**3GPP TSG RAN WG1 #100bis-e R1-2003201**

**e-Meeting, 20th – 30th April, 2020**

**Agenda item:** 7.2.11.8

**Source:** Moderator (NTT DOCOMO, INC.)

**Title:** Summary on email discussion [100b-e-NR-UEFeatures-Remaining] NR positioning

**Document for:** Discussion and Decision

1. Introduction

This contribution summarizes the following email discussion in AI 7.2.11 regarding Rel-16 NR UE features.

[100b-e-NR-UEFeatures-Remaining] Email discussion/approval of remaining issues (especially the one identified as low priority items in FL’s summaries) starting no earlier than 4/30 till next meeting – Hiroki (DCM)/Ralf (ATT)

Companies are encouraged to check further updates for UE features list based on R1-2003073 shown below and provide feedback if any. Please note that the target of this email discussion is to reflect agreeable updates rather than solving any controversial discussion point. If there is any controversial discussion point, it should be discussed in the next RAN1 meeting.

Based on the email discussion, further updates on UE features list for NR positioning were made as shown in section 2.

**The proposal from moderator is to consider the updated UE features list as a baseline for further discussion in next meeting.**

1. NR positioning

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

a) FR1 bands: {5, 10, 20, 40, 50, 80, 100}b) FR2 bands: {50, 100, 200, 400}1. DL PRS buffering capability: Type 1 or Type 2
2. Type 1 – sub-slot/symbol level buffering
3. Type 2 – slot level buffering
4. Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz, which is supported and reported by UE.
5. T: {8, 16, 20, 30, 40, 80, 160, 320, 640, 1280} ms
6. N: {0.125, 0.25, 0.5, 1, 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, 45, 50} ms

Notes:* 1. UE reports one combination of (N, T) values per band, where N is a duration of DL PRS symbols in ms processed every T ms for a given maximum bandwidth (B) in MHz supported by UE
	2. UE is not expected to support DL PRS bandwidth that exceeds the reported DL PRS bandwidth value
	3. UE DL PRS processing capability is defined for a single positioning frequency layer. UE capability for simultaneous DL PRS processing across positioning frequency layers is not supported in Rel.16 (i.e. for a UE supporting multiple positioning frequency layers, a UE is expected to process one frequency layer at a time)
	4. UE DL PRS processing capability is agnostic to DL PRS comb factor configuration
	5. The reporting of (N, T) values for maximum BW in MHz is not dependent on SCS
1. Max number of DL PRS resources that UE can process in a slot under it
	1. FR1 bands: {1, 2, 4, [6], 8, 12, 16, [24], 32, [48], 64} for each SCS: 15kHz, 30kHz, 60kHz
	2. FR2 bands: {1, 2, 4, [6], 8, 12, 16, [24], 32, [48], 64} for each SCS: 60kHz, 120kHz

Note: The above parameters are reported assuming a configured measurement gap and a maximum ratio of measurement gap length (MGL) / measurement gap repetition period (MGRP) of no more than X% (FFS: X).FFS case w/o measurement gap configured |  | Yes | N/A |  | Per band | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-2 | DL PRS Resources for DL AoD | 1. Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE.

Values = {1, 2}1. Max number of DL PRS Resources per DL PRS Resource Set

Values = {[1], 2, 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}1. Max number of TRPs across all positioning frequency layers per UE.

Values = {[3], 6, 12, [16], 24, 32, 64, 128, 256}1. Max number of DL PRS Resources per positioning frequency layer.

Values = {32, 64, 128, 256, 512, 1024}1. [Max number of positioning frequency layers UE supports

Values = {1, 2, 3, 4}] | 13-1 | No | N/A |  | [Per UE] | N/A | [Yes] | N/A | Need for location server to know if the feature is supported.FFS: split of candidate values for FR1/FR2/mixed FR1-FR2 for each component | Optional with capability signaling |
| 13. NR Positioning | 13-3 | DL PRS Resources for DL-TDOA | 1. Max number of DL PRS Resource Sets per TRP per frequency layer.

Values = {1, 2}1. Max number of DL PRS Resources per DL PRS Resource Set.

Values = {1, 2, 4, 8, 16, 32, 64}1. Max number of DL PRS Resources across all frequency layers, TRPs and DL PRS Resource Sets.

Values = {64, 128, 192, 256, 512, 1024, 2048}1. Max number of TRPs across all positioning frequency layers per UE.

Values = {[3,] 6, 12, [16], 24, 32, 64, 128, 256} 1. Max number of DL PRS Resources per positioning frequency layer.

Values = {32, 64, 128, 256, 512, 1024}1. [Max number of positioning frequency layers UE supports

Values = {1, 2, 3, 4}] | 13-1 | No | N/A |  | [Per UE] | N/A | [Yes] | N/A | Need for location server to know if the feature is supported.FFS: split of candidate values for FR1/FR2/mixed FR1-FR2 for each component | Optional with capability signaling |
| 13. NR Positioning | 13-4 | DL PRS Resources for Multi-RTT | 1. Max number of DL PRS Resource Sets per TRP per frequency layer.

Values = {1, 2}1. Max number of DL PRS Resources per DL PRS Resource Set.

Values = {1, 2, 4, 8, 16, 32, 64}1. Max number of DL PRS Resources across all frequency layers, TRPs and DL PRS Resource Sets.

