**3GPP TSG RAN WG1 #100bis-e R1-2002460**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on UE features for NR Positioning

Agenda Item: 7.2.11.8

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

# **Introduction**

This contribution summarizes the discussions and proposals in AI 7.2.11.8 regarding UE features for NR Positioning.

In R1-2001484 [1] which is the version after [100e-NR-Rel-16-UEFeatures] email discussion, there are following feature groups for NR Positioning.

* 13a-1 NR E-CID DL SSB RRM measurements for NR Positioning
* 13a-2 NR E-CID DL CSI-RS RRM measurements for NR Positioning
* 13b-1 Reception of DL PRS and UE measurement reporting to facilitate NR DL AoD support
* 13c-1 Reception of DL PRS and UE measurement reporting to facilitate NR DL-TDOA support
* 13d-1 Transmission of SRS for positioning
* 13e-1 Reception of DL PRS and transmission of SRS for positioning to facilitate NR Multi-RTT support

Based on the discussions summarized in Section 2-6, following is the suggested list of issues to be discussed and priority order considering RAN2 impact especially for capability signaling design.

**FL proposal of list of issues/proposals and priority:**

**1st priority issues (high level direction on features list structure):**

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

**2nd priority issues (such as a certain FG is necessary or not):**

* **13a-1**
  + **Clarify the motivation to introduce FG13a-1**
* **13a-2**
  + **Clarify the motivation to introduce FG13a-2**
* **13e-1**
  + **Whether the dedicated transmission of SRS for positioning is defined as a separate UE feature or not**
* **New [13f-1]**
  + **Whether the FG13f-1 for Support of simultaneous processing of LTE PRS and NR PRS is introduced or not**
* **New [13g-1]**
  + **Whether the FG13g-1 for Support of simultaneous transmissions of SRS for positioning on a symbol is introduced or not**
* **New [13h-1]**
  + **Whether the FG13h-1 for Support of concurrent measurements (DL RSRP, DL RSTD, UE Rx-Tx Time Difference) is introduced or not**
* **New [13h-2]**
  + **Whether to define indication of concurrent configuration of list of measurements in supported CA Band Combination in the BandCombinationList or not**

**3rd priority issues (such as components, type and xDD/FRx differentiation that have capability signaling impacts):**

* **13b-1**
  + **Confirm that FG 13b-1 is reported per band**
  + **Whether component 1 includes 5MHz in addition to 20, 50, 100, 200, 400 or not**
  + **Whether configurable values T for component 2 should be minimized or not**
* **13c-1**
  + **Confirm that FG13c-1 is reported per band**
  + **Whether component 1 includes 5MHz in addition to 20, 50, 100, 200, 400 or not**
  + **Whether configurable values T for component 2 should be minimized or not**
  + **How to signal 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 by UE**
* **13d-1**
  + **Whether the additional values should be included for each components listed below:**
    - **Component 1: 4, 8, 12**
    - **Component 2: 1, 4, 8, 16, 32**
    - **Component 3: 1, 4, 8, 16, 32**
    - **Component 4: 1, 4, 8, 16, 32**
  + **Whether the bracket of value 1 for component 9 is removed or not**
  + **Whether the bracket for component 15 is removed or not**
  + **Whether all Rel-16 UEs support any number of SRS resources for positioning per slot or not**

**4th priority issues (such as issues with no capability signaling impact and hence can be postponed):**

* **FG common question**
  + **How to define the detail design of common components for UE DL PRS processing among feature groups DL AoD(13b)/DL-TDOA(13c)/Multi-RTT(13e)**
* **13a-1**
  + **Whether FG13a-1 is mandatory or optional**
* **13b-1**
  + **Confirm that the brackets for component 14 to 17 are removed**
  + **Whether some notes of component 2 are removed (if needed, merged with main description) or not**
  + **Whether the brackets for component 12 and 13 are removed or not**
* **13c-1**
  + **Confirm that the brackets for component 14 to 18 are removed**
  + **Whether some notes of component 2 are removed (if needed, merged with main description) or not**
  + **Whether the brackets for component 12 and 13 are removed or not**
  + **Confirm that DL AoD(13b) feature group is not a pre-requisite of DL-TDOA(13c) feature group**
  + **Whether to introduce different independent components for DL PRS RSRP and DL RSTD measurmeents in DL-TDOA(13c) feature group, considering that RAN2 agreed to include RSRP into NR-DL-TDOA-MeasElement**
    - **Option A. In case of DL-TDOA, DL PRS RSRP components are assumed to be the same as for DL-RSTD**
    - **Option B. In case of DL-TDOA, DL PRS RSRP components are inherited from DL-AoD**
    - **Option C. In case of DL-TDOA, DL PRS RSRP and DL-RSTD components are defined independently**
* **13d-1**
  + **Whether the new component 16 (Spatial relation of SRS Resources for positioning with CSI-RS resources from serving cell) is added or not**
* **13e-1**
  + **Confirm that the bracket for component 5 is removed**
  + **Whether the bracket for component 6 is removed or component 6 is removed**
  + **Confirm that DL TDOA(13c) is not pre-requisites of Multi-RTT(13e) feature group**
  + **Confirm that transmission of SRS for positioning(13d) is pre-requisites of Multi-RTT(13e) feature group**
  + **Whether to introduce different components for DL PRS RSRP and DL PRS receive timing estimation for UE Rx-Tx measurments for Multi-RTT(13e) feature group, considering that RAN2 agreed to include RSRP into NR- NR-Multi-RTT-MeasElement and UE Rx-Tx time measurement require receive timing estimation similar to RSTD**
    - **Option B. In case of multi-RTT, DL PRS RSRP components and DL PRS receive timing estimation for UE Rx-Tx measurments are inherited from DL-TDOA components**
    - **Option C. In case of multi-RTT, DL PRS RSRP and DL PRS receive timing estimation are defined independently**

Companies are encouraged to check above FL proposals and to provide feedback if any in below.

