3GPP TSG RAN WG2 Meeting #110-e R2-200xxxx

**Electronic meeting,** **1st – 12th June 2020**

**Agenda item:** 6.8.1

**Source:** Intel Corporation

**Title:** Report of offline discussion [608][POS] Positioning capabilities (Intel)

**Document for:**  Discussion and decision

# Introduction

This is the summary of below offline discussion:.

* [AT110-e][608][POS] Positioning capabilities (Intel)

 Scope: Discuss and conclude on the agreeable UE capabilities for positioning in RRC and LPP, considering the common capability email discussion as well as capability-related inputs to the positioning session

 Intended outcome: Agreeable TPs to 38.306 (in R2-2005884), 38.331 (in R2-2005885), and 37.355 (in R2-2005886)

 Deadline: Comments Tuesday 2020-06-09 1000 UTC; output Wednesday 2020-06-10 1000 UTC [note: subject to adjustment based on the general capability discussion]

Rapporteur would suggest to resolve open issues first and then check CRs, and therefore setup an early deadline for open issues:

Open issues deadline for companies' feedback: Monday 2020-06-08 10:00 UTC

# Discussion

Before the meeting, the POS capabilities have been discussed under the email discussion [963]. Rapporteur would like to check companies’ view on the proposals from email discussion [963] in [8].

**Proposal 14:** to confirm, current LPP specification has covered the E-CID capabilities indicated in RAN1 table.

**Proposal 15:** to confirm, define common DL PRS processing capability for 13.1 and it is indicated under per positioning method capability reporting.

**Proposal 16:** to ~~discuss, whether~~ confirm, QCL capabilities should be put ~~as common capability or put~~ under each positioning method.

**Proposal 17:** define 13-2, 13-3 and 13-4 as positioning specific method, i.e. 13-2 for AoD, 13-3 for TDOA, 13-4 for Multi-RTT.

**Proposal 18:** define 13-5, 13-6 and 13-11 as positioning specific method, i.e. 13-5 for AoD, 13-6 for TDOA, 13-11 for Multi-RTT.

**Proposal 20:** group capabilities for SRS resources (13.8, 13. 8a, 13.8b), OLPC (13.9, 13.9a....) and spatial relation (13.10, 13.10a...) separately, i.e. separate SRS resources capability, OLPC SRS capability and spatial relation SRS capability.

**Proposal 21:** Add part 1 SRS resources capabilities and part 3 spatial relation capabilities in LPP. Whether to report full set or simplified capability for part 1 and part 3 can be further discussed.

**Question 1**: Do companies agree the proposals from email discussion summary as above? If not, pls indicate the proposal number and express your reason.

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Company’s comments, if any** |
| Huawei, HiSilicon | No | Proposal14:We have discussion in Question 2.1-1 whether the capability bits will be 2 bits or 4 bits. If this issue in Question 2.1-1 is still pending, we think proposal14 does not make much senseProposal15: We have proposed the following organization of the FGs in the email discussion:13.1, 13.7 and 13.7a can be grouped under common capability. Furthermore, 13.2, 13.3, 13.4, 13.5, 13.6, 13.11 can be put under each positioning method capability reporting.We think more than one companies have the same understanding and maybe we still can have a further discussion on this. Proposal16: Given that the capability is already defined per band, we don’t see the reason why different positioning methods should have different QCL processing capabilityProposal17 and proposal 18:According to the update in RAN1 in this meeting, separate capabilities are defined for 13-2, 13-3 and 13-4 with 13-2(a)(b), 13-3(a)(b), and 13-4 (a)(b)separate capability defined as 13-11(a)Proposal20:We don’ think it is suitable to group 13.8a and 13.8b with 13.8 because it would be more convenient to indicate no support for aperiodic and semi-persistent SRS. According to the latest RAN1 agreement, we have 13.9f, which is reported per UE, not per band. RAN1 has also agreed that 13-10f is per UE, hence cannot be grouped. Proposal21:Update in RAN1 in this meeting is that part 1 is not needed in LPP.C:\Users\y00397895\AppData\Roaming\eSpace_Desktop\UserData\y00397895\imagefiles\2969B696-812B-463C-9538-3E6753C29F01.png The previous note was Need for location server to know if the feature is supported. |
| Qualcomm | Yes |  |
| Intel | Yes | Although RAN1 updated their feature group little bit, but we can still follow the principle, i.e. capabilities are put under each positioning methods. P21, RAN1 is still discussing whether part 1 is needed or not in LPP in their email discussion. In addition, RAN1 have agreed, part 2/3 shall be known by LMF.  |
| CATT | Yes |  |
| Nokia | No | Proposal 15: Not OK. Depending on support of a specific positioning method, 13-1 shall be mandatory e.g. if UE is DL-TDOA capable then the UE shall also be DL PRS processing capable. The same is true for DL AoD and Multi-RTT.Proposal 16: Not OK. Depending on support of a specific positioning method, one of 13-7 or 13-7a shall be mandatory and the other one optional e.g. if UE is DL-TDOA capable then the UE shall also be capable of using SSB from neighbour cell as QCL source of a DL PRS. The same is true for DL AoD and Multi-RTT. Alternatively, both 13-7 and 13-7a can be optional but UE shall support one of them.Proposal 18: Not OK. Depending on support of a specific positioning method, the corresponding measurement reporting capability shall be mandatory e.g. if UE is DL-TDOA capable then the UE shall also be capable of 13-6 DL PRS RSTD/[RSRP] Measurement Report for DL-TDOA. The same is true for DL AoD and Multi-RTT i.e. if UE is DL AoD capable it shall also support 13-5 DL PRS Measurement Report for DL-AoD. If UE is Multi-RTT capable it shall also support 13-11 UE Rx-Tx Measurement Report for Multi-RTT.Proposal 20: 13-8a and 13-8b must be optional capability. One of {13-9a, 13-9b, 13-9c, 13-9d, 13-9e} must be mandatory for UE if UE supports 13-9. One of {13-10a, 13-10b, 13-10c, 13-10d, 13-10e, 13-10f} must be mandatory for UE if UE supports 13-10. 13-8 shall be mandatory if UE supports any of the UL positioning methods.Proposal 21: If LMF knows the UE is UL TDOA or UL AoA or Multi-RTT capable, then it is enough for LMF to know whether the UE is capable of 13-8, 13-8a, 13-8b, 13-9 and 13-10. No need for others to be reported to LMF. |

