also think that whether or not to support SS-RSRP and SS-RSRQ does not need to be separated. |

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

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| --- | --- |
| 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.Reply to Ericsson: We would like to explain that UE supporting CSI-RS based RRM does not necessarily mean that it supports CSI-RS RRM reporting through LPP. For example, a Rel-15 UE that supports LPP and CSI-RS based RRM, but it does not support reporting CSI-RS RRM report in LPP.[v15] To futurewei, by saying network, we should differentiate between gNB and LMF in the context of positioning. Currently we think it is related to capability exchange between UE and LMF. That is to say, even if UE supports RRM based SSB as mandatory feature in Rel-15 or UE supports RRM based on CSI-RS with capability signaling, but UE may not support the same measurement reported in LPP, as clearly Rel-15 UEs and even some Rel-16 UEs do not support that. |
| Ericsson | We would like to understand the need for this feature group. The underlying capability is already reported by the UE to the network since release 15. If so, couldn’t the network relay the capability to the location server when establishing the cell E-CID toward the location server. |
| Qualcomm | We support this FG. |
| CATT | We support this FG. For a UE that informs the LMF that it support NR E-CID, it may have the option not supporting CSI-RS measurements for NR E-CID.  |
| Intel | Support for the LPP reasons |
| Futurewei | Why is this needed? i.e. whether it is SSB or CSI-RS RRM, they are known to the network. |
| Nokia/NSB | We support this FG and share a similar view as HW.  |
| Samsung | Share same view as Ericsson. This may not be needed. |
| LG | Support this FG. We also think that whether or not to support RSRP and RSRQ does not need to be separated. |

## **(Finished) [Common] DL PRS Processing Capability**

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| --- | --- |
| 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.Reply to Ericsson: Our understanding is that number of PRS resources in a resource set for DL-AoD may be different from others, as we propose that the minimum number to be 2, simply because you cannot do DL-AoD if UE only support single PRS resource per set. |
| Ericsson | Support. Moreover If a common group for DL PRS processing capability is signalled, we also ask to clarify the reason to also have separate processing capability features per methods for DL PRS Resources (for AOD, OTDOA, MRTT). It seems that a common core of processing capability would be more suitable, including basic DL processing capability and DL PRS resource capability. The distinction between the different methods should only be for measurement and reporting.  |
| Qualcomm | We support this FG. Based on the email discussion, this FG may need to be split into 2 FGs: “DL PRS Processing within Measurement Gaps” and “DL PRS Processing without Measurement Gaps”. To Ericsson: The PRS processing and beam management procedures are different for AoD compared to TDOA. For AoD, the UE just need to report RSRP, whereas for TDOA, Timing measurements are needed. For TDOA, in FR1 or FR2, a deployment could be OK by sweeping fewer beams, but that is not true for AoD. E.g., TDOA with fewer wider beams could still work assuming larger repetition factor, but how would you do AoD with “wide” beams? Also, already RAN2 signaling is structured under this assumption: The UE gets a big database of assistance data, and then the assistance data are split for different RAT-dependent methods. With regards to processing capabilities, the concept of “common” is because the UE is reusing the same Baseband, RF and Hardware blocks across positioning methods (if it supports concurrency of methods). |
| vivo | We support this FG. Regarding the comment from Qualcomm about splitting into 2 FGs: “DL PRS Processing within Measurement Gaps” and “DL PRS Processing without Measurement Gaps”. Our preference is not to do so as we expressed in the email discussion [100b-e-NR-Pos-01] UE DL PRS Processing Capability. |
| CATT | We support this FG. Similar with Ericsson, our preference is to have a common group for DL PRS processing capability for all positioning methods that are based on the DL PRS (e.g. AOD, DL-TDOA, MRTT).  |
| Intel | Support |
| Futurewei | Support |
| Nokia/NSB | We support this FG. Regarding QC’s comment we should wait for the corresponding email discussion to be completed before deciding on any potential splitting.  |
| Samsung  | Support |
| LG | We support this FG, and we also think that this would be a common capability for all positioning techniques using PRS. It would not be a basic feature, since some UEs could possibly support UL only positioning method. |

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

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| --- | --- |
| 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.Reply to QC: We do not think it is necessary unless we see related behaviour. In the example showed, there is behaviour for CSI-RS associated with SSB that if SSB is not detected, UE is not required to measure the CSI-RS. Agreeing with this may imply that UE supporting this feature is expected to perform additional RRM measurement for receiving PRS. |
| Ericsson | We would like to understand why there is a need for a capability for this. If you have the capability to perform RRM on an SSB from the neighbor cell, we don’t understand where is the need for additional capability. We did not find similar capabilities for QCL in release 15. |
| Qualcomm | We support this FG. To HW/HiSi: this issue being discussed in RAN4. There is no need of connecting them in this discussion here. When the FG is added, RAN4 can add additional constraints as: “Reuse of SSB from RRM for PRS”. To Ericsson: In Rel-15, there is a different capability for SSB to CSIRS for RRM depending on whether the CSIRS for RRM is associated with SSB or not:

|  |  |
| --- | --- |
| 1-5 | CSI-RS based RRM measurement **with associated SS-block** |
| 1-5a | CSI-RS based RRM measurement **without associated SS-block** |

 |
| vivo | Support this FG. |
| CATT | We are fine with this FG. But, we share the similar view with HW that there is need to clarify the FG implies the UE has the capability to use available SSB RRM measurements as QCL source, but not imply the UE will specifically performance RRM measurement for the purpose. |
| Intel | Support. Suggest merging all QCL related rows under the same FG with different components with independent indication of capability |
| Futurewei | Support |
| Nokia/NSB | We are okay to support this FG and agree with Intel’s comment to merge the QCL related row. |
| Samsung | Support |
| LG | Support.  |