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | **Regarding 1st Priority**, which should involve the restructuring and “number of rows”, we would like to point out the following:   * There are many rows that have multiple components in them that are “Support of X/Y/Z sub-feature”. Example:  |  |  | | --- | --- | | 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 |   Question 1: Is there a need according to the RAN2 guidelines ([R1-2001513](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2001513.zip)) to try to split such a row into multiple rows?  [Moderator] Yes, if support of X/Y/Z sub-feature needs to have separate capability indication, it should be split into multiple FGs. But I would suggest to discuss it separately from the reconstructing the features list to align with RAN2 agreed capability signaling.  Question 2: It is not clear which list should now be the starting point of the restructuring. Should it be the one proposed in R1-2001484 or are we expecting a revision before the ED starts?  [Moderator] I’m considering to use rapporteur’s (i.e., Intel’s) updated features list as the starting point.  **Regarding the 2nd priority issues proposed above**:   * With regards to the [13h-1] and [13h-2], we would like to be updated as: * **New [13h-1]**   + **Whether the FG13h-1 for Support of concurrent measurements (DL RSRP, DL RSTD, UE Rx-Tx Time Difference) or concurrent positioning methods (NR-OTDOA, NR-AoD, Multi-RTT) is introduced or not** * **New [13h-2]**   + **Whether to define indication of concurrent configuration of list of measurements or positioning methods in supported CA Band Combination in the BandCombinationList or not**   With regards to the detailed 3rd and 4th priority issues that are shown above, since it is expected that there will be restructuring and changes based on the agreements, is it fair to assume that these lists would be updated according to the progress being made? In other words, the 3rd and 4th priority issues shown above are not expected to be complete list of issues, correct?  [Moderator] Yes, above issues list is based on the current features list in R1-2001484 and contributions discussing based on the current features list. So depending on restructuring result, we would have more or less issues for lower priorities. |
| Huawei/HiSilicon | Regarding 1st priority, we have the following questions for clarification.   * Are we going to address the issue such like grouping a common PRS capability among positioning methods (sub-features) into a new sub-feature? By the way, our understanding of a sub-feature is something like 13a, 13b,…, where each sub-feature may have one or multiple FGs.   [Moderator] 1st priority issue above is to reconstruct the features list according to RAN2 agreements. Discussion on whether a certain new FG is necessary or not is next level discussion although it is also high priority.   * 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.   * Do we need to allow for the protocol to convey the capability, as it is special for positioning since capability may be transferred by either LPP or RRC? It may require special attention when it comes to multi-RTT.   [Moderator] Sorry, but I could not get your point. Do you want to discuss a certain capability reporting regarding the support of protocol (i.e., propose to add more rows)? Or do you want to discuss on the protocol to be used to convey the capability?  Regarding other priorities, similar to QC’s comments, we have to make sure that the list may be subject to further update.  For the information from RP-200502, should we discuss whether or not to define basic FG for NR positioning? And if so, I guess it falls into low priority (3 or 4)?  [Moderator] If it is the discussion on features list structure (e.g., whether a certain FG (row) is necessary or not) according to approach 1 in RP-200502, it is high priority discussion. If it is the discussion whether/how to define basic FGs according to approach 2 in RP-200502, it is low priority.  For the guideline from R2-2002378, should we target avoiding introducing per-BC and per-band-in-a-BC, or are we being flexible as well?  [Moderator] We should keep RAN2 guidance in mind. But I think we should not cause an issue in real due to unnecessarily strictly following the guidance. |
| Intel | We overall agree with a list of issues and priorities to be addressed.  Regarding e-mail discussion, we also think that we need to have a starting point i.e. reference list to work with. It would be good to have a proposal on the revised reference list to be debated according to submitted contributions. For example, we can take a list from Intel contribution or prepare some merged list as a starting point for e-mail discussion and work further to modify it. We believe it can save some time of the WGs comparing to the previous version in the latest version of RAN1 UE feature list and facilitate faster progress.  We agree that RAN1 need to fix first the list of all feature groups. i.e. have basic structure as for example shown in table below (probably with some controversial features added in brackets) and desirably with a list of components as a reference for discussion.   |  |  | | --- | --- | | 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 |   In example above the FG - Basic DL PRS processing capability ( If Intel tdoc is used as a reference) seems need further revision and may accommodate multiple components from other FGs.  Additionally, let me note that it is planned to have an independent e-mail discussion (expected to be confirmed by chair) to address the following UE capability  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   Therefore, it is recommended not to discuss issues related to this capability in e-mail thread on NR Positioning Feature List. |

# **Updated FL Proposals**

The moderator recommends following email discussions for FL Proposals 1, 2, 3, 4 and 5.

* High priority items are recommended for discussion starting Monday, April 20th, 2020. Ideally, discussions on high priority items can be concluded by Friday, April 24, 2020.
* Medium priority items are recommended for discussion starting at the time that high priority items are (almost) converged before Monday, April 27th, 2020, otherwise starting at Monday, April 27th, 2020.
* Low priority items are recommended for discussion starting at Monday, April 27th, 2020 only if high and medium priority items are converged before Monday, April 27th, 2020. Otherwise, discussion on low priority items will be postponed to next RAN1 meeting.

**FL Proposal 1 (high priority): Email discussion/approval on reconstructing the feature group structure for NR positioning (20th-24th April)**

* **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**

|  |  |
| --- | --- |
| 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 |

**FL Proposal 2 (high priority): Email discussion/approval on the need of possible new FGs for NR positioning (20th-24th April)**

* **Discuss whether or not to introduce following new FGs. If there is no consensus to add a new feature group at the end of this email discussion, the new feature group is not introduced in Rel-16.**
  + **Support of the dedicated transmission of SRS for positioning**
  + **Support of simultaneous processing of LTE PRS and NR PRS**
  + **Support of simultaneous transmissions of SRS for positioning on a symbol**
  + **Support of concurrent measurements (DL RSRP, DL RSTD, UE Rx-Tx Time Difference)**
  + **Indication of concurrent configuration of list of measurements in supported CA Band Combination in the BandCombinationList**

**FL Proposal 3 (medium priority): Email discussion/approval on issues with capability signaling impacts for NR positioning based on DL PRS (TBD)**

* **Discuss on component(s) of each FG that need to be reported and candidate values for the component(s)**
* **Discuss on reporting type of each FG**
* **Discuss on the need of xDD and/or FRx differentiation for each FG of per-UE type**
* **Note that discussed FGs in this email discussion are derived by outcome of high priority email discussions (e.g., FG13-3~8 in FL proposal 1)**

**FL Proposal 4 (medium priority): Email discussion/approval on issues with capability signaling impacts for NR positioning based on SRS (TBD)**

* **Discuss on component(s) of each FG that need to be reported and candidate values for the component(s)**
* **Discuss on reporting type of each FG**
* **Discuss on the need of xDD and/or FRx differentiation for each FG of per-UE type**
* **Note that discussed FGs in this email discussion are derived by outcome of high priority email discussions (e.g., FG13-9~11 in FL proposal 1)**

**FL Proposal 5 (medium priority): Email discussion/approval on issues with capability signaling impacts for NR positioning based on ECID and for multi-RTT (TBD)**

* **Discuss on component(s) of each FG that need to be reported and candidate values for the component(s)**
* **Discuss on reporting type of each FG**
* **Discuss on the need of xDD and/or FRx differentiation for each FG of per-UE type**
* **Note that discussed FGs in this email discussion are derived by outcome of high priority email discussions (e.g., FG13-1/2/12/13 in FL proposal 1)**

# **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 Capabilities  b) Transmission of SRS for positioning  c) DL PRS RSRP Measurement Reporting  d) UE Rx-Tx Measurement Reporting  e) DL PRS RSRP Measurement Reporting  Proposal 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.16  Configuration 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 UE  N/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.16  Configuration 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 UE  N/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-AoD   1. 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-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} 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-TDOA   1. 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-TDOA   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.   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-RTT   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. |  | 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 component  This 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-RTT   1. 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-RTT   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   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   1. 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   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] | 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.16  Configuration and reporting of SSB RRM measurements (SS-RSRP, SS-RSRQ) based on Rel.15 for NR Positioning in Rel.16  Note: 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.16  Configuration and reporting of CSI-RS for RRM (CSI-RSRP, CSI-RSRQ) for NR Positioning in Rel.16  Note: No new UE capability is assumed on top of the R15 capabilities. | [FG 1-4  FG1-5] | [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        - one (N1,N2,T) for T > “slot duration” with 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        - one (N1,N2,T) for T > “slot duration” with    * 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        - one (N1,N2,T) for T > “slot duration” with 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        - one (N1,N2,T) for T > “slot duration” with    * 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     - one (N1,N2,T) for T > “slot duration” with  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     - one (N1,N2,T) for T > “slot duration” with * 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 positioning   1. 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} ms  T = {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 1-4  FG 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} |

# **13a-1: NR E-CID DL SSB RRM measurements for NR Positioning**

In [1], FG13a-1 is captured 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.16  Configuration and reporting of SSB RRM measurements (SS-RSRP, SS-RSRQ) based on Rel.15 for NR Positioning in Rel.16  Note: 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** |

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

|  |  |  |
| --- | --- | --- |
| [8] | CATT | We think this feature should be mandatory, since all UEs should support SSB RRM measurements in Rel-15. |
| [13] | Ericsson | Remove feature groups 13a-1 and 13a-2 since the motivation for the 13a-1 and 13-a2 Feature group is unclear. |

**Based on above, following points should be discussed for this feature.**

* **Clarify the motivation to introduce FG13a-1.**
* **Whether FG13a-1 is mandatory or optional.**

# **13a-2: NR E-CID DL CSI-RS RRM measurements for NR Positioning**

In [1], FG13a-2 is captured with bracket 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-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.16  Configuration and reporting of CSI-RS for RRM (CSI-RSRP, CSI-RSRQ) for NR Positioning in Rel.16  Note: No new UE capability is assumed on top of the R15 capabilities. | [FG 1-4  FG1-5] | [No] | NA | **UE CSI-RS for RRM measurements and signalling to facilitate E-CID NR Positining are not supported** |  | [No] |  |  |  | Optional with capability signaling |