Based on companies’ input in the email discussion, following issues should be further discussed.

## ECID

|  |  |  |  |
| --- | --- | --- | --- |
| 13. NR Positioning | [13-12] | [NR E-CID DL SSB RRM measurements with LPP support for NR Positioning] | 1. [NR E-CID DL SSB RRM measurements with LPP support for NR Positioning]
 |
| 13. NR Positioning | [13-12a] | [NR E-CID DL CSI-RS RRM measurements with LPP support for NR Positioning] | 1. [NR E-CID DL CSI-RS RRM measurements with LPP support for NR Positioning]
 |

During the email discussion, some comments are received:

* Should rsrp and rsrp report to be separate capabilities, i.e. two bits as in existing LPP specification, or 1 bit to indicate both rsrp and rsrp?
* Whether to clarify in the field description, ss\*Sup includes also support for ResultsPerSSB-Index, and csi\*Sup includes also support for ResultsPerCSI-Index.

**Question 2.1-1**: Should rsrp and rsrp report to be separate capabilities, i.e. two bits as in existing LPP specification, or 1 bit to indicate both rsrp and rsrp?

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **2bits (same as current LPP) or 1 bit** | **Company’s comments, if any** |
| Huawei, HiSilicon | 1 bit | The basic principle in RAN1 FG design is that each FG only requires one capability bit to indicate and if two capability bits are needed, the two bits will correspond to two FGs.  |
| Qualcomm | 2bits | Typically, we have quite fine granularity of capabilities in LPP, since all positioning features are in general optional. |
| Intel | 2bits | * Same as Qualcomm.
 |
| CATT | 2bits | 2 bits should be used, i.e. 1 bit for each case. |
| Huawei/HiSilicon (update) | 1 bit | According to RAN1 LS R1-2005096, single bit per FG is concluded. This FG also has single component, why would RAN2 decide to have two capability bits for an FG with single component?

|  |  |  |  |
| --- | --- | --- | --- |
| 13. NR Positioning | 13-12 | NR E-CID DL SSB RRM measurements with LPP support for NR Positioning | 1. NR E-CID DL SSB RRM measurements with LPP support for NR Positioning
 |
| 13. NR Positioning | 13-12a | NR E-CID DL CSI-RS RRM measurements with LPP support for NR Positioning | 1. NR E-CID DL CSI-RS RRM measurements with LPP support for NR Positioning
 |

Does it mean that UE can support only RSRP report, but not RSRQ? We do not think such a UE exist. Also note from measurement request perspective, LMF may only request RSRP measurement, but it should not mean that UE should report separate capability bits for RSRP and RSRQ. |

**Question 2.1-2**: Whether to clarify in the field description, ss\*Sup includes also support for ResultsPerSSB-Index, and csi\*Sup includes also support for ResultsPerCSI-Index.?