## **[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.Reply to QC: Our understanding is that for PRS-based BM, UE should always support it at least for FR2. We are OK to list it here if we agree to discuss it whether it should be a component in the basic FG.[v15] Reply to all, we do not think a dedicated capability bit should be assigned to this FG. It is meaningless to do so. Even if UE does not support it, network could anyway provide QCL-D information, and we do not think there would any different expectation from network between from UE supporting it and from UE not supporting it.Our humble opinion is that once a capability is introduced, there should be a different expectation at network toward UE supporting it and UE not supporting it.To Intel, based on the first round check with the session chair, it should be commonly understood that if each component needs to have a separate capability indication (single bit to our understanding), they should be into different FGs, i.e. it should be single bit per FG to indicate support all components for the FG.* When we restructure a FG, is it common understanding that components-wise switch should be avoided. For example, should it be avoided that UE reports supporting one components and not supporting the other components under the same FG?

[Moderator] Yes, if support of each component needs to have separate capability indication, it should be split into multiple FGs. |
| Ericsson | We would like to understand why there is a need for a capability for this. If you have the capability to receive a certain PRS from the neighbor cell, we don’t understand where is the need for additional capability. We did not find similar capabilities for QCL in release 15.  |
| Qualcomm | We support the FG. Having Type-D from PRS to PRS was not added just for the purpose of AoD. It can be useful for regular PRS-based beam management. In the agreements also, even though DL-AoD was one of the reasons this Type-D was added, it was not the only reason. Please see reply above that the was similar capabilities from neighboring cell SSB to CSIRS in Rel-15 |
| vivo | We support the FG.  |
| CATT | We are fine with the FG. In our understanding, this FG may be useful if the DL PRS resources from a TRP are transmitted with QCL-TypeD, although we assume this may not be a common deployment scenario. |
| Intel | Support. Suggest merging all QCL related rows under the same FG with different components with independent indication of capability |
| Futurewei | Support |
| Nokia/NSB | We are okay to support this FG and agree with Intel’s comment to merge the QCL related row. |
| Samsung | Support this FG. |
| LG | Support. |

## **(Finished) 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. |
| Ericsson | We think the Resource FGs for the different methods should be put under one single FG. |
| Qualcomm | Support this FG. |
| vivo | Our preference is the same as Ericsson as to group those DL PRS resource FGs (e.g. those maximum number of PRS resources) into one FG.  |
| CATT | Our preference is the same as Ericsson/vivo. During the discussion of the maximum values Xn (n=1, …), we actually do not assume different methods have different Xn.  |
| Intel | Support this FG |
| Nokia/NSB | Support |
| Samsung | Support |
| LG | Support  |

## **(Finished) DL PRS Measurement Report for DL-AoD**

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We support this FG. |
| Ericsson | Support |
| Qualcomm | Support this FG |
| vivo | Support this FG |
| CATT | Support |
| Intel | Support this FG |
| Futurewei | Support |
| Nokia/NSB | Support this FG if needed, though it needs to be supported for any UE supporting the method in the first place. |
| Samsung | Support |
| LG | Support |

## **[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. |
| Ericsson | Support |
| Qualcomm | Support this FG. |
| CATT | Support |
| Intel | Do not support. Suggest to see another FG or component which is independent of positioning method, e.g.Inter-frequency DL PRS RSRP measurement report in RRC\_CONNECTED state |
| Futurewei | Support |
| Nokia/NSB | We can accept this FG.  |
| Samsung | Support |
| LG | Support |

## **(Finished) 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. |
| Ericsson | We think the Resource FGs for the different methods should be put under one single FG. |
| Qualcomm | Support this FG. To Ericsson: See earlier reply. |
| vivo | Our preference is to group those DL PRS resource FGs (e.g. those maximum number of PRS resources) into one FG.  |
| CATT | Our preference is the same as Ericsson/vivo. During the discussion of the maximum values Xn (n=1, …), we actually do not assume different methods have different Xn.  |
| Intel | Support. Assume that amount of RSRP and RSTD measurement are the same. OK to discuss further split as Huawei mentioned. |
| Futurewei | Support |
| Nokia/NSB | Support |
| Samsung | Support |
| LG | Support |

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

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| --- | --- |
| 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)? |
| Ericsson | We would not like to have separate FGs for RSRP and RSTD for DL TDOA, as it would fragment support for the DL-TDOA feature. The motivation for this is unclear. |
| Qualcomm | For UE-A, this is about how many RSTD measurements are reported for TDOA. For UE-B, this feature would not be needed to be supported by the UE. We prefer to leave any discussion for “Basic FGs” for later discussion after we see what rows have been defined. To Ericsson: See reply below. |
| vivo | Our original preference is to put DL PRS RSTD together with DL PRS RSRP measurement report for DL-TDOA into one FG. Considering RAN2 signaling CR quoted by Qualcomm below, we can support this FG. |
| CATT | We are fine to have this FG, although our preference is not to have separate FGs for RSRP and RSTD reporting. |
| Intel | Support if we remover RSTD from title. Do not see the reason to split on RSRP and RSTD |
| Futurewei | Support with RSRP and RSTD reporting considered together |
| Nokia/NSB | Support this FG if needed, though it needs to be supported for any UE supporting the method in the first place. We agree with Futurewei and Intel on RSRP and RSTD considered together. |
| Samsung | Agree with Ericsson and CATT |
| LG | Support this FG, but we do not prefer having separate FGs for RSRP and RSTD for DL-TDOA method. |