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [8] | CATT | |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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.16  Configuration and reporting of CSI-RS for RRM (CSI-RSRP, CSI-RSRQ) for NR Positioning in Rel.16  Note: No new UE capability is assumed on top of the R15 capabilities. | [FG 1-4  FG1-5] | [No] | NA | **UE CSI-RS for RRM measurements and signalling to facilitate E-CID NR Positining are not supported** | **Per UE** | [No] |  |  |  | Optional with capability signaling | |
| [13] | Ericsson | Remove feature groups 13a-1 and 13a-2 since the motivation for the 13a-1 and 13-a2 Feature group is unclear. |

**Based on above, following point should be discussed for this feature.**

* **Clarify the motivation to introduce FG13a-2.**

# **13b-1: Reception of DL PRS and UE measurement reporting to facilitate NR DL AoD support**

In [1], FG13b-1 is captured 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 |
| 13b. NR DL AoD | 13b-1 | Reception of DL PRS and UE measurement reporting to facilitate NR DL AoD support | -------------- UE DL PRS Processing Capability of RSRP for DL AoD -------------   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} 2. Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE for DL PRS RSRP 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 RSRP measurement report   Values = [1, 4, 8, 16, 32, 64]   1. Max number of DL PRS Resources supported by UE for DL PRS RSRP measurement report 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 for DL PRS RSRP measurement report. Values = [16, 32, 64, 128, 256] 3. Max number of DL PRS Resources per positioning frequency layer for DL PRS RSRP measurement report. 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}]   ------- UE DL PRS RSRP Measurement Reporting Capability 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} 2. Support of inter-frequency DL PRS RSRP measurement report in RRC\_CONNECTED state 3. [Support of SSB from serving cell as QCL Type C source of a DL PRS resource from serving cell] 4. [Support of SSB from neighbor cells as QCL Type C source of a DL PRS resource from neighbor cells] 5. [Support of SSB from serving cell as QCL Type D source of a DL PRS resource from serving cell] 6. [Support of SSB from neighbor cells as QCL Type D source of a DL PRS resource from neighbour cells] 7. [Support of a DL PRS resource from serving cell as QCL Type D source of another DL PRS resource from serving cell] 8. [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 and signalling to facilitate DL-AoD NR Positining are not supported** |  | [No] |  |  |  | Optional with capability signaling |

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

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | * For component 2 * UE DL PRS processing capability is agnostic to the configured SCS settings of DL PRS * Reported values of T per band * Separate report for the case w/ and w/o configuration of measurement gap * Component 12 and 13 are the basic components and there is no need to introduce additional capability report. * For the component 14, 15, 16 and 17 about QCL type D, the capability report should be separate for FR1 and FR2 |
| [8] | CATT | |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 13b-1 | Reception of DL PRS and UE measurement reporting to facilitate NR DL AoD support | -------------- UE DL PRS Processing Capability of RSRP for DL AoD -------------   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} 2. Max number of DL PRS Resource Sets per TRP per frequency layer supported by UE for DL PRS RSRP 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 RSRP measurement report   Values = [1, 4, 8, 16, 32, 64]   1. Max number of DL PRS Resources supported by UE for DL PRS RSRP measurement report 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 for DL PRS RSRP measurement report. Values = [16, 32, 64, 128, 256] 3. Max number of DL PRS Resources per positioning frequency layer for DL PRS RSRP measurement report. 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}]   ------- UE DL PRS RSRP Measurement Reporting Capability 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} 2. Support of inter-frequency DL PRS RSRP measurement report in RRC\_CONNECTED state 3. [Support of SSB from the same serving cell as QCL Type C source of a DL PRS resource from serving cell] 4. [Support of SSB from the same neighbor cells as QCL Type C source of a DL PRS resource from neighbor cells] 5. [Support of SSB from the same serving cell as QCL Type D source of a DL PRS resource from serving cell] 6. [Support of SSB from the same neighbor cells as QCL Type D source of a DL PRS resource from neighbour cells] 7. [Support of a DL PRS resource from the same serving cell as QCL Type D source of another DL PRS resource from serving cell] 8. [Support of a DL PRS resource from the same neighbour cells as QCL Type D source of another DL PRS resource from neighbour cells] |  | [No] | NA | **UE measurements and signalling to facilitate DL-AoD NR Positining are not supported** | **Per band** | [No] |  |  |  | Optional with capability signaling |   Component 1: Support  Component 2, it is unclear how to use the T values smaller than the DL PRS period. Suggest we set the values of T as the values of agrred DL PRS cycles.  Components 3 - 6: Support  Component 7, we don’t see the need to measure RSRP from 256 TRPs.  Component 8, we don’t see the need for UE to measure 1024 RSRP in one frequency layer.  Component 9, we don’t see the need for UE to measure 128 DL PRS resources in one TRP.  Component 10. In RAN#99, the following agreement was made on DL PRS RSRP measurements.  Agreement:  The prior agreement is updated as given below:  UE can be configured to measure and report up to N=8 (> 1) DL PRS RSRP measurements on different DL PRS resources from the same TRP  • N=[3] FFS: N is a UE capability  It is so far undecided whether N is a UE capability. In our view, there is no need to set N as an UE capability, since the UE will at least try to measure all DL PRS from one TRP, and can report N=8 DL PRS RSRP measurements if the UE detects 8 or more DL PRS. |
| [10] | Nokia, Nokia Shanghai Bell | Component 1: include 5MHz BW UEs  Component 2: The definition is confusing as duration of DL PRS symbol and window T are not necessarily the same. In any case we should try to minimize the amount of configurations to strike a reasonable balance between UE and system complexity. Given that the shorter values have no clear use case at the moment, we propose the following range for T: [1,40,320,1280]  Notes:   1. No need to capture here 2. Can be part of main description 3. No need to capture here 4. No need to capture here 5. values could be differentiated according to FR, if needed. Otherwise no need for the notes themselves. 6. No need to consider the cases independently. Network can assume processing capability w/o gaps and shouldn’t need UE to have gaps to meet performance for positioning   Component 9: we are not sure why this is needed, as it is not part of the RAN1 agreement  Components 12 to 17: remove brackets (no separate capability signalling is assumed for those components). |

**Based on above, following points should be discussed**

* **Confirm that the brackets for component 14 to 17 are removed.**
* **Confirm that FG 13b-1 is reported per band.**
* **Whether component 1 includes 5MHz in addition to 20, 50, 100, 200, 400 or not.**
* **Whether configurable values T for component 2 should be minimized or not.**
* **Whether some notes of component 2 are removed (if needed, merged with main description) or not.**
* **Whether the brackets for component 12 and 13 are removed or not.**

# **13c-1: Reception of DL PRS and UE measurement reporting to facilitate NR DL-TDOA support**

In [1], FG13c-1 is captured 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 |
| 13c. NR DL-TDOA | 13c-1 | Reception of DL PRS and UE measurement reporting to facilitate NR DL-TDOA support | -------------- UE DL PRS Processing Capability of RSTD for DL-TDOA ----------   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 RSTD 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 RSTD measurement report. Values = {1, 2} 3. Max number of DL PRS Resources per DL PRS Resource Set a UE can be configured for DL RSTD measurement report. Values = [1, 4, 8, 16, 32, 64] 4. Max number of DL PRS Resources supported by UE for DL RSTD 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 RSTD measurement report. Values = [16, 32, 64, 96, 128, 256] 6. Max number of DL PRS Resources per positioning frequency layer for DL RSTD 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}]   ----------UE DL RSTD Measurement Reporting Capability for DL-TDOA ----------   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.   1. Support of inter-frequency DL RSTD measurement report in RRC\_CONNECTED state 2. [Support of SSB from serving cell as QCL Type C source of a DL PRS resource] 3. [Support of SSB from neighbor cells as QCL Type C source of a DL PRS resource] 4. [Support of SSB from serving cell as QCL Type D source of a DL PRS resource] 5. [Support of SSB from neighbor cells as QCL Type D source of a DL PRS resource] 6. [Support of a DL PRS resource from serving cell as QCL Type D source of another DL PRS resource from serving cell] 7. [Support of a DL PRS resource from neighbor cells as QCL Type D source of another DL PRS resource from neighbor cells] 8. [Support of DL RSTD measurement quality metric] | **[13b]** | **[No]** | **NA** | **UE measurements and signalling to facilitate DL-TDOA NR Positionign are not supported** |  | **[No]** |  |  |  | **Optional with capability signaling** |