Values = {64, 128, 192, 256, 512, 1024, 2048}1. Max number of TRPs across all positioning frequency layers per UE.

Values = {[3], [6], [12], [16], 24, 32, 64, 128, 256}1. Max number of DL PRS Resources per positioning frequency layer.

Values = {32, 64, 128, 256, 512, 1024}1. [Max number of positioning frequency layers UE supports

Values = {1, 2, 3, 4}] | 13-1 | Yes | N/A |  | [Per UE] | N/A | [Yes] | N/A | Need for location server to know if the feature is supported.FFS: split of candidate values for FR1/FR2/mixed FR1-FR2 for each component | Optional with capability signaling |
| 13. NR Positioning | 13-5 | DL PRS Measurement Report for DL-AoD | 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} | 13-2, | No | N/A |  | [Per UE] | N/A | [Yes] | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-5a | Inter-frequency measurement for DL-AoD | 1. Support of inter-frequency measurement for DL-AoD
 | 13-2 | No | N/A |  | [Per band] | N/A | [Yes] | N/A | Need for location server to know if the feature is supported. | Optional with capability signalling{supported, notSupported} |
| 13. NR Positioning | 13-6 | DL PRS RSTD/[RSRP] Measurement Report for DL-TDOA | 1. [DL RSTD measurements per pair of TRPs. Values = {1, 2, 3, 4}]
2. [Support RSRP measurements. Values = {0, 1}]
 | 13-3 | No | N/A |  | [Per UE] | N/A | [Yes] | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-6a | Inter-frequency measurement for DL-TDOA | 1. Support of inter-frequency measurement for DL-TDOA
 | 13-3 | No | N/A |  | [Per band] | N/A | [Yes] | N/A | Need for location server to know if the feature is supported. | Optional with capability signalling{supported, notSupported} |
| 13. NR Positioning | [13-7] | [Support of SSB from neighbor cell as QCL source of a DL PRS] | 1. [Support of SSB from neighbor cell as QCL source of a DL PRS]
2. [Support of reuse SSB measurement from RRM for receiving PRS]

Note: Refers to Type-C for FR1 and Type-C & Type-D support for FR2 | 13-1 | No | N/A |  | [Per band] | N/A | [Yes] | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | [13-7a] | [Support of DL PRS from serving/neighbor cell as QCL source of a DL PRS] | 1. [Support of DL PRS from serving/neighbor cell as QCL source of a DL PRS]

Note: Refers to Type-D support for FR2 | 13-1 | No | N/A |  | [Per band] | N/A | [Yes] | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-8 | SRS Resources for Positioning | 1. Max number of SRS Resource Sets for positioning supported by UE per BWP.

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

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

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

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

Values = {1,2,3,4,5,6,8,10,12,14}] |  | Yes | N/A |  | [Per FS] | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-8a | Support of Aperiodic SRS Resources for positioning | 1. Max number of aperiodic SRS Resources for positioning per BWP.

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

 Values = {1,2,3,4,5,6,8,10,12,14}] | 13-8 | Yes | N/A |  | [Per FS] | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-8b | Support of Semi-persistent SRS Resources for positioning | 1. Max number of semi-persistent SRS Resources for positioning supported by UE per BWP.

Values = {1,2,4,8,16,32,64}1. [Max number of semi-persistent SRS Resources for positioning supported by UE per BWP per slot.

Values = {1,2,3,4,5,6,8,10,12,14}] | 13-8 | Yes | N/A |  | [Per FS] | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-9 | OLPC for SRS for positioning based on PRS from the serving cell | 1. OLPC for SRS for positioning based on PRS from the serving cell
 | [13-1],[One of {13-2, 13-3, 13-4}], and 13-8 | No | N/A |  | [Per band] | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-9a | OLPC for SRS for positioning based on SSB from neighbouring cells | 1. OLPC for SRS for positioning based on SSB from neighbouring cells
 | 13-8 and [13-9d] | No | N/A |  | [Per band] | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-9b | OLPC for SRS for positioning based on PRS from the neighbouring cells | 1. OLPC for SRS for positioning based on PRS from the neighbouring cells
 | 13-8 and 13-9 | No | N/A |  | [Per band] | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-9c | OLPC for SRS for positioning based on CSI-RS from serving cell | 1. OLPC for SRS for positioning based on CSI-RS from serving cell
 | 13-8 | No | N/A |  | [Per band] | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-9d | OLPC for SRS for positioning based on SSB from serving cell | 1. [OLPC for SRS for positioning based on SSB from serving cell]
 | 13-8 | No | N/A |  | [Per band] | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-9e | [PathLoss estimate maintenance] | 1. [Max number of pathloss estimates that the UE can simultaneously maintain for all the SRS resource sets for positioning across all cells in addition to the up to four pathloss estimates that the UE maintains per serving cell for the PUSCH/PUCCH/SRS transmissions.

Values = {1,4,8,16}]1. [Max number of pathloss estimates that the UE can simultaneously maintain for all the SRS resource sets for positioning per serving cell in addition to the up to four pathloss estimates that the UE maintains per serving cell for the PUSCH/PUCCH/SRS transmissions.