## **[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?Reply to QC: The current RAN2 spec cannot be generally used as the argument for support that in RAN1, because some of it has not been discussed in RAN2 at all. For example, the current LPP uses 4 capability bits to indicate whether UE support SS-RSRP, SS-RSRQ, CSI-RSRP, and CSI-RSRQ in E-CID, which is not needed from RAN1 perspective, as SS-RSRP/SS-RSRQ should be supported using single bit. |
| Ericsson | We would not like to have separate FGs for RSRP and RSTD for DL TDOA, as it would fragment support for the DL-TDOA feature. The motivation for this is unclear. |
| Qualcomm | Support this FG. A UE in TDOA should not be required to report RSRP. This was not needed in LTE, and it was not shown in the SI or WI in NR any big usefulness of this feature. For example, I don’t recall a company showing results actually for the usefulness of RSRP reporting in TDOA. Either way, already in Ran2 has included this as part of the RAN2 CR (that is, the UE can report capability of RSRP measurement report or not, in TDOA): Capabilities indicate support for RSRP (prsrsrpSup):-- ASN1STARTNR-DL-TDOA-ProvideCapabilities-r16 ::= SEQUENCE {    nr-DL-TDOA-Mode-r16               PositioningModes,    nr-DL-TDOA-MeasCapability-r16      NR-DL-PRS-MeasCapability-r16                  OPTIONAL,    nr-DL-TDOA-MeasSupported-r16       BIT STRING { prsrsrpSup (0)} (SIZE(1..8)),    additionalPathsReport-r16          ENUMERATED { supported }                      OPTIONAL,    periodicalReporting-r16            ENUMERATED { supported }                      OPTIONAL,    ...}-- ASN1STOPIf supported, the LMF may request the RSRP (prsrsrpReq):NR-DL-TDOA-RequestLocationInformation-r16 ::= SEQUENCE {    nr-DL-PRS-RstdMeasurementInfoRequest-r16    ENUMERATED { true }            OPTIONAL, -- Need ON    nr-RequestedMeasurements-r16               BIT STRING {prsrsrpReq (0)} (SIZE(1..8)),    nr-AssistanceAvailability-r16              BOOLEAN,    nr-DL-TDOA-ReportConfig-r16               NR-DL-TDOA-ReportConfig-r16     OPTIONAL, -- Need ON    additionalPaths-r16                       ENUMERATED { requested }       OPTIONAL, -- Need ON    ...} |
| vivo | Our original preference is to put DL PRS RSRP together with DL PRS RSTD measurement report for DL-TDOA into one FG. Considering RAN2 signaling CR quoted by Qualcomm above, we can support this FG. |
| CATT | We are fine to have this FG, although our preference is not to have separate FGs for RSRP and RSTD reporting. |
| Intel | Do not support. Prefer to have single FG DL PRS Measurement Report for DL-TDOA |
| Futurewei | Support with RSRP and RSTD reporting considered together |
| Nokia/NSB | Support this FG if needed, though it needs to be supported for any UE supporting the method in the first place. We agree with Futurewei and Intel on RSRP and RSTD considered together. |
| Samsung | Support with merging RSRP and RSTD. |
| LG | We prefer having single feature group for RSRP and RSTD. |

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

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| --- | --- |
| 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. |
| Ericsson | Support.  |
| Qualcomm | Support this FG. |
| vivo | Support.  |
| CATT | Support.  |
| Intel | Do not support. Unclear why it should be associated with method rather than measurement. Suggest **RSTD** **inter-frequency measurements.** Can be also component for other FG |
| Futurewei | Support |
| Nokia/NSB | We can accept this FG. |
| Samsung | Support |
| LG | Support |

## **(Finished) SRS Resources for Positioning**

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| --- | --- |
| 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. |
| Ericsson | Support.  |
| Qualcomm | Support this FG. Our assumption is that this could have components like: total number of SRS resources across time-domain beahviors, if supported, and/or “Max number of active spatial relations including both DL PRS Resources and SSB” from the lists presented in the Tdocs. Either way, details on the components can be designed later. For example, for the max number of each time-domain behavior it might make more sense to add them as part of the AP or SP SRS Resource FG separately, otherwise what would be the usefulness of reporting “Max number of AP-SRS” as component of the “SRS Resources for Positioning” FG if the UE does not support “AP SRS”?  |
| vivo | Support.  |
| CATT | Support.  |
| Intel | Support |
| Futurewei | Support |
| Nokia/NSB | Support |
| Samsung  | Support |
| LG | Support |

## **(Finished) [Support of Aperiodic SRS Resources for positioning]**

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| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We support this FG, if RAN3 decides it is feasible. |
| Ericsson | Support.  |
| Qualcomm | Support this FG |
| vivo | Support.  |
| CATT | Support.  |
| Futurewei | Support |
| Nokia/NSB | Support. |
| Samsung | Support |
| LG | Support |

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

|  |  |
| --- | --- |
| Company | Comment |
| Huawei/HiSilicon | We support this FG. |
| Ericsson | Support.  |
| Qualcomm | Support this FG |
| vivo | Support.  |
| CATT | Support.  |
| Futurewei | Support |
| Nokia/NSB | Support |
| Samsung | Support |
| LG | Support |

## **[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. |
| Ericsson | The SRS for positioning support for carrier switching should be clarified first. Given that SRS for positoiing does not support TPC-based power control, the interpretation of DCI 2\_3 for SRS for positioning is unclear.  |
| Qualcomm | Support this FG. It could have additional components as needed for either AP-SSRS of P/SP SRS without TPC command, but we **are also OK to split it in 2 FGs**: Aperiodic SRS with Carrier Switching and P/SP SRS carrier switching. To Ericsson: CRs may be needed, but it is better to add a FG bit, rather than arguing later. Already 38.212 describes such the existence of such a feature for SRS carrier switching, and it is according to the agreements. Most features may need further clarifications (see for example the “PRS Processing capability”, for which, there is a whole ED dedicated), but we are still do progress and propose capability bits assuming these features would be clarified further.  |
| CATT | We would like to have further discussion on this. 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. SRS carrier switching 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.
 |