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

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | * For component 2 * UE DL PRS processing capability is agnostic to the configured SCS settings of DL PRS * Reported values of T per band * Separate report for the case w/ and w/o configuration of measurement gap * Component 12 and 13 are the basic components and there is no need to introduce additional capability report. * For the component 14, 15, 16 and 17 about QCL type D, the capability report should be separate for FR1 and FR2 * Remove component 18 in FG 13c-1 |
| [8] | CATT | |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 13c-1 | Reception of DL PRS and UE measurement reporting to facilitate NR DL-TDOA support | -------------- UE DL PRS Processing Capability of RSTD for DL-TDOA ----------   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 RSTD 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 RSTD measurement report. Values = {1, 2} 3. Max number of DL PRS Resources per DL PRS Resource Set a UE can be configured for DL RSTD measurement report. Values = [1, 4, 8, 16, 32, 64] 4. Max number of DL PRS Resources supported by UE for DL RSTD 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 RSTD measurement report. Values = [16, 32, 64, 96, 128, 256] 6. Max number of DL PRS Resources per positioning frequency layer for DL RSTD 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}]   ----------UE DL RSTD Measurement Reporting Capability for DL-TDOA ----------   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.   1. Support of inter-frequency DL RSTD measurement report in RRC\_CONNECTED state 2. [Support of SSB from the same serving cell as QCL Type C source of a DL PRS resource] 3. [Support of SSB from the same neighbor cells as QCL Type C source of a DL PRS resource] 4. [Support of SSB from the same serving cell as QCL Type D source of a DL PRS resource] 5. [Support of SSB from the same neighbor cells as QCL Type D source of a DL PRS resource] 6. [Support of a DL PRS resource from the same serving cell as QCL Type D source of another DL PRS resource from serving cell] 7. [Support of a DL PRS resource from the same neighbor cells as QCL Type D source of another DL PRS resource from neighbor cells] 8. [Support of DL RSTD measurement quality metric] | **[13b]** | **[No]** | **NA** | **UE measurements and signalling to facilitate DL-TDOA NR Positionign are not supported** | **Per band** | **[No]** |  |  |  | **Optional with capability signaling** |   Component 1: Support  Component 2: it is unclear how to use the T values smaller than the DL PRS period. Suggest we set the values of T as the values of agrred DL PRS cycles.  Components 3 - 6: Support  Component 7: we don’t see the need to measure RSTD from 256 TRPs.  Component 8: we don’t see the need for UE to measure 1024 RSTD in one frequency layer.  Component 9: we don’t see the need for UE to measure 128 DL PRS resources in one TRP.  Component 10-17: Support. However, we should make it clear that QCLed signals should come from the same neighbour cell. Thus, we suggest add the following clarification:  “from the same serving cell”  “from the same neighbour cells”  Component 18: Support |
| [10] | Nokia, Nokia Shanghai Bell | Component 1: include 5MHz BW UEs  Component 2: The definition is confusing as duration of DL PRS symbol and window T are not necessarily the same. In any case we should try to minimize the amount of configurations to strike a reasonable balance between UE and system complexity. Given that the shorter values have no clear use case at the moment, we propose the following range for T: [1,40,320,1280]  Notes:   1. No need to capture here 2. Can be part of main description 3. No need to capture here 4. No need to capture here 5. values could be differentiated according to FR, if needed. Otherwise no need for the notes themselves. 6. No need to consider the cases independently. Network can assume processing capability w/o gaps and shouldn’t need UE to have gaps to meet performance for positioning   Component 9: we are not sure why this is needed, as it is not part of the RAN1 agreement  Component 10: it needs to be clarified that these max number of measurements are performed on the same pair of TRPs  Components 12 to 18: remove brackets (no separate capability signalling is assumed for those components). |
| [13] | Ericsson | Move the notes of component 2 in 13c-1 to the note section. |

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

* **Confirm that the brackets for component 14 to 18 are removed.**
* **Confirm that FG13c-1 is reported per band.**
* **Whether component 1 includes 5MHz in addition to 20, 50, 100, 200, 400 or not.**
* **Whether configurable values T for component 2 should be minimized or not.**
* **Whether some notes of component 2 are removed (if needed, merged with main description) or not.**
* **Whether the brackets for component 12 and 13 are removed or not.**

# **Views on Tentative Proposals for Previous Question**

In [1], question for FG13c-1 is captured. A tentative proposal was made as below.

|  |
| --- |
| **How to signal 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 by UE**  Summary: Three companies expressed the view to defer discussion. Three companies made proposals:   1. Function of number of samples or number of symbols for a reference SCS 2. Multiple pairs of (N, T) 3. Multiple combinations of (N1,N2,T) per band and per MG configured-or-not, where N1, N2 is the number of PRS symbols and PRS resources respectively per T   Proposal F:   * Continue discussion aiming to conclude at 100E-bis meeting. |

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

|  |  |  |
| --- | --- | --- |
| [3] | vivo | In our opinion, multiple pairs of (N, T) per band could be reported from a UE indicating different capability of DL PRS processing (i.e., N) under different processing period T.  On the proposal to report (N1, N2, T) where N1, N2 is the number of PRS symbols and PRS resources respectively per T, we feel this proposal is a bit redundant given that either N1 or N2 indicating UE DL PRS processing capability. It’s not clear about how much difference of N1 and N2 on the actual UE processing capability. Our slight preference is not to report both N1 and N2. Regarding UE report per MG configured-or-not, we think it is not necessary. More details can be referred to our contribution [3]. |
| [4] | OPPO | Multiple combinations of {time duration of PRS, T ms } per band for with or without configuration of measurement gap. |
| [5] | MediaTek Inc. | 3) is preferred. |
| [7] | Intel Corporation | For the case when measurement gap is configured, define signalling of multiple pairs (N, T) for a reference SCS and assuming max BW supported by UE, where N is a number of symbols that can be processed within T ms |
| [8] | CATT | We assume there is a need to have more detailed discussion (maybe in AI 7.2.8.1) on how to define the processing capability based on the existing agreements, and then define the corresponding values for UE capability. |
| [9] | Samsung | The duration of DL PRS symbol in units of ms a UE can process every T ms assuming maximum DL PRS bandwidth in MHz can be pre-defined. |
| [11] | Qualcomm Incorporated | 3) is preferred.  *Define the DL PRS processing capabilities as:*   * *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.*    + *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 and for measurement gaps configured or not, the UE reports*      - *a single Bmax*     - *One or both of the following two:*       * *one (N1,N2,T) for T = “slot duration” with*       * *one (N1,N2,T) for T > “slot duration” with*   + *This capability is reported per band* |
| [12] | Huawei, HiSilicon | We have a t-doc to specifically address that in 7.2.8.1. So far, we do not think it should be discussed in UE feature session. |

**Based on above, each company’s preferences are diverse. So, we need to take further discussion.**

# **Answers on Additional Question**

In [1], additional questions for FG13c-1 are captured as below.

* Whether DL AoD(13b) feature group is a pre-requisite of DL-TDOA(13c) feature group?