Values = {1,4,8,16}] | One of {13-9, 13-9a,b,c,[d]} | No | N/A |  | [Per band]  | N/A | N/A | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-10 | Spatial relation for SRS for positioning based on SSB from the serving cell | 1. Spatial relation for SRS for positioning based on SSB from the serving cell
 | 13-8 | No | N/A |  | [Per band] | N/A | N/A (FR2 only) | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-10a | Spatial relation for SRS for positioning based on CSI-RS from the serving cell | 1. Spatial relation for SRS for positioning based on CSI-RS from the serving cell
 | 13-10 | No | N/A |  | [Per band] | N/A | N/A (FR2 only) | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-10b | Spatial relation for SRS for positioning based on PRS from the serving cell | 1. Spatial relation for SRS for positioning based on PRS from the serving cell
 | One of {13-2, 13-3, 13-4} and13-8 | No | N/A |  | [Per band] | N/A | N/A (FR2 only) | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-10c | Spatial relation for SRS for positioning based on SRS | 1. Spatial relation for SRS for positioning based on SRS
 | 13-8, | No | N/A |  | [Per band] | N/A | N/A (FR2 only) | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-10d | Spatial relation for SRS for positioning based on SSB from the neighbouring cell | 1. Spatial relation for SRS for positioning based on SSB from the neighbouring cell
 | 13-10 | No | N/A |  | [Per band] | N/A | N/A (FR2 only) | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-10e | Spatial relation for SRS for positioning based on PRS from the neighbouring cell | 1. Spatial relation for SRS for positioning based on PRS from the neighbouring cell
 | 13-10b | No | N/A |  | [Per band] | N/A | N/A (FR2 only) | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | [13-10f] | [Spatial relation maintenance] | 1. [Component 1: Max Number of maintained spatial relations for all the SRS resource sets for positioning across all serving cells in addition to the spatial relations maintained spatial relations per serving cell for the PUSCH/PUCCH/SRS transmissions.

Values = {0,1,2,4,8,16}]1. [Component 2: Max Number of maintained spatial relations for all the SRS resource sets for positioning per serving cell in addition to the spatial relations maintained spatial relations per serving cell for the PUSCH/PUCCH/SRS transmissions.

Values = {0,1,2,4,8,16}] | One of {13-10, 13-10a, b, d, e} | No | N/A |  | [Per band] | N/A | N/A (FR2 only) | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-11a | Inter-frequency measurement for Multi-RTT | 1. Inter-frequency measurement for Multi-RTT
 | 13-4 and 13-8 | Yes | N/A |  | [Per UE] | N/A | [Yes] | N/A | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | [13-11] | [UE Rx-Tx Measurement Report for Multi-RTT] | 1. Max number of UE 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.

[Note: The DL PRS resource/resource sets can be in different positioning frequency layers]1. [Support RSRP measurements. Values = {0, 1}]
 | 13-4 and 13-8 | No | N/A |  | [Per UE] | [N/A] | [Yes] | [N/A] | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | [13-12] | [NR E-CID DL SSB RRM measurements with LPP support for NR Positioning] | 1. [NR E-CID DL SSB RRM measurements with LPP support for NR Positioning]
 |  | No | N/A |  | [Per band] | [N/A] | [N/A] | [N/A] | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | [13-12a] | [N R E-CID DL CSI-RS RRM measurements with LPP support for NR Positioning] | 1. [NR E-CID DL CSI-RS RRM measurements with LPP support for NR Positioning]
 | 13-12 | No | N/A |  | [Per band] | [N/A] | [N/A] | [N/A] | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-13 | Simultaneous DL-AoD and DL-TDoA processing | 1. Support of simultaneous processing for DL AoD and DL TDoA measurements

If it is not indicated, a UE is not expected to perform simultaneously the processing for deriving DL AoD and DL TDoA measurements  | 13-2 and 13-3 | No | N/A |  | [Per band] | [N/A] | [N/A] | [N/A] | Need for location server to know if the feature is supported. | Optional with capability signaling |
| 13. NR Positioning | 13-14 | Simultaneous DL-AoD and Multi-RTT processing | 1. Support of simultaneous processing for DL AoD and Multi-RTT measurements

If it is not indicated, a UE is not expected to perform simultaneously the processing for deriving DL AoD and M-RTT measurements  | 13-2, 13-4 and 13-8 | No | N/A |  | [Per band] | [N/A] | [N/A] | [N/A] | Need for location server to know if the feature is supported. | Optional with capability signaling |

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| --- | --- |
| Company | Comment |
| MTK | * FG 13-1:
	+ component 4, item b, it should be corrected as

FR2 bands: {1, 2, 4, 8, 16, 32, 64} for each SCS: ~~15kHz, 30kHz,~~ 60kHz, 120 kHz* + MGL/MGRP <= 15%, i.e., X = 15
	+ It seems that the component “Max number of positioning frequency layers supported by UE. Values = {1, 2, 3, 4}]” is removed in this FG and the intention is to signal this component per positioning method, i.e., in FG 13-2, 13-3, and 13-4. We’re OK with this arrangement.
* FG 13-2:
	+ For all components in this FG, we suggest that UE may signal value for each component with following differentiations:
		- UE supports FR1-only
		- UE supports FR2-only
		- UE supports mixed FR1-FR2
			* In this case, the value of each component may be different for FR1 and FR2