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Yes/No?** | **Company’s comments, if any** |
| Huawei, HiSilicon | Y | OK to add, anyway there is only one capability bit  |
| Qualcomm | N (slightly) | An additional capability to indicate whether per-beam results are supported or not would be preferred (e.g., FR1 only UEs).  |
| Intel | N | * It is not indicated in RAN1 table, and would prefer not introduce additional capability on that.
 |
| CATT |  | We have no strong opinion. |
| Nokia | Y | If I remember right, our ASN.1 signalling has this per index reporting as optional. So, some clarification is good. |
| Huawei, HiSilicon [Update]  | Y | In response to QC: There is no such capability for RRM.In response to Intel: We are not introducing new capability signalling, we are saying the existing capability signalling should include both cell-specific and beam specific measurement report support. The intention is to clarify on the component to the FG. We should also stick to the principle to follow RAN1 table when it comes to Question 2.1-1. |

## DL AoD, DL TDOA, Multi RTT

**Proposal 19:** Continue the discussion on whether 13.5a, 13.6a and 13.11a are covered by 13.2, 13.3 and 13.4.

RAN4 agreed not to differentiate intra/inter-frequency measurements and such definitions will not be introduced for Positioning. RAN1 capability for intra/inter-frequency measurement may no longer be needed.

|  |
| --- |
| Do not define intra/inter-frequency definition for PRS-RSTDNote: Accuracy may be different depending whether the measurements are done on the same positioning frequency layer or not.Do not define intra/inter-frequency definition for PRS-RSRP Note: Classification of accuracy requirements is FFS (e.g. whether to define different accuracy for measurements on different frequencies)Do not define intra/inter-frequency definition for UE Rx-Tx timing differenceNote: Classification of accuracy requirements is FFS (e.g. whether to define different accuracy for measurements on different frequencies)Then Rapporteur would suggest to capture 13.5a, 13.6a and 13.11a for now.  |

**Question 2.2-1**: 13.5a, 13.6a and 13.11a on interFreq measurement are not needed.

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Company’s comments, if any** |
| Huawei, HiSIlicon | No | RAN1 only agreed to remove 13.5a, 13.6a. But has agreed to keep 13.11a with a new name |
| Qualcomm | No | Same understanding as Huawei |
| Intel |  | * RAN1 have agreed to remove interfreq capability since RAN4 decided no such concept. The only part 13.11a is for DL PRS/UL SRS in different frequency which is the new concept. So We just need to update based on RAN1 table.
 |
| CATT |  | We share the same view as Intel. |
| Nokia |  | Align with RAN1 decisions. |

In [5], PRS capabilities are also captured in RRC CR as per FS as below

FeatureSetDownlink-v16xy ::= SEQUENCE {

 supportedPRS-Processing-r16 PRS-ProcessingCapability-r16 OPTIONAL,

 supportedPRS-Multi-RTT-r16 PRS-Multi-RTT-Capability-r16 OPTIONAL

}

PRS-ProcessingCapability-r16 ::= SEQUENCE {

 supportedBandwidthPRS-r16 SupportedBandwidth

 dl-PRS-BufferCapability ENUMERATED {type1, type2}

 durationOfPRS-Processing-r16 SEQUENCE {

 durationOfPRS-ProcessingSysmbols-r16 ENUMERATED {nDot125, nDot25, nDot5, n1, n2, n4, n8, n12, n16, n20, n25, n30, n35, n40, n45, n50}

 durationOfPRS-ProcessingSymbolsInEveryTms-r16 ENUMERATED {n8, n16, n20, n30, n40, n80, n160, n320, n640, n1280}

 }

 maxNumOfDL-PRS-ResProcessedPerSlotFR1-r16 ENUMERATED {n1, n2, n4, n8, n16, n32, n64},

 maxNumOfDL-PRS-ResProcessedPerSlotFR2-r16 ENUMERATED {n1, n2, n4, n8, n16, n32, n64}

}

PRS-Multi-RTT-Capability-r16 ::= SEQUENCE {

 maxNrOfDL-PRS-ResourceSetPerTrpPerFrequencyLayer-r16 INTEGER (1..2),

 maxNrOfDL-PRS-ResourcesPerResourceSet-r16 ENUMERATED {n1, n2, n4, n8, n16, n32, n64},

 maxNrOfDL-PRS-ResourcesAcrossAllFL-TRP-ResourceSet-r16 ENUMERATED {n64, n128, n192, n256, n512, n1024, n2048},

 maxNrOfPositioningFrequencyLayers-r16 ENUMERATED {[3], [6], [12], [16], 24, 32, 64, 128, 256},

 maxNrOfDL-PRS-ResourcesPerPositioningFrequencylayer-r16 ENUMERATED {n1, n2, n3, n4}