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

|  |  |  |
| --- | --- | --- |
| [3] | vivo | Yes. Looking at the components of feature group 13b (DL-AoD) and feature group 13c (DL-TDOA), we see exactly the same UE DL PRS processing capability for DL-AoD and DL-TDOA and very minor difference on measurement reporting capability. Our understanding is that DL-TDOA does require UE reporting of RSRP measurements on different PRS resources corresponding to those RSTD measurement report. In this case, we think feature group 13b should be a pre-requisite of feature group 13c. |
| [4] | OPPO | No. The table of UE feature for NR positioning shall be organized based on UE functions of reference signal processing and positioning measurement. Furthermore, defining one positioning method as pre-requisite of another positioning method does not make sense technically. |
| [5] | MediaTek Inc. | No. |
| [6] | LG Electronics | No. In case of DL-TDOA technique, the UE needs to report timing measurement such as RSTD, but reporting of RSRP and/or PRS resource ID would not be essential, while the UE should report RSRP and/or PRS resource-ID in case of DL-AoD technique. The two techniques seem to be independent, so we think that DL AoD is not pre-requisite of DL-TDOA. |
| [7] | Intel Corporation | No. |
| [8] | CATT | No. |
| [11] | Qualcomm Incorporated | No. |
| [12] | Huawei, HiSilicon | Our answer is No.  Note that positioning capability is exchanged on a per-method basis, so that for capability exchange for DL-TDOA, there is no need for capability exchange for DL-AoD. In addition, the values may be different for UE to support DL-TDOA and DL-AoD. |

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

* **Confirm that DL AoD(13b) feature group is not a pre-requisite of DL-TDOA(13c) feature group.**
* Whether to introduce different independent components for DL PRS RSRP and DL RSTD measurments in DL-TDOA(13c) feature group, considering that RAN2 agreed to include RSRP into NR-DL-TDOA-MeasElement?
  + Option A. In case of DL-TDOA, DL PRS RSRP components are assumed to be the same as for DL-RSTD
  + Option B. In case of DL-TDOA, DL PRS RSRP components are inherited from DL-AoD
  + Option C. In case of DL-TDOA, DL PRS RSRP and DL-RSTD components are defined independently

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

|  |  |  |
| --- | --- | --- |
| [3] | vivo | Option B is preferred.  Considering DL-AoD(13b) feature group is a pre-requisite of DL-TDOA(13c), then DL PRS RSRP measurement reporting capability components for DL-TDOA are inherited from those of DL-AoD. |
| [4] | OPPO | The UE feature of DL PRS RSRP measurement and RSTD measurement shall be defined not under the positioning method. |
| [5] | MediaTek Inc. | Option B is preferred. |
| [6] | LG Electronics | We think that this issue needs to be more clarified for better understanding. If this issue is to define the UE capability on the same type of measurements such as RSRP for each positioning technique, we are not sure that it is needed. However, if we need to choose one of the above options, the option A seems reasonable. |
| [7] | Intel Corporation | Option A is preferred. |
| [8] | CATT | Option A is preferred. |
| [11] | Qualcomm Incorporated | As shown in our proposed feature groups below, the reporting of RSRP and RSTD would need to be separate as was already agreed in the RAN2 LPP CR [3].  The DL PRS capabilities are reported for each applicable method separately. The SRS transmission capabilities should be reported for each applicable method separately.  The per-method reported DL PRS capabilities and SRS transmission capabilities include any PRS processing/configuration and SRS transmission capabilities the UE is capable of supporting across all Positioning methods.  With regards to the DL PRS capabilities, in case of TDOA (or Multi-RTT), the DL PRS capabilities are common, the Measurement capabilities are different. There exist three main aspects inside the TDOA(or Multi-RTT), feature, where the “DL PRS capabilities” is about TDOA (or Multi-RTT), and not for each measurement separately:  a) DL PRS Capabilities  b) DL PRS RSTD (or Rx-Tx) Measurement Reporting  c) DL PRS RSRP Measurement Reporting  d) Transmission of SRS for positioning for Multi-RTT only |
| [12] | Huawei, HiSilicon | Our answer is Option A.  It means the number of resources for DL RSTD measurement should be the same as for DL PRS-RSRP measurements, and it also means that if UE support inter-frequency measurement, UE supports inter-frequency RSTD and RSRP measurement at the same time. The number of RSTD measurement reporting per TRP pair should also be extended to the number of RSRPs for the target TRP. |

**Based on above, each company’s preferences are diverse. So, we need to take further discussion.**

# **13d-1: Transmission of SRS for positioning**

In [1], FG13d-1 is captured 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 |
| 13d. NR SRS for positioning | 13d-1 | Transmission of SRS for positioning | 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. 5. Support of SSB for serving cell DL pathloss estimation and OLPC for SRS for positioning. 6. Support of SSB for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning. 7. Support of DL PRS for serving cell DL pathloss estimation and OLPC for SRS for positioning. 8. Support of DL PRS for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning. 9. 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} 10. Spatial relation of SRS Resources for positioning with DL PRS Resources from serving cell 11. Spatial relation of SRS Resources for positioning with DL PRS Resources from neighbour cells 12. Spatial relation of SRS Resources for positioning with SSB from serving cell 13. Spatial relation of SRS Resources for positioning with SSB from neighbour cells 14. Spatial Relation of SRS Resources for positioning with other SRS resources 15. [Max number of active spatial relations including both DL PRS Resources and SSB. Values = [FFS]] |  | **[Yes]** | **NA** | **UE signaling to facilitate UL-TDOA and multi\_RTT NR positioning is not supported** |  | **[No]** |  |  |  | **Optional with capability signaling** |

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

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | 1. Max number of SRS Resource Sets for positioning supported by UE per BWP. Values = {1, 4, 8, 12, 16}. 2. Max number of aperiodic SRS Resources for positioning supported by UE across all SRS Resource Sets per BWP. Values = {1, 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, 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, 4, 8, 16, 32, 64}. 5. Support of SSB for serving cell DL pathloss estimation and OLPC for SRS for positioning. There is no need to introduce additional capability report on this component. 6. Support of SSB for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning. 7. Support of DL PRS for serving cell DL pathloss estimation and OLPC for SRS for positioning. 8. Support of DL PRS for neighbour cell(s) DL pathloss estimation and OLPC for SRS for positioning. 9. 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} 10. Spatial relation of SRS Resources for positioning with DL PRS Resources from serving cell 11. Spatial relation of SRS Resources for positioning with DL PRS Resources from neighbour cells 12. Spatial relation of SRS Resources for positioning with SSB from serving cell 13. Spatial relation of SRS Resources for positioning with SSB from neighbour cells 14. Spatial Relation of SRS Resources for positioning with other SRS resources 15. Max number of active spatial relations including both DL PRS Resources and SSB. Values = {1, 4, 8, 16, 32, 64} 16. Spatial relation of SRS Resources for positioning with CSI-RS resources from serving cell |

**Based on above, following points should be discussed for FG13d-1.**

* **Whether the additional values should be included for each components listed below:**
  + **Component 1: 4, 8, 12**
  + **Component 2: 1, 4, 8, 16, 32**
  + **Component 3: 1, 4, 8, 16, 32**
  + **Component 4: 1, 4, 8, 16, 32**
* **Whether the bracket of value 1 for component 9 is removed or not.**
* **Whether the bracket for component 15 is removed or not.**
* **Whether the new component 16 (Spatial relation of SRS Resources for positioning with CSI-RS resources from serving cell) is added or not.**

# **Views on Tentative Proposals for Previous Question**

In [1], question for FG13d-1 is captured. A tentative proposal was made as below.

|  |
| --- |
| **Whether to define max number of SRS resources for positioning per slot?**  Summary: Do not support – five companies. Support – five companies. Seems there is no concensus and it is suggested to continue discussion  Proposal C:   * Continue discussion. Companies are encouraged to bring technical arguments why it is necessary and for which cases/scenarios. |

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

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | No. For UL, there is not much complexity for SRS transmission because of no detection at UE side. So there is not much difference between more and less SRS resources per slot for UE capability. |
| [3] | vivo | Our slight preference is not to define this unless a solid and necessary reason. During RAN1#100e [100e-NR-Rel-16-UEFeatures] email discussion, the support argument to define max number of SRS resources for positioning per slot is that Rel-15 SRS has defined this UE capability. Given that each SRS resource for positioning has a limit on the number of symbols in a slot, we feel this max number of SRS resources for positioning per slot UE capability reporting may give little additional benefit. |
| [4] | OPPO | Yes. |
| [7] | Intel Corporation | Yes. Support the following feature components for SRS resources for positioning:   * Maximum number of aperiodic SRS resources for positioning (configured to UE) per BWP per slot * Maximum number of periodic SRS resources for positioning (configured to UE) per BWP * Maximum number of periodic SRS resources for positioning (configured to UE) per BWP per slot |
| [8] | CATT | No. UE should be able to support any number of SRS resources allowed to be configured in a slot. |
| [9] | Samsung | No. |
| [11] | Qualcomm Incorporated | Yes. In NR Rel-16, SRS resources for positioning could be anywhere in the slot, and they could even before the PUSCH of that slot. Given the Rel-15 capability where a UE could even report that it supports single resource per slot, it is unreasonable to assume that, for Rel-16, all UEs supporting the SRS for positioning feature, would be required to support up to 14 SRS resources in a slot! It is clear that there is a need of some intermediate values for this feature to be supportable and useful. |
| [12] | Huawei, HiSilicon | Yes. Add the following UE capability under SRS for positioning.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 13d. NR Multi-RTT  13e. SRS for positioning | 13d-x  13e-y | SRS resources in a slot per BWP | Max number of SRS resources for positioning in a slot per BWP | FFS | Yes |  | Network does not know whether it is allowed to configure SRS for positioning in a slot | 2) Per band | No | No | NA |  | Optional with capability signalling  {1, 2} | |