At least value of component 6 needs to be reported with the above differentiations.* + Component 4: Values = {3, 6, 12, 16, 24, 32, 64, 128, 256}
	+ Component 7 is not needed
* FG 13-3:
	+ For all components in this FG, we suggest that UE may signal value for each component with following differentiations:
		- UE supports FR1-only
		- UE supports FR2-only
		- UE supports mixed FR1-FR2
			* In this case, the value of each component may be different for FR1 and FR2

At least value of component 6 needs to be reported with the above differentiations.* + Component 4: Values = {3, 6, 12, 16, 24, 32, 64, 128, 256}
	+ Component 7 is not needed
* FG 13-4:
	+ For all components in this FG, we suggest that UE may signal value for each component with following differentiations:
		- UE supports FR1-only
		- UE supports FR2-only
		- UE supports mixed FR1-FR2
			* In this case, the value of each component may be different for FR1 and FR2

At least value of component 6 needs to be reported with the above differentiations.* + Component 4: Values = {3, 6, 12, 16, 24, 32, 64, 128, 256}
	+ Component 7 is not needed
* FG 13-5a: The prerequisite feature group should be FG 13-2 instead of FG 13-5
* FG 13-6: Remove [RSRP] in the title of this FG
* FG 13-6a: The prerequisite feature group should be FG 13-3 instead of FG 13-6
* FG 13-8: Don’t understand the difference between component 4 and 5. Suggest to remove component 5.
* FG 13-11: value: 1,2,3,4
* FG 13-13: Per UE with FR differentiation
* FG 13-14:Per UE with FR differentation
 |
| Huawei/HiSilicon | General comments* We have observed the column labelled as “Need for the gNB to know if the feature is supported”, we would like to clarify that this “gNB” may actually be “LMF” for some UE capability.
* We have also seen some discrepancies for the column “Need for the gNB to know if the feature is supported”, e.g. FG13-2 and FG13-3 are marked as “No” while FG13-4 is marked as “Yes”. We would like to ask for clarification what the gNB/LMF’s assumption is if it does not know if the feature is supported.

FG-specifc comments* For FG13-1
	+ Component 3: The Notes (c-e) should be moved to “Note” column, and Notes (a-b) should be deleted.
	+ The second Note “The above parameters…” should be merged with component 3, so that component 3 reads
		- 3. Duration of DL PRS symbols N in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz assuming a configured measurement gap and a maximum ratio of measurement gap length (MGL) / measurement gap repetition period (MGRP) of no more than X% (FFS: X).
	+ Component 4: The SCS for FR2 should be 60kHz, 120kHz
* For FG13-2
	+ Component 2: 1 should not be supported, as single PRS resource per set will not work for DL-AoD. Suggest to split with the following 2 values
		- FR1: {2, 4, 8}
		- FR2: {2, 8, 16, 64}
	+ Component 3: Suggest to split with the following 4 values
		- FR1 only: minimum value should be 6, i.e, {6, 24, 128, 512}
		- FR2 only: minimum value should be 24, i.e. {24, 96, 512, 2048}
		- FR1 in mixed FR1-FR2: minimum value should be 6, i.e. {6, 24, 64, 256}
		- FR2 in mixed FR1-FR2: minimum value should be 24, i.e. {24, 96, 256, 1024}
	+ Component 5: Suggest to split with the following 2 values
		- FR1: minimum values should be 6, i.e. {6, 24, 128}
		- FR2: minimum value should be 24, i.e. {24, 96, 512}
	+ Component 7: No need to have this component.
* For FG13-3
	+ Component 2: suggest to split with the following 2 values
		- FR1: {1, 2, 4, 8}
		- FR2: {1, 8, 16, 64}
	+ Component 3: Suggest to split with the following 4 values
		- FR1 only: minimum value should be 3, i.e, {3, 24, 128, 512}
		- FR2 only: minimum value should be 24, i.e. {24, 96, 512, 2048}
		- FR1 in mixed FR1-FR2: minimum value should be 3, i.e. {3, 24, 64, 256}
		- FR2 in mixed FR1-FR2: minimum value should be 24, i.e. {24, 96, 256, 1024}
	+ Component 5: Suggest to split with the following 2 values
		- FR1: minimum values should be 3, i.e. {3, 24, 128}
		- FR2: minimum value should be 24, i.e. {24, 96, 512}
	+ Component 7: No need to have this component.
* For FG13-4
	+ Component 2: suggest to split with the following 2 values
		- FR1: {1, 2, 4, 8}
		- FR2: {1, 8, 16, 64}
	+ Component 3: Suggest to split with the following 4 values
		- FR1 only: minimum value should be 3, i.e, {3, 24, 128, 512}
		- FR2 only: minimum value should be 24, i.e. {24, 96, 512, 2048}
		- FR1 in mixed FR1-FR2: minimum value should be 3, i.e. {3, 24, 64, 256}
		- FR2 in mixed FR1-FR2: minimum value should be 24, i.e. {24, 96, 256, 1024}
	+ Component 5: Suggest to split with the following 2 values
		- FR1: minimum values should be 3, i.e. {3, 24, 128}
		- FR2: minimum value should be 24, i.e. {24, 96, 512}
	+ Component 7: No need to have this component.
* For FG13-5a
	+ We do not see any dependence between FG13-5a and FG13-5.
* For FG13-6
	+ Suggest to remove “RSRP” from the name of the feature group
* For FG13-6a
	+ We do not see any dependence between FG13-6a and FG13-6.
* For FG13-6a
	+ Suggest to add another component
		- 2. Support of reuse SSB measurement from RRM for receiving PRS
* For FG13-8
	+ Component 3: This is related to a Rel-15 capability counting only MIMO SRS. We would like to make sure that the value reported should be no lower than the value for periodic MIMO SRS in a slot.
	+ Component 5: It seems to be the same as Component 4.
* For FG13-8a
	+ Is it correct understanding that if UE does not report anything in the FG, UE does not support AP-SRS for positioning?
* For FG13-8b
	+ Is it correct understanding that if UE does not report anything in the FG, UE does not support SP-SRS for positioning?
* For FG13-9
	+ Should we change the prerequisite FG “at least one from 13-2 to 13-4” to 13-1?
	+ Regarding per band reporting, is it per SRS band or per PRS band?
* For FG13-9a
	+ Regarding per band reporting, is it per SRS band or per SSB band?
* For FG13-9b
	+ Regarding per band reporting, is it per SRS band or per PRS band?
* For FG13-9c
	+ Suggest to have a basic FG to include this. Only need to design the signaling of the basic FG.
* For FG13-9d
	+ Suggest to have a basic FG to include this. Only need to design the signaling of the basic FG.
* For FG13-9e
	+ Component 1: How can component 1 be interpreted if it is reported per band? Should it be all serving cells within the reported band?
* For FG13-10
	+ Suggest to have a basic FG to include this, and it is for FR2. Only need to design the signaling of the basic FG.
* For FG13-10a
	+ Suggest to have a basic FG to include this, and it is for FR2. Only need to design the signaling of the basic FG.
* For FG13-10b
	+ Regarding per band reporting, is it per SRS band or per PRS band?
* For FG13-10d
	+ Regarding per band reporting, is it per SRS band or per SSB band?
* For FG13-10e
	+ Regarding per band reporting, is it per SRS band or per PRS band?
* For FG13-10f
	+ Component 1: How can component 1 be interpreted if it is reported per band? Should it be all serving cells within the reported band?
* For FG13-12
	+ It is LPP support of SSB RRM measurement report, why should be it per band? Suggest to have per UE.
* For FG13-12a
	+ It is LPP support of SSB RRM measurement report, why should be it per band? Suggest to have per UE.