## **[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? |
| Ericsson | Support the FG.  |
| Qualcomm | Support this FG. Yes, our understanding is also that there is one bit for each row. We also prefer to **add one more FG** with the “PL estimate maintenance” as suggested with HW, because indeed the agreement says that the UE can report “0”, so in other words, a UE may not be supporting additional PL estimates. We have a preference to **have a separate FG** for “PRS-based” pathloss measurement from serving cell (compared to CSIRS/SSB-based Pathloss measurement). A UE not supporting Multi-RTT might not need PRS-based Pathloss of SRS.  |
| vivo | Support.  |
| CATT | Support.  |
| Intel | Support |
| Futurewei | Support |
| Nokia/NSB | Support. We are okay with a PL estimate maintenance FG. To QC’s comment on “PRS-based” if the UE supports PL measurement from serving cell and also supports PRS (i.e., also indicated multi-RTT support) could it be assumed to that this is then an additional option for PL measurement by LMF?  |
| Samsung | Support |
| LG | Support |

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

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| --- | --- |
| 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.[Update in v10] We suggest to add another FG: Spatial relation maintenance to cover the components of number of PL estimates, so that the number of spatial relations for the UE to measure does not blow.Reply to Ericsson, there is this UE capability in Rel-15.***spatialRelations***Indicates whether the UE supports spatial relations. The capability signalling comprises the following parameters.- *maxNumberConfiguredSpatialRelations* indicates the maximum number of configured spatial relations per CC for PUCCH and SRS. It is not applicable to FR1 and applicable to FR2 only. The UE is mandated to report 16 or higher values;- *maxNumberActiveSpatialRelations* indicates the maximum number of active spatial relations with regarding to PUCCH and SRS for PUSCH, per BWP per CC. It is not applicable to FR1 and applicable and mandatory to report for FR2 only;- *additionalActiveSpatialRelationPUCCH* indicates support of one additional active spatial relation for PUCCH. It is mandatory with capability signalling if *maxNumberActiveSpatialRelations* is set to n1;- *maxNumberDL-RS-QCL-TypeD* indicates the maximum number of downlink RS resources used for QCL type D in the active TCI states and active spatial relation information, which is optional.[v15] In response to CATT, in Rel-15, SRS and PUCCH/PUSCH is the target RS/channel, while CSI-RS/SSB is the source RS, and the capability simply says regardless of target RS/channel, the total number of source DL RS/channel serving as the spatial relation of the target is bounded by a UE capability. It is NOT spatial relation between SRS and PUCCH/PUSCH, instead it is between DL RS/channel and SRS/PUCCH/PUSCH. We have configured spatial relations, and active spatial relations, and in case the active spatial relation is 1, we have mandatory capability to support additional one(s) for PUCCH only. |
| Ericsson | Similar to our QCL comment for PRS, we would like to understand why there is a need for a capability for this. If you have the capability to transmit SRS and also the capability of receiving a DL Signal (CSI-RS/SSB/PRS), what is the additional capability? We did not find similar capabilities for spatial relation in release 15. |
| Qualcomm | Support this FG but **we have preference to split into separate FG** bits for different Reference Signals, at least one FG bit for CSI-RS/SSB/SRS, and one FG bit for PRS. To Ericsson: A UE not supporting Multi-RTT might not need PRS-based Spatial Relation of SRS.  |
| vivo | Support.  |
| CATT | We would like to have a further understanding on the need for this capability. The UE capability in Rel-15 quoted by HW is between SRS and another UL signals: SRS and PUCCH/PUSCH. But, we assume the FG is discussing the QCL between SRS for positioning and another DL signals CSI-RS/SSB/PRS.  |
| Intel | Support. Suggest to have independent components for serving and neighbor cell under the same FG **Support of Spatial relation for SRS for positioning** |
| Nokia/NSB | Support. Similar to QC as in the above FG on PL measurement for PRS, is it fully necessary to have a different bit for PRS? |
| LG | Support |

## **[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. |
| Ericsson | Similar to our QCL comment for PRS, we would like to understand why there is a need for a capability for this. If you have the capability to transmit SRS and also the capability of receiving a DL Signal (SSB/PRS), what is the additional capability? We did not find similar capabilities for spatial relation in release 15. |
| Qualcomm | Support this FG but we have **preference to split this FG** it for SSB and PRS in a separate FG. To Ericsson: A UE not supporting Multi-RTT might not need PRS-based Spatial Relation of SRS. Also, there is no other case in Rel-15 where the source of SRS is from neighbor cell. If it existed, there would be such feature added also, as it was the case of SSB to CSIRS for RRM from Rel-15.  |
| Qualcomm | Support this FG.  |
| vivo | Support this FG.  |
| CATT | We would like to have a further understanding on the need for this capability. The UE capability in Rel-15 is between SRS and another UL signals: SRS and PUCCH/PUSCH. But, we assume the FG is discussing the QCL between SRS for positioning and another DL signals CSI-RS/SSB/PRS.  |
| Intel | Support. Suggest to have independent components for serving and neighbor cell under the same FG **Support of Spatial relation for SRS for positioning** |
| Nokia/NSB | Same comment as on the above FG.  |
| LG | Support |

## **(Finished) 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. |
| Ericsson | We think the Resource FGs for the different methods should be put under one single FG. |
| Qualcomm | Support this FG. To Ericsson: Please see reply in an earlier comment. |
| vivo | Our preference is the same as Ericsson as to group those DL PRS resource FGs (e.g. those maximum number of PRS resources) into one FG.  |
| CATT | Our preference is the same as Ericsson/vivo. During the discussion of the maximum values Xn (n=1, …), we actually do not assume different methods have different Xn.  |
| Intel | Support |
| Futurewei | Unless there is compelling reasons, DL PRS should be in a single FG  |
| Nokia/NSB | We can accept this FG |
| Samsung | Support |