**Based on above, following point should be discussed for this feature.**

* **Whether all Rel-16 UEs support any number of SRS resources for positioning per slot or not.**

# **13e-1: Reception of DL PRS and transmission of SRS for positioning to facilitate NR Multi-RTT support**

In [1], FG13e-1 is captured 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 |
| 13e. NR Multi-RTT | 13e-1 | Reception of DL PRS and transmission of SRS for positioning to facilitate NR Multi-RTT support | ------------UE Rx-Tx Measurement Reporting Capability for Multi-RTT------------   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   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   1. 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   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] | [13c,  **13d]** | **[Yes]** | **NA** | **UE measurements and signalling to facilitate Multi-RTT NR Positioning are not supported** |  | **[No]** |  |  |  | **Optional with capability signaling** |

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

|  |  |  |
| --- | --- | --- |
| [5] | MediaTek Inc. | Remove component 6 of FG 13e (DL-TDOA) since component 6 is covered by component 3. |
| [8] | CATT | |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 13e-1 | Reception of DL PRS and transmission of SRS for positioning to facilitate NR Multi-RTT support | ------------UE Rx-Tx Measurement Reporting Capability for Multi-RTT------------   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   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   1. 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   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] | [13c,  **13d]** | **[Yes]** | **NA** | **UE measurements and signalling to facilitate Multi-RTT NR Positioning are not supported** | **Per band** | **[No]** |  |  |  | **Optional with capability signaling** |   Components 1 – 5: Support  Component 6: Not support. We assume there can be two motivations for adding the component 6:  1) Support UE to report one or more UE Rx–Tx time difference measurement where UE receives PRS from one carrier (or more carriers) and UE transmits SRS for positioning in a different carrier;  2) Support UE to report one or more UE Rx–Tx time difference measurement where UE receives PRS from one carrier (or more carriers) and UE transmits SRS for positioning in more than one different carrier.  In our view, the first scenario is already covered by Component 3. For the second scenario, it was discussed in RAN1, but not agreed. Therefore, we proposed to remove Component 6. |
| [10] | Nokia, Nokia Shanghai Bell | Components 5 and 6: remove brackets (no separate capability signalling is assumed for those components). |

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

* **Confirm that the bracket for component 5 is removed.**
* **Whether the bracket for component 6 is removed or component 6 is removed.**

# **Answers on Additional Question**

In [1], additional questions for FG13e-1 are captured as below.

* Whether DL TDOA(13c) and transmission of SRS for positioning(13d) are pre-requisites of Multi-RTT(13e)?

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

|  |  |  |
| --- | --- | --- |
| [3] | vivo | Yes. Considering the nature of Multi-RTT positioning method where a UE measure time difference between a DL PRS resource and a SRS for positioning resource, we think feature group 13c (DL-TDOA) and feature group 13d (SRS for positioning) should be pre-requisites of feature group 13e (Multi-RTT). Furthermore, if DL-AoD(13b) feature group is a pre-requisite of DL-TDOA(13c) feature group, then DL AoD(13b) feature group is also a pre-requisite of Multi-RTT(13e). |
| [4] | OPPO | No. The table of UE feature for NR positioning shall be organized based on UE functions of reference signal processing and positioning measurement. The method of DL TDoA shall not be pre-requisite for multi-RTT method. |
| [5] | MediaTek Inc. | FG 13c (DL-TDOA) is not needed to be a prerequisite feature group for FG 13e (mutli-RTT) since DL-AoD, DL-TDOA, and multi-RTT may be independent positioning methods. |
| [6] | LG Electronics | Yes. In case of Multi-RTT, the UE needs to estimate the timing of arrival of the configured PRS resources and also the UE should transmit SRS resource for positioning, so DL TDOA and transmission of SRS resource for positioning would be considered as pre-requisite components of Multi-RTT. |
| [7] | Intel Corporation | Transmission of SRS for positioning is a pre-requisite for Multi-RTT capability support |
| [8] | CATT | Supporting SRS or positioning is a pre-requirement for supporting multi-RTT. |
| [11] | Qualcomm Incorporated | No. They are different method. Multi-RTT feature group would include by itself DL PRS capabilities and SRS for transmission capabilities. |
| [12] | Huawei, HiSilicon | Our answer is No.  First DL TDOA and Multi-RTT are different positioning method, and just with the same reason as DL-TDOA and DL-AoD, the capability for DL TDOA cannot be used for Multi-RTT. Another example is that UE may support inter-frequency DL RSTD measurement, but does not inter-frequency UE Rx – Tx tim difference measurement. For transmission of SRS, we would assume the capability of SRS will be reported to gNB, instead of LMF, so our understanding is that the capability to gNB cannot be the prerequisite of the capability to LMF. |

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

* **Confirm that DL TDOA(13c) is not pre-requisites of Multi-RTT(13e) feature group.**
* **Confirm that transmission of SRS for positioning(13d) is pre-requisites of Multi-RTT(13e) feature group.**
* Whether to introduce different components for DL PRS RSRP and DL PRS receive timing estimation for UE Rx-Tx measurments for Multi-RTT(13e) feature group, considering that RAN2 agreed to include RSRP into NR- NR-Multi-RTT-MeasElement and UE Rx-Tx time measurement require receive timing estimation similar to RSTD?
  + Option A. In case of multi-RTT, DL PRS RSRP components are assumed to be the same as for DL-AoD
  + Option B. In case of multi-RTT, DL PRS RSRP components and DL PRS receive timing estimation for UE Rx-Tx measurments are inherited from DL-TDOA components.
  + Option C. In case of multi-RTT, DL PRS RSRP and DL PRS receive timing estimation are defined independently.

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

|  |  |  |
| --- | --- | --- |
| [3] | vivo | Option B is preferred. |
| [4] | OPPO | The UE feature of DL PRS RSRP measurement and RSTD measurement shall be defined not under the positioning method. It is up to system implementation to choose NR positioning method. For each UE, the system can choose the positioning method based on the positioning functions (including reference signal processing and measurements) that the UE supports. |
| [5] | MediaTek Inc. | Option B is preferred. |
| [6] | LG Electronics | Option B is slightly preferred. |
| [7] | Intel Corporation | In our view for the case of Multi-RTT, the DL PRS resource capabilities for DL PRS RSRP and UE Rx-Tx measurements can be assumed to be the same.  Introduce the following feature groups   * DL PRS Resources for DL AoD (for DL PRS RSRP) * DL PRS Resources for DL TDOA (for DL PRS RSRP + DL RSTD measurements) * DL PRS Resources for Multi-RTT (for DL PRS RSRP + UE Rx-Tx time difference measurements) |
| [8] | CATT | For simplicity, option B is preferred. |
| [11] | Qualcomm Incorporated | As shown in our proposed feature groups below, the reporting capabilities of RSRP and Rx-Tx would need to be separated as has already been part of the RAN2 CR.  With regards to the DL PRS capabilities, in case of TDOA (or Multi-RTT), the DL PRS capabilities are common, the Measurement capabilities are different. There exist three main aspects inside the TDOA(or Multi-RTT), feature, where the “DL PRS capabilities” is about TDOA (or Multi-RTT), and not for each measurement separately:  a) DL PRS Capabilities  b) DL PRS RSTD (or Rx-Tx) Measurement Reporting  c) DL PRS RSRP Measurement Reporting  d) Transmission of SRS for positioning for Multi-RTT |
| [12] | Huawei, HiSilicon | Our answer is Option D (revised from Option A). In case of Multi-RTT, DL PRS RSRP components are assumed to be the same as for UE Rx – Tx time difference measurement.  The question formulation seems to imply that multi-RTT feature should have some prerequisite FGs, which we cannot agree. Our understanding is similar to the previous question for RSRP and RSTD measurement. |

**Based on above, following proposal would be acceptable.**

* **We can discuss based on two options as below.**
  + **Option B. In case of multi-RTT, DL PRS RSRP components and DL PRS receive timing estimation for UE Rx-Tx measurments are inherited from DL-TDOA components.**
  + **Option C. In case of multi-RTT, DL PRS RSRP and DL PRS receive timing estimation are defined independently.**
* Whether to introduce dedicated transmission of SRS for positioning components for Multi-RTT(13e)?