New FG proposal* Based on RAN1 agreement, the following new FGs should be introduced.

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| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs (V2X WI only)”.** | **Consequence if the feature is not supported by the UE** | **Type****( 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 | 13-15 | Simultaneous SRS transmission for intra-band CA | 1. The number of SRS resources for positioning on a symbol for intra-band CA.

Values: {1,2} | 13-8 | Yes | N/A |  | Per band | [N/A] | [N/A] | [N/A] |  | Optional with capability signaling |
| 13. NR Positioning | 13-16 | Simultaneous SRS transmission for inter-band CA | 1. The number of simultaneously transmitted SRS resources for positioning for inter-band CA.
 | 13-8 | Yes | N/A |  | [Per band combination or per FS] | [N/A] | [N/A] | [N/A] |  | Optional with capability signaling |

* In addition, we suggest to have the following FG.
	+ If FG13-18 is not supported, we would like to see conclusion that UE is not expected to support parallel processing of LTE PRS and NR PRS.

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| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs (V2X WI only)”.** | **Consequence if the feature is not supported by the UE** | **Type****( 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 | 13-17 | AP-SRS with carrier switching | 1. Support of AP-SRS for positioning with carrier switching triggered by DCI format 2\_3.
 | 13-8 | Yes | N/A |  | Per UE | [N/A] | [N/A] | [N/A] |  | Optional with capability signaling |
| 13. NR Positioning | 13-18 | Parallel LTE/NR PRS processing | 1. Support of parallel LTE PRS and NR PRS processing
 | 13-1 | Yes | N/A |  | Per UE | [N/A] | [N/A] | [N/A] |  | Optional with capability signaling |

 |
| Qualcomm | Overall comment: There is some confusion that if a feature that is related to “across all CCs, or across all layers, or across all bands, etc”, cannot be reported per band. This is not true. As an example, lets consider the “Max number of frequency layers per UE across all FR1/FR2 bands”. The understanding could be if it is reported per band that: For a UE supporting different values between an FR1 band and FR2 band, if the UE is configured within FR1 (FR2) only, then the reported value for the FR1 (FR2) band value is used, otherwise the minimum between the FR1 and FR2 values is assumed. Similar understanding for the case of bands within FR. * **13.1**
* **Component 4**:

The value “12” was already part of the previous agreement. We ‘d like to suggest to add (in addition to 12 which was part of the agreement) also the values “6”, “24”, “48”. The SCS is wrong for FR2.Max number of DL PRS resources that UE can process in a slot under it* FR1 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 15kHz, 30kHz, 60kHz
* FR2 bands: {1, 2, 4, 6, 8, 12, 16, 24, 32, 48, 64} for each SCS: 60kHz, 120 Khz
* **Component 5:** Keep the “Max number of frequency layers per UE across all FR1/FR2 bands” inside 13.1 and keep the reporting per band.
* **Add new FG** about “Common PRS processing without MG” which is reported per band, and includes the same components as 13-1.
	+ If this FG is not agreed, conclude that PRS processing in Rel-16 is happening under the assumption of MG configured in both FR1 and FR2.
* **13.2**
	+ - **Reported per band**. We don’t agree with reporting it per UE.
		- **Component 2:** OK to remove “1” as an option.
		- **Component 4:** Value 3 is too low to be added. Suggest to keep the minimum at 6 TRPs.
		- Remove **component 6**, and keep it inside 13.1. If it is kept to be reported in each method separately, then it should be about “Max number of frequency layers across all FR1/FR2 bands and methods”. However, it would still make more sense to be in the common PRS capability.
		- OK to remove **component 7**.
* **13.3**
	+ - **Reported per band**. We don’t agree with reporting it per UE.
		- **Component 4:** Value 3 is too low to be added. Suggest to keep the minimum at 16 TRPs for timing methods.
		- Remove **component 6**, and keep it inside 13.1. If it is kept to be reported in each method separately, then it should be about “Max number of frequency layers across all FR1/FR2 bands and methods”. However, it would still make more sense to be in the common PRS capability.
		- OK to remove **component 7**
* **13.4**
	+ - **Reported per band**. We don’t agree with reporting it per UE.
		- **Component 4:** Value 3,6,12 is too low to be added. Suggest to keep the minimum at 16 TRPs for timing methods.
		- Remove **component 6**, and keep it inside 13.1. If it is kept to be reported in each method separately, then it should be about “Max number of frequency layers across all FR1/FR2 bands and methods”. However, it would still make more sense to be in the common PRS capability.
		- OK to remove **component 7**.
		- **Component 2**: Add the value “2” if it was added inside the component 2 of 13.3.
* **13.5, 13-5a, 13-6a, 13-7, 13-7a, 13-9, 13-9a, 13-9b, 13-9c, 13-9d, 13-10, 13-10a to 13-10f, 13-12, 13-12a, 13-13, 13-14**
	+ **Reported per band**. We don’t agree with reporting it per UE.
* **13.6**
	+ Add the following components:
* DL RSTD measurements per pair of TRPs. Values = {1, 2, 3, 4}
	+ 1. 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 RSRP measurements. Values = {0, 1}* Note: if UE supports RSRP measurements, then the UE can report the same value as the number of RSTDs.
* **13.7, 13.7a**
	+ Support both features. Report per band.
* **13.8, 13.8a, 13-8b**
	+ - Reported per FS
		- Remove all brackets in the components and values.
* **13.9d**
	+ - Not needed. Should be assumed that all UEs supporting SRS for positioning can do OLPC with serving cell SSB.
* **13.9e**
	+ - Keep both components
* **13-10f**
	+ - Keep only first component (“across all cells”). No need to have a per-cell maximum.
* **13.11**
	+ The following Note is not true if the UE does not support inter-frequency RTT measurements, and should be removed: “Note: The DL PRS resource/resource sets can be in different positioning frequency layers”
* Add the following component :

2.Support RSRP measurements. Values = {0, 1}* Note: if UE supports RSRP measurements, then the UE can report the same value as the number of Rx-Tx.
	+ Values for component 1 are: {0,1,2,3,4}
* Add **new FG** for AP-SRS for SRS carrier switching (per band reporting)

|  |  |
| --- | --- |
| AP-SRS with carrier switching | 1. Support of AP-SRS for positioning with carrier switching triggered by DCI format 2\_3.
 |

* **13-5a**
	+ 13-2 should be prerequise and not 13-5. Inter-frequency measurement for AoD can happen in UE-based, and there is no need the UE to support reporting of measurements
* **13-6a**
	+ 13-3 should be prerequise and not 13-5. Inter-frequency measurement for TDOA can happen in UE-based, and there is no need the UE to support reporting of measurements
 |
| Moderator (NTT　DOCOMO) | According to feedbacks, following further updates are made.* 13-1
	+ In component 4, FR2 SCS description error is corrected
	+ Additional candidate values {6, 12, 24, 48} are added with brackets for component 4
* 13-2, 13-3, 13-4, 13-5, 13-5a, 13-6a, 13-7, 13-7a, 13-13, 13-14
	+ Report type is “[per band]” instead of “[per UE]”
* 13-2
	+ Value 1 in component 2 is in bracket
	+ Value 16 in component 4 is added with bracket, and value 3 in component 4 is in bracket
	+ “FFS: split of candidate values for FR1/FR2/mixed FR1-FR2” is added for each component
	+ Component 6 is in bracket, and component 7 is removed
* 13-3
	+ Value 16 in component 4 is added with bracket, and value 3 in component 4 is in bracket
	+ “FFS: split of candidate values for FR1/FR2/mixed FR1-FR2” is added for each component
	+ Component 6 is in bracket, and component 7 is removed
* 13-4
	+ Value 2 in component 2 is added
	+ Value 16 in component 4 is added with bracket, and value 3, 6, 12 in component 4 are in brackets
	+ “FFS: split of candidate values for FR1/FR2/mixed FR1-FR2” is added for each component
	+ Component 6 is in bracket, and component 7 is removed
* 13-5a
	+ Prerequisite FG is 13-2 instead of 13-5
* 13-6
	+ Add two components “DL RSTD measurements per pair of TRPs. Values = {1, 2, 3, 4}” and “Support RSRP measurements. Values = {0, 1}” with brackets
* 13-6a
	+ Prerequisite FG is 13-3 instead of 13-6
	+ Add component “Support of reuse SSB measurement from RRM for receiving PRS” with bracket
* 13-9
	+ In prerequisite FG column, “13-1” is added with bracket and “At least one from 13-2 to 13-4” is in bracket