## **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)?Reply to QC: The current RAN2 spec cannot be generally used as the argument for support that in RAN1, because some of it has not been discussed in RAN2 at all. For example, the current LPP uses 4 capability bits to indicate whether UE support SS-RSRP, SS-RSRQ, CSI-RSRP, and CSI-RSRQ in E-CID, which is not needed from RAN1 perspective, as SS-RSRP/SS-RSRQ should be supported using single bit. |
| Ericsson | Support this feature group. We think that the RSRP measurement for multi RTT should be part of the FG.  |
| Qualcomm | Support this FG. We don’t see why RSRP is mandatory for a basic Multi-RTT reporting. It is already in Ran2 as a separate capability to be reported (prsrsrpSup)-- ASN1STARTNR-Multi-RTT-ProvideCapabilities-r16 ::= SEQUENCE { nr-DL-PRS-MeasCapability-r16 NR-DL-PRS-MeasCapability-r16, nr-UL-SRS-MeasCapability-r16 NR-UL-SRS-MeasCapability-r16, nr-Multi-RTT-MeasSupported-r16 BIT STRING { prsrsrpSup (0)} (SIZE(1..8)), additionalPathsReport-r16 ENUMERATED { supported } OPTIONAL, periodicalReporting-r16 ENUMERATED { supported } OPTIONAL, ...}-- ASN1STOP |
| vivo | Support.  |
| CATT | Support.  |
| Intel | Support.  |
| Futurewei | Support |
| Nokia/NSB | Support this FG if needed, though it needs to be supported for any UE supporting the method in the first place.  |
| Samsung | Support |

## **[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?Reply to QC: We do not understand why PRS would be part of one CC. It can be in a band where no CC is configured but that UE support, e.g. before CA is configured, or in a band with a CC, but the RBs of PRS is not overlap with the CC at all. |
| Qualcomm | A PRS would be part of at least one CC (e.g. CC0). SRS will be part of a CC (CC1). The baseline scenario would be that the PRS and SRS are in the same CC right? The additional feature would be that the PRS and SRS can be in different CCs. I am wondering whether for HW/HiSi, the example given here is considered an “inter-frequency measurement for Multi-RTT”, so this is merged as part of the “inter-frequency MRTT”. The issue is that currently there is no clear definition for inter-frequency measurement for either RSTD, Rx-Tx, RSRP (all are being discussed in RAN4), so this may create confusion.  |
| CATT | Fine with this FG, assume this is FG for CA case where DL PRS and SRS for positioning are in different CCs. In |
| Intel | Agree with Huawei comments. Clarification is needed. |

## **[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.Reply to QC: UE Rx – Tx time difference and RSRP (to be reported for multi-RTT) already support inter-frequency measurement, based on the current TS 38.215. |
| Qualcomm | Definition of Inter-frequency measurements (for RSTD, Rx-Tx, RSRP) is happening in RAN4. We are OK to leave it as “Inter-Frequency measurements for Multi-RTT” for this FG.  |
| vivo | We support this FG and prefer to be “Inter-Frequency measurements for Multi-RTT”.  |
| CATT | Support. There is a need to distinguish previous FG, if the FG is for the case when DL PRS and SRS for positioning are in different carriers but the same band.  |
| Intel | More discussion is needed. It can be considered as independent component under UE Rx-Tx measurement report or as a part of other FG |

## **[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?Reply to QC: The current RAN2 spec cannot be generally used as the argument for support that in RAN1, because some of it has not been discussed in RAN2 at all. For example, the current LPP uses 4 capability bits to indicate whether UE support SS-RSRP, SS-RSRQ, CSI-RSRP, and CSI-RSRQ in E-CID, which is not needed from RAN1 perspective, as SS-RSRP/SS-RSRQ should be supported using single bit. |
| Ericsson | We do not want to split RSRP from UE RxTx in multi RTT.  |
| Qualcomm | Support this FG. We don’t see why RSRP is mandatory for a basic Multi-RTT reporting. It is already in Ran2 as a separate capability to be reported (prsrsrpSup)NR-Multi-RTT-ProvideCapabilities-r16 ::= SEQUENCE { nr-DL-PRS-MeasCapability-r16 NR-DL-PRS-MeasCapability-r16, nr-UL-SRS-MeasCapability-r16 NR-UL-SRS-MeasCapability-r16, nr-Multi-RTT-MeasSupported-r16 BIT STRING { prsrsrpSup (0)} (SIZE(1..8)), additionalPathsReport-r16 ENUMERATED { supported } OPTIONAL, periodicalReporting-r16 ENUMERATED { supported } OPTIONAL, ...} |
| CATT | We are fine with this FG.  |
| Intel | Do not support. Same reasons as provided by Huawei |
| Futurewei | Should not split RSRP from UE Rx-Tx. DO not support |
| Nokia/NSB | Do not support. |
| Samsung | Do not support |

## **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[v15] To Intel, should we assume that periodic SRS for positioning and OLPC from the serving cell for SRS for positioning is supported anyway? |
| Qualcomm | Some comments:* Discussion on Basic Groups can happen in a later stage as needed, after some progress has been made.
* We proposed a few additional splits of the above FGs based on further input.
* It should be clear that we are generally open into additional FG if/as need arises from other replies. We didn’t reply whether it is “per band” or “per FR” or “per UE” since it wasn’t asked in the above categorization.
 |
| Intel | Prefer to postpone discussion on basic FG. Overall there may be no need to define basic FGs. |
| Nokia/NSB | We are open to define basic FGs for positioning methods, especially if it helps in addressing some of the concerns raised by other companies above on signaling structure, e.g. on having common feature across different methods.  |