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

|  |  |  |
| --- | --- | --- |
| [3] | vivo | No. Our preference is to keep the same transmission of SRS for positioning UE capability components among 13d and 13e. |
| [4] | OPPO | No. The transmission of SRS for positioning shall be defined as a separate UE feature |
| [5] | MediaTek Inc. | No. |
| [6] | LG Electronics | In contrast with transmission of SRS for UL-TDOA technique, transmission of SRS for positioning for Multi-RTT needs to be associated with some DL PRS resources where they are used for UE RX-TX time difference measurements. For example, the UE RX beam to receive PRS resource and UE TX beam to transmit SRS resource for positioning need to be the same direction. In the current phase, it is unclear what the dedicated transmission of SRS is, so we would like to discuss it. |
| [7] | Intel Corporation | In our view, the feature group transmission of SRS for positioning is the same across UL-TDOA, UL-AoA and Multi-RTT. |
| [8] | CATT | No. |
| [11] | Qualcomm Incorporated | Yes. |
| [12] | Huawei, HiSilicon | Our answer is Yes.  We think RAN2 is also discussing the SRS capability transfer to LMF. In our understanding, a lite version of SRS capability should be provided to LMF, e.g. support of SRS for positioning, and other SRS capabilities may be requested from gNB/AMF, which needs LS to RAN2/RAN3/CT1. In summary, a dedicated transmission of SRS for positioning components is needed at least to cover whether UE supports SRS for positioning. |

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

* **Whether the dedicated transmission of SRS for positioning is defined as a separate UE feature or not.**

# **FG common question**

In [1], additional question is captured as below.

* Are there any common components for UE DL PRS processing among feature groups DL AoD(13b)/DL-TDOA(13c)/Multi-RTT(13e)?

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

|  |  |  |
| --- | --- | --- |
| [3] | vivo | Our preference is to have the same common components (item 1 – 9 in the table for 13b and 13c) of UE DL PRS processing capability among feature groups DL-AoD(13b)/DL-TDOA(13c)/Multi-RTT(13e). |
| [4] | OPPO | The table of UE feature for NR positioning shall be organized based on UE functions of reference signal processing and positioning measurement, not based on the methods of NR positioning. For instance, if a UE supports the DL PRS processing and RSTD measurement, then the system can implement DL TDoA method based on the UE RSTD measurement obtained from processing DL PRS. |
| [7] | Intel Corporation | Introduce feature groups for basic DL PRS processing and DL PRS QCL processing capabilities with the following list of components   * Basic DL PRS processing   + #1 Maximum DL PRS bandwidth 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   + #3 Max number of positioning frequency layers supported by UE * DL PRS QCL processing   + #17 Support of SSB from serving cell as QCL Type C source of a DL PRS resource from serving cell   + #18 Support of SSB from neighbor cells as QCL Type C source of a DL PRS resource from neighbor cells   + #19 Support of SSB from serving cell as QCL Type D source of a DL PRS resource from serving cell   + #20 Support of SSB from neighbor cells as QCL Type D source of a DL PRS resource from neighbour cells   + #21 Support of a DL PRS resource from serving cell as QCL Type D source of another DL PRS resource from serving cell   + #22 Support of a DL PRS resource from neighbour cells as QCL Type D source of another DL PRS resource from neighbour cells |
| [8] | CATT | UE DL PRS processing is actually common capability for DL AoD(13b)/DL-TDOA(13c)/Multi-RTT(13e). |
| [9] | Samsung | UE may report the maximum PRS bandwidth BWmax and (N, T) for each SCS. The reported value for N should include the impact of cell phase synchronization error between TRPs. The UE DL PRS processing capability is not exactly scaled inversely proportional to DL PRS processing bandwidth.  • Option 1: UE reports the capability corresponding to maximum PRS bandwidth to be supported. Scaling rule in Table 2 is applied to interpret UE’s capability if network configures smaller BW.  • Option 2: UE reports multiple PRS bandwidth values to indicate scaling boundaries. |
| [11] | Qualcomm Incorporated | The reported DL PRS processing capabilities are expected to be the same across Positioning methods.  In other words, if the UE reports it can process X PRS resources every T msec, it applies across positioning methods and it is not only for OTDOA or AoD or Multi-RTT. |
| [12] | Huawei, HiSilicon | Our answer is Yes.  We think that PRS processing capability can be viewed as the common FGs across multiple positioning method. |

**Based on above, following point should be discussed for this feature.**

* **The detail design of common components for UE DL PRS processing among feature groups DL AoD(13b)/DL-TDOA(13c)/Multi-RTT(13e).**

# **New feature group proposal**

# **New [13f-1]: Support of simultaneous processing of LTE PRS and NR PRS**

In [1], a tentative proposal was made as below.

|  |
| --- |
| **Whether to define “Support of simultaneous processing of LTE PRS and NR PRS”?**  Summary: One company assumes that it should be supported by default. Two companies are not in favour based on the reasons of different accuracy or lack of RSTD b/w E-UTRA and NR. Six companies are in favour.  Proposal A:   * Feature “Support of simultaneous processing of LTE PRS and NR PRS in different bands” is introduced * Notes: Other DL PRS processing capabilities are not affected by introduction of this feature. If feature is not supported, it is up to UE implementation to select RAT for DL PRS processing |

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

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | No. We don’t support to define such UE capability since we have agreed that RSTD measured between an E-UTRA cell and an NR cell is not supported in Rel-16. |
| [3] | vivo | Yes. (Support proposal A) |
| [4] | OPPO | No. |
| [5] | MediaTek Inc. | Yes. (Support proposal A) |
| [6] | LG Electronics | Not support to introduce the simultaneous processing of LTE PRS and NR PRS unless timing measurement reporting using concurrent measurements from LTE PRS and NR PRS is allowed. |
| [7] | Intel Corporation | Further discuss the need to define feature group “Support of simultaneous processing of LTE PRS and NR PRS in different bands” including the followins aspects   * Impact on NR DL PRS processing capabilities when UE performs simultaneous LTE PRS processing * How LMF will use this feature group if it is defined and mechanism for LMF to identify UE that indicated support of simultaneous LTE PRS and NR PRS processing on different bands * Support of simultaneous NR DL PRS + NR DL PRS processing on different positioning frequency layers |
| [8] | CATT | Yes, if we assume the capability means UE can simultaneously process LTE PRS and NR PRS but independently, e.g., separate LTE RSTD and NR RSTD measurements, but not mixed LTE/NR measurements such as mixed LTE/NR RSTD. |
| [9] | Samsung | No. |
| [11] | Qualcomm Incorporated | Yes. We are supportive of this feature assuming it is within a common framework of concurrency of RAT-dependent methods which includes (LTE OTDOA, NR-TDOA, NR-AOD, NR-Multi-RTT). |
| [12] | Huawei, HiSilicon | Yes. Add the following UE capability under common NR DL PRS processing feature.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 13. Common NR DL PRS processing | 13-x | Concurrent LTE/NR PRS processing | Support of concurrent processing of LTE PRS and NR PRS | FFS 13-1 | Yes |  | Network does not know whether OTDOA and NR DL/RTT positioning can be used together. | 1) Per UE | No | No | NA |  | Optional with capability signalling  {supported, notSupported} | |