In addition, “Need for the gNB to know if the feature is supported” column should be clarified that whether it is for “gNB” or for “LMF”, and Yes or No descriptions should be updated accordingly. “[Yes]” is described for now as all FGs would be optional. |
| Huawei/HiSilicon | We cannot agree with QC that the following FGs are reported per band, simply because it cannot work, or it needs extensive explanation on how this capability can work.* 13-2, 13-3, 13-4, 13-5, 13-10f, 13-12, 13-12a, 13-13, 13-14.

In the explanation QC raised “As an example, lets consider the “Max number of frequency layers per UE across all FR1/FR2 bands”. The understanding could be if it is reported per band that: For a UE supporting different values between an FR1 band and FR2 band, if the UE is configured within FR1 (FR2) only, then the reported value for the FR1 (FR2) band value is used, otherwise the minimum between the FR1 and FR2 values is assumed. Similar understanding for the case of bands within FR.”That could work for some components, but not for some others, e.g. “Max number of DL PRS Resources supported by UE across all frequency layers, TRPs and DL PRS Resource Sets”. This value will be reported significantly different for FR1 bands and FR2 bands of course as FR2 will have more Tx beams, but you cannot take the smallest values among all FR1 bands and FR2 bands, which means that the total number of resources will be limited by FR1 if we have mixed FR1-FR2 positioning.Since most of the capability goes to LPP rather than RRC, and the supported band list will additionally be provided in LPP, we think per UE with proper FR1/FR2 differentiation will be the best choice without much explanation to interprete the capability.Regarding some minimum numbers, we think setting 3 TRPs or 3 PRS resources within a FL or across all FLs will allow introducing low power/capability UE doing DL positioning for this release and even future releases. This numbers are set to make positioning work.Apologies to the rapporteur, FG13-6a, component 2 should be moved to 13-7, which was a mistaken. |
| Moderator (NTT DOCOMO) | The component 2 of FG13-6a is moved to FG13-7. |
| MTK | * We cannot agree with QC’s view that the following FGs are reported per band: FG 13-2, 13-3, 13-4, 13-12, 13-12a
	+ For FG 13-2, 13-3, 13-4:
		- The values in the each component are designed based on the consideration that it is per UE with FR differentiation.

If these FGs are signaled per band, then some numbers become unreasonable. For example, the value 256 for component 4 will indicate that within one band there can be 256 TRPs configured to the UE, which we believe is not the original intention to introduce the value 256 for this component* + - The purpose of component 6 is to indicate that how many frequency layers that UE can be configured across all bands in FR1 and/or FR2. The purpose cannot be achieved if these FGs are signaled per band
		- If it is QC’s intention to indicate “the maximum number of frequency layers that UE can support per band”, then in our view we can copy component 6 to FG 13-1 where the capability is signaled per band
* For FG 13-5a, 13-6a, 13-11a: these FGs should be with the same reporting type. We can accept signaling per band
* We would like to clarify why the column “Need for the gNB to know if the feature is supported” becomes “yes” for all FGs?

Why “all FGs are optional” is a reason to support this change? The gNB here is different from LMF in our understanding. In our view, gNB doesn’t need to know whether an DL-only FG is supported or not. For UL-related FGs, gNB need to know whether they are supported by UE.* For FG 13-2,
	+ Component 2: We think the value 1 can be removed as DL-AoD won’t work with this value
	+ Component 4: We can accept value 3 since it represents an low cost UE implementation
* For FG 13-3, 13-4:
	+ Component 4: We can accept value 3 since it represents an low cost UE implementation
* For FG 13-6, what is the difference of component 1 and component 2? In our understanding, both components indicate the max value of DL PRS-RSTD measurements per pair of TRP.