}

**Question 2.2-2**: should PRS common processing capability 13.1 and PRS multi-RTT capability 13.4 be captured in RRC?

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Company’s comments, if any** |
| Huawei, HiSilicon | No | RAN1 has agreed that gNB does not need to know about this.  |
| Qualcomm | No | In general, we do not see the need to overload RRC with any positioning capabilities.  |
| Intel | No | * Same understanding as Huawei on RAN1 agreements.
 |
| CATT | No | Agree with RAN1 agreements. |
| Nokia | No |  |

**Question 2.2-3**: should per frequency PRS capability be captured as per FS, per band in LPP? , e.g. RAN1 indicated 13.1 to be per band except component 3 (per UE)

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Per band/per FS** | **Company’s comments, if any** |
| Huawei, HiSilicon | per Band | This is clear from RAN1 agreement in this meeting.  |
| Qualcomm | Per band | Not clear what FS means in the context of positioning/LPP. Each Provide Capabilities message is a FS per se.  |
| Intel |  | * We just need to follow RAN1 table, so far some are per UE, some are per Band, and some are per BC.
 |
| CATT |  | Agree to follow RAN1 agreements. |
| Nokia |  | Align with RAN1 decisions. |

## SRS capabilities

In [5], SRS is captured under FS as

FeatureSetUplink-v16xy ::= SEQUENCE {

 supportedSRS-PosResources-r16 SRS-PosResources-r16 OPTIONAL,

}

SRS-PosResources-r16 ::= SEQUENCE {

 maxNumberAperiodicSRS-PerBWP-r16 ENUMERATED {n1, n2, n4, n8, n16, n32, n64},

 maxNumberAperiodicSRS-PerBWP-PerSlot-r16 ENUMERATED (n1, n2, n3, n4, n5, n6, n8, n10, n12, n14),

 maxNumberPeriodicSRS-PerBWP-r16 ENUMERATED {n1, n2, n4, n8, n16},

 maxNumberPeriodicSRS-PerBWP-PerSlot-r16 INTEGER (1..6),

 maxNumberSemiPersistentSRS-PerBWP-r16 ENUMERATED {n1, n2, n4, n8, n16},

 maxNumberSemiPersistentSRS-PerBWP-PerSlot-r16 INTEGER (1..6),

 maxNumberSRS-Ports-PerResource-r16 ENUMERATED {n1, n2, n4}

}

OLPC and spatialRelation are missing.

**Question 2.3-1**: Do companies agree that:

**SRS is captured under FS**;

**spatialRelation is captured under** MIMO-ParametersPerBand;

**OLPC is captured under** RF-Parameters /BandNR

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Yes/No?** | **Company’s comments, if any** |
| Huawei, HiSilicon | No | Spatial relation capability and OLPC both have perUE capability. Hence, for the per UE capability, they cannot all be put under MIMIO-ParametersPerBand and RFPrametersBandNR, respectively. |
| Qualcomm | No | These are all positioning capabilities. Not clear why this has to be defined as a FS in RRC. In particular, what is the relation to MIMO. |
| Intel |  | * So far spartialReltion in rel15 was put under MIMO.
* I agree, per UE capabilities cannot be put under as per band/per BC.
 |
| CATT | No | Agree with above that perUE capability should not be put in per band/per BC. |
| Nokia |  | I would assume that gNB needs to know the UE spatial relation capability if it is to be configured by gNB/RRC but exactly how to organize the capability can be revisited if the proposed placement above is not OK. Note that LMF may need to know the spatial relation capability of UE if it were to provide recommendations to gNB. |

**Proposal 21:** Add part 1 SRS resources capabilities and part 3 spatial relation capabilities in LPP. Whether to report full set or simplified capability for part 1 and part 3 can be further discussed.