**Based on above, following points should be discussed for FG13f-1.**

* **Whether “simultaneous processing” means the processing with separate LTE RSTD and NR RSTD measurement or not**
* **Impact on NR DL PRS processing capabilities when UE performs simultaneous LTE PRS processing**
* **How LMF will use this feature group if it is defined and mechanism for LMF to identify UE that indicated support of simultaneous LTE PRS and NR PRS processing on different bands**
* **Support of simultaneous NR DL PRS + NR DL PRS processing on different positioning frequency layers**

# **New [13g-1]: Support of simultaneous transmissions of SRS for positioning on a symbol**

In [1], a tentative proposal was made as below.

|  |
| --- |
| **Whether to define max number of simultaneous transmissions of SRS for positioning on a symbol?**  Summary: Do not support - five companies. Support – four companies. Support for different CCs only – one company. Seems there is no concensus. Given that not many companies considered multi-CC scenario, it is suggested to conclude on the following proposal.  Proposal B:   * RAN1 to discuss and select one alternative:   + Alt.1. Feature “Simultaneous transmissions of SRS for positioning on a symbol” is not supported in R16, including transmission on different CCs   + Alt.2. Feature “Simultaneous transmissions of SRS for positioning on a symbol” is supported only for transmission of SRS for positioning on different CCs including intra-band and inter-band CA cases |

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

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | Support Alt.1. Otherwise, power control among multiple resources should be clarified. |
| [3] | vivo | We support Alt.2. During RAN1#100e [100e-NR-Rel-16-UEFeatures] email discussion, several companies including us thought this is not need given the agreement made in [100e-NR-Pos-ULRS-01] where “the UE is not expected to transmit multiple SRS resources with different spatial relations in the same symbol”. However, we noticed that the discussion in [100e-NR-Pos-ULRS-01] is only for single carrier case. For intra-band and inter-band CA cases where transmission of SRS for positioning is on different CCs, we think this feature is beneficial. |
| [4] | OPPO | Support Alt.2. We shall define the maximum number of SRS resources across CCs for CA case. |
| [6] | LG Electronics | Support Alt.2. |
| [7] | Intel Corporation | Support Alt.2. |
| [8] | CATT | No strong opinion. SRS is transmitted in a single port. We don’t see the usage for UE to simultaneously transmit multiple SRS resources for positioning on the same symbol. |
| [9] | Samsung | Support Alt.2. |
| [12] | Huawei, HiSilicon | Support Alt.2. Add the following UE capability under SRS for positioning.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 13d. NR Multi-RTT  13e. SRS for positioning | 13d-x  13e-y | Simultaneous transmission | Max number of SRS resources for positioning on a symbol for intra-band CA | FFS | Yes |  | Network does not know whether it is allowed to configure SRS for positioning across CC for intra-band CA | 2) Per band | No | No | NA |  | Optional with capability signalling  {1, 2} | |

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

* **Whether “Simultaneous transmissions of SRS for positioning on a symbol” is supported or not.**
  + **Alt 1. “Simultaneous transmissions of SRS for positioning on a symbol” is not supported in R16, including transmission on different CCs**
  + **Alt 2. “Simultaneous transmissions of SRS for positioning on a symbol” is supported as a new feature only for transmission of SRS for positioning on different CCs including intra-band and inter-band CA cases**
  + **Alt 3. “Simultaneous transmissions of SRS for positioning on a symbol” is supported as a component of FG13b-1.**

# **New [13h-1]: Support of concurrent measurements (DL RSRP, DL RSTD, UE Rx-Tx Time Difference) and [13h-2]: indication of concurrent configuration of list of measurements**

In [1], a tentative proposals was made as below.

|  |
| --- |
| **Whether to define capability for support of concurrent measurements (DL RSRP, DL RSTD, UE Rx-Tx Time Difference)?**  Summary: Do not support – four companies (two companies mentioned support of concurrent measurements by default). Support – five companies. One company supports concurrency per method not per measurement.  It seems there is no concensus to define capability for concurrent measurements.  Proposal D:   * Companies are encouraged to bring technical arguments why it is necessary to define capability for concurrent measurements/methods and whether concurrent measurements can be assumed by default. |

|  |
| --- |
| **Whether to define indication of concurrent configuration of list of measurements in supported CA Band Combination in the BandCombinationList?**  Summary: Do not support – five companies (two companies mentioned support of concurrent measurements by default). Support – two companies. Seems there is no consensus and there is a dependency on resolution of D)  Proposal E:   * Continue discussion (it has dependency on outcome of Proposal D) |

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

**For proposal D**

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | Yes. |
| [3] | vivo | As we expressed in the discussion of UE DL PRS processing for UE capability under email thread [100e-NR-Pos-DL-PRS-02], our understanding is that when a UE process DL PRS, concurrent measurements and consequently measurement report generation based on the same DL PRS should always be allowed. Thus, there’s no need to define concurrent measurements.  We noticed that RAN2 specify UE capability signaling per positioning method. We think it’s natural to define UE capability signaling to indicate whether supporting a particular positioning method. Though we don’t see a big difference in terms of UE DL PRS processing capability whether a UE support one or multiple positioning methods. |
| [4] | OPPO | No. |
| [5] | MediaTek Inc. | Yes. The capability is per band. |
| [7] | Intel Corporation | Clarify the meaning for concurrency of supported measurements/methods to facilitate positioning techniques and decide on the need for additional signalling. |
| [8] | CATT | Yes. It is important to let the network know if UE has the capability to measure DL RSRP, DL RSTD, UE Rx-Tx Time Difference simultaneously. |
| [9] | Samsung | No. |
| [11] | Qualcomm Incorporated | Add a sub-feature within the OTDOA, AoD and Multi-RTT capabilities, for the UE to report concurrency of methods (NR OTDOA, NR AoD, NR Multi-RTT) per UE. |
| [12] | Huawei, HiSilicon | Our answer is No. However, we can discuss the capability of simultaneous positioning methods within DL-TDOA, DL-AoD, and Multi-RTT. |

**For proposal E**

|  |  |  |
| --- | --- | --- |
| [2] | ZTE | Yes. |
| [3] | vivo | No. As we expressed above toward Proposal D, there’s no need to define concurrent measurements. As a result, the concurrent configuration of list of measurements in supported CA Band Combination in the BandCombinationList is also not needed. We would be fine to define UE capability signaling to indicate whether supporting concurrent configuration of list of positioning methods. |
| [4] | OPPO | No. |
| [5] | MediaTek Inc. | No. An indication of capability supporting positioning method per band is sufficient. |
| [8] | CATT | Not in Rel-16. It may need further discussion on how to support NR positioning for CA case. |
| [9] | Samsung | No. |
| [11] | Qualcomm Incorporated | Add a sub-feature within the OTDOA, AoD and Multi-RTT capabilities, for a UE supporting concurrency of 2 or more methods, to report concurrency of methods (NR OTDOA, NR AoD, NR Multi-RTT) per supported CA Band Combination. |
| [12] | Huawei, HiSilicon | Our answer is No for now, as at least some clarification is needed. As we are discussing UE capability reported to LMF, and PRS does not have to be transmitted on any CC, we do not see the need to report such. |

**Based on above, following point should be discussed for this feature.**

* **Whether the FG13h-1 for Support of concurrent measurements (DL RSRP, DL RSTD, UE Rx-Tx Time Difference) is introduced or not.**

**If it is agreed that this feature is introduced, additionally following points should be discussed.**

* **How to clarify the meaning of “capability for support of concurrent measurements (DL RSRP, DL RSTD, UE Rx-Tx Time Difference)”.**
* **Whether this FG is reported per UE or per band.**
* **Whether the FG13h-2 for indication of concurrent configuration of list of measurements are introduced or not.**
* **Whether any sub-feature is added or not.**

# **References**

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

[2] R1-2001605 NR positioning UE features ZTE

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

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

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

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

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

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

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

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

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

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

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