**FL proposals:**

* Following FGs are included in UE features list for positioning.
* NR E-CID DL SSB RRM measurements with LPP support for NR Positioning
* NR E-CID DL CSI-RS RRM measurements with LPP support 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/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 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
* Inter-frequency measurement for Multi-RTT

**Comments**

|  |  |
| --- | --- |
| Qualcomm | 1. With regards to RSRP/RSTD Measurement Report: We have technical concerns that we expressed with specific questions that have not been answered.
	* RSRP reporting for Timing methods (TDOA/MRTT) was never considered as mandatory feature for TDOA/MRTT, nor performance results were ever presented. RSRP was added mainly for the purpose of AoD, and with some “wishful” thinking that it can potentially be useful for the timing methods. Until more precise reasoning, common understanding is achieved, we don’t see how this can be considered a mandatory feature for a UE to support TDOA/MRTT.

**Proposal 1:** Introduce Separate capability bits for RSRP measurement in TDOA & MRTT. 1. Using PRS as Spatial Relation source of pathloss reference for SRS needs to have a separate FG than the CSIRS/SSB/SRS. For example, for UEs, not supporting Multi-RTT, maybe it would prefer to not support PRS as QCl source or pathloss reference. Also, CSIRS or SSB-based Spatial Relation or pathloss is a feature that is supported in Rel-15, in which case there is no additional complexity/implementation needed.

**Proposal 2**: Make the following changes:* + Split the “Support of Spatial relation for SRS for positioning from serving cell” to 2 FGs:
		- Support of CSI-RS/SSB/SRS as Spatial relation source for SRS for positioning from serving cell
		- Support of PRS as Spatial relation source for SRS for positioning from serving cell
	+ Split the “Support of Spatial relation for SRS for positioning from neighbor cell” to 2 FGs:
		- Support of SSB as Spatial relation for SRS for positioning from neighbor cell
		- Support of PRS as Spatial relation for SRS for positioning from neighbor cell
	+ Split the “Support of OLPC for SRS for positioning from neighbor cell” to 2 FGs:
		- Support of SSB as OLPC pathloss Reference for SRS for positioning from neighbor cell
		- Support of PRS as OLPC pathloss Reference for SRS for positioning from neighbor cell
	+ Introduce one FG for “Support of PRS as OLPC pathloss Reference for SRS for positioning from serving cell“
1. In current spec the SRS for positioning with carrier switching is supported. There may be a need of CRs, but we cannot assume that this feature is a basic feature, so a separate FG bit is needed.

**Proposal 3**: Support of SRS for positioning with Carrier Switching1. There has been an agreement that: “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}”

We observe that this feature has the value “0”. Our understanding is that such a UE capability is preferred to be a separate FG and it is missing in the list above**Proposal 4**: Add a FG for “PL estimate maintenance”.  |
| Huawei/HiSilicon | We have concerns on the following FGs, which has not been addressed.* 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

In addition, we think it is fair to add a new FG similar to PL estimate maintenance* Spatial relation maintenance

Regarding comment from QC**Proposal 1:** we can think of another way of handling it. * We remove the capability of RSRP measurement for DL-TDOA and Multi-RTT.
* LMF requesting RSRP measurement in those two positioning method is regarded by the UE as a recommendation (rsrp-Req 🡪 rsrp-Prferred).
* In response, it is up to UE to include or drop RSRP measurement along with RSTD or UE-RxTxTimeDiff in the measurement report, since it is anyway optional.

**Proposal 2:** we support QC’s proposal.**Proposal 3:** We support this concept in principle, so that UE may support SRS carrier switching for MIMO, but not SRS carrier switching for positioning. However, we have the following question for clarification from QC.* By adding this new FGs, does it imply a single bit switch per UE (potentially with FRx differentiation)?
* Does the existing SRS switch time capability reporting applicable to SRS for positioning, i.e. *srs-SwitchingTimesListNR*?
* We notice that there has been a RAN2 email discussion regarding reporting SRS resources on a PUSCH-less scell, where FeatureSetUplink does not exist. The solution is introducing SRS-Resources in FeatureSetDownlink as proposed by R2-2002036. Would the proposed capability signalling be achieved equivalently by not reporting *SRS-Resources* in FeatureSetDownlink?
* Another related UE capability is *tpc-SRS-RNTI*, indicating whether UE supports TPC-SRS-RNTI, and to our understanding, the applicability of the capability is generic SRS. Is it the intention to add another similar capability such as *tpc-SRS-RNTI-ForPositioning*, and change the meaning of *tpc-SRS-RNTI* to UE supporting TPC-SRS-RNTI associated with SRS configured by *SRS-Resource*?

**Proposal 4:** We support QC’s proposal. |
| Qualcomm2 | With regards to **Proposal 1** and the comment from HW (or any other company supporting this): * If the UE does not report capability bit for RSRP reporting, and it is up to the UE to report it, what would be the assumption in Ran4? Will there be RAN4 conformance tests for RSRP measurement that the UE would have to pass? If yes, then how is it “optional” I don’t understand. If a UE has to pass a MRTT/TDOA test for RSRP, I don’t understand how this is optional.
	+ If RSRP is considered as part of basic feature for MRTT/TDOA, it would give the wrong impression to RAN4 that an RSRP measurement conformance test is needed as part of a basic functionality. However, in RAN1, no company has shown any gains, performance results, that can demonstrate why MRTT/TDOA cannot work without this feature as part of baseline capability.
* Or are you saying that it would be without conformance test as it is the case of “quality report”?