Thus, one of components 1,2 can be removed.* For FG13-9, FG13-9a,b, FG13-10b, we have the same question as HW:
	+ Regarding per band reporting, is it per SRS band or per PRS band?
	+ Or it is assumed that SRS and PRS are in the same band?
* For FG13-9e, FG13-10f, we have the same question as HW:
	+ Component 1: How can component 1 be interpreted if it is reported per band? Should it be all serving cells within the reported band?
 |
| OPPO | * FG 13-2, 13-3, 13-4, 13-5: shall reported be per UE, not per band.
* FG 13-2, Component 2: the value 1 shall be kept since the UE might report supporting 2 in component 1. Furthermore, it is ok to differentiate the value of component 2 for FR1 and FR2.
* FG 13-1a: add a new FG for “DL PRS processing capability without MG”. Current FG13-1 only covers the case with configured MG. And we shall differentiate the UE capability for the cases of with and without MG
* FG 13-2: Component 4: support to keep 3 as minimum value
* FG 13-3: Component 4: support to keep 3 as minimum value
* FG 13-4: Component 4: support to keep 3 as minimum value
* FG 13-7: support it and the [] shall be removed
* FG 13-7a: support it and the [] shall be removed.
* FG 13-8:
	+ Component 4 and component 5 are same. Suggest to remove Component 4.
	+ Component 3: support it and the [] shall be removed.
* FG 13-8a: support it and the [] shall be removed.
* FG 13-8b: support it and the [] shall be removed.
* FG 13-9d: suggest to remove the [] to support it
* FG 13-9e:
	+ It shall be supported and remove all the []s;
	+ Support both components 1 and 2.
* FG 13-10f:
	+ Support it. Suggest to remove the []s
	+ Add one new component 3: Max Number of maintained spatial relations based on SSB from neighboring cells for all the SRS resource sets for positioning across all serving cells.
		- This component can also be added in FG 13-10d.
	+ Add one new component 4: Max Number of maintained spatial relations based on DL PRS from neighboring cells for all the SRS resource sets for positioning across all serving cells.
		- This component can also be added in FG 13-10e.
 |
| vivo | * FG 13-1: suggest to remove “FFS case w/o measurement gap configured” in componets after the “Note: The above parameters are reported assuming a configured measurement gap and a maximum ratio of measurement gap length (MGL) / measurement gap repetition period (MGRP) of no more than X% (FFS: X).” During [100b-e-NR-Pos-01] email discussion, our understanding is that it has already been concluded that UE capability for DL PRS processing in Rel-16 is defined assuming the case with configured measurement gap.So no need FFS.
* We disagree with Qualcomm and OPPO’s comments to “add new FG (13-1a) about “Common PRS processing without MG” which is reported per band, and includes the same components as 13-1”. See our above comment for reason.
* We support FG 13-2, 13-3, 13-4 and 13-5 per band report.The reason is that some components (e.g., components 1and 2 in FG 13-2, 13-3, 13-4 ) are obviously per band. We believe there should not be confusion as the titles for other components are clear that the values reported may be the same across bands (e.g., max number of reosurces across all layers, per UE).
* Component 1 and 2 in current FG 13-6 seem the same thing as both are for RSTD measurement per piar of TRPs. While the number of RSRP measurement is missing. Suggest to revise component 2 to “Max number of DL PRS RSRP measurements on different PRS resources per pair of TRPs. Values = {1, 2, 3, 4, 5, 6, 7, 8}.
* FG 13-8, suggest to remove a duplicated component 4 and keep component 5
 |
| Samsung | * One general commnet is there is no need to have two sepearte sets for FR1 and FR2.
* Agree with OPPO that FG 13-2, 13-3, 13-4, 13-5: shall reported be per UE, not per band.
* FG 13-2, FG 13-3 and FG 13-4, remove 3 and 16 for max number of TRPs across all positioning frequency layers per UE
* FG 13-7, component 2 is not supported.
* FG 13-9e, per cell maximum value is sufficient.
* FG 13-10f, per cell maximum value is sufficient.
 |
| Moderator (NTT DOCOMO) | Based on feedbacks, following further updates were made.* “[per UE]” for FG13-2/3/4/5 (considering majotiry views, but it is still with bracket so that it should be discussed in next meeting)
* Descriptions in “Prerequisite feature groups” column are updated so that
	+ “x-x, y-y and z-z” means all FGs (x-x, y-y and z-z) need to be supported to support the FG
	+ “one of {x-x, y-y, z-z}” means at least one of {x-x, y-y, z-z} needs to be supported to support the FG
* For “Need for the gNB to know if the feature is supported” column, is it correct understanding that “yes” here means both gNB and LMF need to know while “no” here means only LMF needs to know but gNB doesn’t? Assuming so, yes/no descriptions are changed to original.
* Remove component 1 of FG13-6
 |
| CATT | * 13-2:
	+ Component 4: Support Values = {6, 12, 16, 24, 32, 64, 128, 256}
* 13-3:
	+ Component 4: Support Values = {6, 12, 16, 24, 32, 64, 128, 256}
* 13-4:
	+ Component 4: Support Values = {6, 12, 16, 24, 32, 64, 128, 256}
* 13-8:
	+ Support Per FS
	+ Support to add Component 5, and remove Component 3, 4 and 6.
* 13-8a:
	+ Support Per FS
	+ Support to remove Component 2.
* 13-8b:
	+ Support Per FS
	+ Support to remove Component 2.
* 13-9 ~ 13-10f:
	+ Support Per band
* 13-9d:
	+ Not needed. All UEs should support SRS for positioning can do OLPC based on SSB from serving cell.
* 13-9e:
	+ Support to add Component 1 and 2.
* 13-10f:
	+ Support Per band
	+ Support to add Component 1 and 2.
 |
| Huawei/HiSilicon | FG13-11a, it should be [per band], as its counterparts in FG13-5a, and FG13-6a are [per band]. We also notice that RAN4 is still defining what inter-frequency measurement means for DL-TDOA, DL PRS-RSRP, UE Rx – Tx time difference.FG13-12 and FG13-12a, it should be per UE, as it is LPP reporting support, not SSB/CSI-RS measurement capability. |