Our strong preference for **Proposal 2** on splitting these 3 rows as proposed in our previous reply remains.

|  |  |
| --- | --- |
| Current Agreement | Update |
| * [Support of OLPC for SRS for positioning from neighbor cell]
 | * Support of **SSB** as OLPC pathloss Reference for SRS for positioning from neighbor cell
* Support of **PRS** as OLPC pathloss Reference for SRS for positioning from neighbor cell
 |
| * [Support of Spatial relation for SRS for positioning from serving cell]
 | * Support of **CSI-RS/SSB/SRS** as Spatial relation source for SRS for positioning from serving cell
* Support of **PRS** as Spatial relation source for SRS for positioning from serving cell
 |
| * [Support of Spatial relation for SRS for positioning from neighbor cell]
 | * Support of **SSB** as Spatial relation for SRS for positioning from neighbor cell
* Support of **PRS** as Spatial relation for SRS for positioning from neighbor cell
 |

With regards to **Proposal 3**: * Our understanding is that the spec now supports Aperiodic SRS carrier switching for an SRS resource of positioning (see 38.212 Table 7.3.1.1.2-24). Not sure if this will eventually exist or dropped (waiting an input from RAN3 on AP-SRS). But what I know is that, if the spec has it, there needs to be a separate bit because it is clearly . Any details on CRs for the spec (including all the questions you raise above), shall be moved in the main agendas (UL SRS for positioning). Until then, we prefer to have the capability bit.

Finally, for **Proposal 4,** there is already an agreement that would require separate FG because the UE can report “0”. 1. There has been an agreement that: “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}”

We observe that this feature has the value “0”. Our understanding is that such a UE capability is preferred to be a separate FG and it is missing in the list above |
| Huawei/HiSilicon2 | The concerns from us from QCL to PRS can be lifted after the web conference.For comments from Qualcomm.With regards to **Proposal 1**: When you say “conformance test”, I assume that should be covered by RAN5? Or do you actually mean performance requirement to be captured in 38.133? In our understanding, if UE reports RSRP associated with RSTD/UE Rx – Tx time difference, UE shall meet the RSRP measurement performance requirement; however, UE has the choice of not reporting it at all, which is why I suggest to ask RAN2 to change the request message from rsrp-Req to rsrp-Preferred, so that UE is not required to report RSRP if it sees the performance requirement is not met. And in this capability part, we simply mentioned RSTD, without saying anything related to RSRP.No companies evaluated the DL-TDOA and Multi-RTT additionally based on RSRP to our knowledge in the SI. When it comes to RSRP reporting, I remembered that it was Qualcomm who proposed to add PRS-RSRP to DL-TDOA and Multi-RTT in the agreed LS to RAN2 in R1-1909796 during RAN1#98.With regards to **Proposal 3**: There is no such capability bits even in Rel-15, and so far as I know, network knows that UE supports SRS carrier switching based on *srs-SwitchingTimesListNR*. Our understanding is this switching time will be also applicable to SRS for positioning used in carrier switching, and it should not introduce additional switching time for SRS for positioning, correct? It also seems you only care about aperiodic carrier switching with TPC, which is more related to this capability *tpc-SRS-RNTI*, correct? I am just trying to clarify my understanding and the analyse potential impact.With regards to **Proposal 4:** One question for clarification regarding the value “0”.* If UE reports NOT supporting the following two FGs, do you think reporting value “0” is still needed? If it is needed, does the value “0” means that UE is expected to maintain pathloss estimates from the serving cell in addition to those that are already associated with PUSCH/PUCCH/MIMO-SRS
	+ Support of **SSB** as OLPC pathloss Reference for SRS for positioning from neighbor cell
	+ Support of **PRS** as OLPC pathloss Reference for SRS for positioning from neighbor cell
* If UE reports supporting the two FGs, do you still think reporting value “0” is needed?
 |
| Qualcomm3 | Replies to the clarification questions from HW:For **Proposal 3**: Yes the same switching times will be applicable for SRS for positioning, there is no intention to update this. Indeed, we are more worried about the fact of AP SRS carrier switching and the fact that Type-A has been updated to included SRS for MIMO OR SRS for positioning as the 38.212 writes, and further clarifications may be needed in main session to understand this better. For **Proposal 4**: yes, we think the FG is needed, becase even if the UE puts 0 in the remaining 2 FGs, the value “0” would mean that UE is not expected to maintain pathloss estimates from the serving cell in addition to those that are already associated with PUSCH/PUCCH/MIMO-SRS.For **Proposal 1**: Yes QC was OK to add RSRP in MRTT/TDOA, but there was no expectation that companies would like this to be mandatory, when no one really has shown results on how to use it. Unfortunately, we still don’t see technical replies from other companies on how they justify such a need.  |
| CATT | * For **Proposal 1**: About whether to separate RSTD and RSRP measurements for DL-TDOA, we assume there may be similar issue for UE Rx-Tx time and RSRP measurements for Multi-RTT. For simplicity, why don’t w the same name as DL PRS Measurement Report for DL-AoD, and then discuss with the RSRP to be optional or mandatory for DL-TDOA and Multi-RTT?
	+ “DL PRS Measurement Report for DL-AoD”
	+ DL PRS ~~RSTD/RSRP~~ Measurement Report for DL-TDOA
	+ DL PRS ~~UE Rx-Tx~~ Measurement Report for Multi-RTT

For **Proposal 2**: We support QC’s proposal.For **Proposal 3**: For the “Support of SRS for positioning with Carrier Switching”, in our view, we should first discuss whether there is a need to support this feature and how it is supported, as well as the impact of the specs in previous meetings. When a UE performs the SRS for positioning with Carrier Switching, the neighboring cells need to be informed also. We would suggest not introducing such capability until it is clear why this feature is needed for positioning.For **Proposal 4**: We are fine to this FG. |
| Intel | * On P1 from QC
	+ RAN2 defined RSRP for DL-TDOA and Multi-RTT as optional => it is up to UE report even if it is requested by LMF
	+ We do not think that RAN4 test for RSRP is needed for the case of DL-TDOA and Multi-RTT
	+ We also assume that all reasonable UE implementations will report RSRP for DL-TDoA and Multi-RTT that can be used for further SINR estimation
	+ We assume that RAN4 will check RSRP for DL-AoD which is enough
* On P2 from QC, we agree and support. Again our assumption is that we introduce as one FG (that groups correlated components) with independent signaling per component that can be discussed further

|  |  |
| --- | --- |
| 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}
 |

|  |  |
| --- | --- |
| 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]
 |

* On P4 from QC, we assume 0 – not supported, 1 suppprted for serving, > 1 supported for serving and neighbor
* On P3 from feature lead. We are not sure that defining capability only at this stage is enough. More discussion on potential RAN1 spec implications is needed.
* On P2 from feature lead. We prefer to support our structure as shown above. We assume further discussion on independent signaling per component.
* Proposal 2: Update the yesterday's agreements as below

|  |  |
| --- | --- |
| Current Agreement | Update |
|   [Support of OLPC for SRS for positioning from neighbor cell]  |   Support of **SSB** as OLPC pathloss Reference for SRS for positioning from neighbor cell  Support of **PRS** as OLPC pathloss Reference for SRS for positioning from neighbor cell |
|   [Support of Spatial relation for SRS for positioning from serving cell]  |   Support of **CSI-RS/SSB/SRS** as Spatial relation source for SRS for positioning from serving cell  Support of **PRS** as Spatial relation source for SRS for positioning from serving cell |
|   [Support of Spatial relation for SRS for positioning from neighbor cell] |   Support of **SSB** as Spatial relation for SRS for positioning from neighbor cell  Support of **PRS** as Spatial relation for SRS for positioning from neighbor cell |

 |
|  |  |

# **Conclusion**

Following agreements were made.

**Agreements:**

* Following FGs are included in UE features list for positioning.
* [NR E-CID DL SSB RRM measurements with LPP support for NR Positioning]
* [NR E-CID DL CSI-RS RRM measurements with LPP support for NR Positioning]
* Common DL PRS Processing Capability
* DL PRS Resources for DL AoD
* DL PRS Resources for DL-TDOA
* DL PRS Resources for Multi-RTT
* SRS Resources for Positioning
* [Support of SSB from neighbor cell as QCL source of a DL PRS]
	+ This does not imply UE is required to perform SSB measurement for Positioning purpose
* [Support of DL PRS from serving/neighbor cell as QCL source of a DL PRS]
* DL PRS Measurement Report for DL-AoD
* Inter-frequency measurements for [DL-AoD]
* [DL PRS RSTD/[RSRP] Measurement Report for DL-TDOA]
* Inter-frequency measurements for [DL-TDOA]
* Support of Aperiodic SRS Resources for positioning
* Support of Semi-persistent SRS Resources for positioning
* ~~[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]~~
* OLPC based on PRS from the serving cell
* OLPC based on SSB from neighbouring cells
* OLPC based on PRS from the neighbouring cells
* Spatial relation for SRS for positioning based on SSB from the serving cell
* Spatial relation for SRS for positioning based on CSI-RS from the serving cell
* Spatial relation for SRS for positioning based on SRS
* Spatial relation based on PRS from the serving cell
* Spatial relation based on SSB from the neighbouring cell
* Spatial relation based on PRS from the neighbouring cell
* [UE Rx-Tx Measurement Report for Multi-RTT]
* Inter-frequency measurement for [Multi-RTT]

**Agreements:**

* [Support of OLPC for SRS for positioning from neighbor cell], [Support of Spatial relation for SRS for positioning from serving cell] and [Support of Spatial relation for SRS for positioning from neighbor cell] in agreements are updated to below.
	+ OLPC based on PRS from the serving cell
	+ OLPC based on SSB from neighbouring cells
	+ OLPC based on PRS from the neighbouring cells
	+ ~~Spatial relation based on SSB/CSI-RS/SRS from the serving cell~~
	+ Spatial relation for SRS for positioning based on SSB from the serving cell
	+ Spatial relation for SRS for positioning based on CSI-RS from the serving cell
	+ Spatial relation for SRS for positioning based on SRS
	+ Spatial relation based on PRS from the serving cell
	+ Spatial relation based on SSB from the neighbouring cell
	+ Spatial relation based on PRS from the neighbouring cell

**Agreements:**

* Adding following FGs
	+ [OLPC for SRS for positioning based on SSB from serving cell]
	+ OLPC for SRS for positioning based on CSI-RS from serving cell

**Agreements:**

* “Spatial relation based on SSB/CSI-RS/SRS from the serving cell” in agreements is updated to below.
	+ Spatial relation for SRS for positioning based on SSB from the serving cell
	+ Spatial relation for SRS for positioning based on CSI-RS from the serving cell
	+ Spatial relation for SRS for positioning based on SRS

**Agreements:**

* Add a FG for “[PathLoss estimate maintenance]”
	+ Component(s) include at least “Max number of monitored pathloss for SRS for positioning [across all cells]”
* Add a FG for “[Spatial relation maintenance]”
	+ Component(s) include at least “Max number of [maintained] spatial relations for SRS for positioning [across all cells]”

**Proposal:**

* Remove bracket from “[Support of SSB from neighbor cell as QCL source of a DL PRS]”

# **References**

[1] R1-2001484 RAN1 UE features list for Rel-16 NR after RAN1#100-E Moderator (AT&T, NTT DOCOMO, INC.)

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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

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

[12] R1-2002712 Rel-16 UE features for NR positioning Huawei, HiSilicon

[13] R1-2002624 View on UE feature description for NR positioning Ericsson