**Option 1: Full lists of part 1 and part 3;**

**Option 2: [6] proposed:**

UE may send a simplified capability to LMF to understand which sort of measurements UE supports and whether UE supports aperiodic or semi-persistent SRS configurations, e.g.

multi-RTT-measurementSupport ENUMERATED {supported},

aperiodicSRS-Support ENUMERATED {supported},

aperiodicSRS-NeighborCellSupport ENUMERATED {supported},

semi-persistentSRSSupport ENUMERATED {supported},

**Option 3: [7] proposed:**

**If reporting of SRS capability from UE to LMF is indeed necessary, we suggest only to introduce the following FGs, reported by single bit per FG with the reporting granularity of per band or per UE.**

* **FG13-x1: Support of SP positioning SRS (Support at least one SP SRS resource)**
* **FG13-x2: Support of spatial relation of SSB from a non-serving cell for positioning SRS**
* **FG13-x3: Support of spatial relation of DL PRS from a non-serving cell for positioning SRS**

**Question 2.3-2**: what UL capabilities should the UE report to the LMF? Option 1,2 or 3?

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Option 1/2/3** | **Company’s comments, if any** |
| Huawei, HiSilicon | Reduced Option3 | RAN1 has agreed not to report part1. Hence, we only need FG13-x2 and x3 in option3.  |
| Qualcomm | Yes, but not limited to these Options. | In general, all positioning capabilities should be in LPP (and NRPPa, when needed at gNB). It is not quite clear why RRC need to be overloaded with features which are not relevant for system operation.  |
| Intel |  | * We just follow RAN1, part 2/3 in LPP. FFS on part 1.
 |
| Nokia |  | It is enough if LMF knows certain high-level SRS related capabilities of the UE. Proposal 21: If LMF knows the UE is UL TDOA or UL AoA or Multi-RTT capable, then it is enough for LMF to know whether the UE is capable of 13-8, 13-8a, 13-8b, 13-9 and 13-10. No need for others to be reported to LMF. |

[7] also proposed, the UL capabilities should be put in both NR-UL-ProvideCapabilities and NR-Multi-RTT-ProvideCapabilities.

**Question 2.3-3**: Do companies agree that UL capabilities should be put in both NR-UL-ProvideCapabilities and NR-Multi-RTT-ProvideCapabilities?

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Company’s comments, if any** |
| Huawei, HiSilicon | Yes |  |
| Qualcomm | Yes |  |
| Intel | Yes |  |
| CATT | Yes |  |
| Nokia | Yes |  |

Qualcomm raised comments on whether UL capabilities should be contained in LPP instead of RRC. Rapporteur added the question here.

RAN1 have agreed UL capabilities shall be known by the gNB. And then there are two ways to achieve this:

Option 1: UE reports UL capabilities to the gNB, regardless whether the UL positioning is triggered or not;

Option 2: UE reports UL capabilities to the LMF and the LMF will forward them to gNB if UL positioning is requested.

**Question 2.3-4**: Should UL capabilities only be captured in LPP and the LMF forwards them to the gNB when needed?

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Option 1 or Option 2** | **Company’s comments, if any** |
| Intel | Slightly prefer option 1 | Traditionally, the capabilities need to be known by the gNB and related to RRC configuration or measurements in gNB are captured in RRC. For instance, LTE rx-tx measurement is captured in RRC.  |
| Nokia | Option 1 | Align with RAN1 decision to always report UL capabilities to gNB but some UL capabilities to help with LMF to make recommendations for spatial relation can also be provided via LPP. But, we don’t like the option of LMF forwarding the UL capabilities to gNB (restrict the capability signalling to LPP or RRC and not use NRPPa for capability signalling). |
| Huawei, HiSilicon | Option 1 | Since SRS is directly configured by RRC, the SRS capability should at least be directly reported in RRC.Although it is for positioning purpose, it is in major a radio capability, and should be managed by RAN.* It is also aligned with RAN1 understanding when filling in the entries of “Need for gNB to know if the feature is supported” and “Need for location server to know if the feature is supported” in the UE feature list.
 |
| Qualcomm | Option 2 | I don’t see the need to overload RRC with capabilities which are needed only if an LMF has decided to use UL positioning. Also from a maintenance/clarity point of view it would be preferred to have all positioning capabilities defined at one place.The “Need for gNB/location server to know” does not imply a particular protocol/architecture, which appears not in RAN1’s realm anyhow. However, if these capabilities are useful for non-positioning purposes, signalling them in RRC may be needed (but I can’t infer this from the list of capabilities). |

# Report summary

*<If needed, to be updated when doing the summary>*

# References

1. R1-2003072 R1-2003072 LS on Rel-16 RAN1 UE features lists for NR
2. R1-2003073 R1-2003073 Rel16\_RAN1\_UE features NR\_afterR1#100bisE.
3. R4-2005192 R4-2005192 LS on Rel-16 RAN4 UE features lists for LTE and NR\_v1-clean
4. R4-2005193 R4-2005193 Rel-16 RAN4 UE feature list
5. R2-2004635 Introduction of UE capability for Positioning Ericsson
6. R2-2005305 UL SRS UE Capability Ericsson
7. R2-2005109 Discussion on the SRS UE capability in LPP Huawei, HiSilicon
8. R2-2005311 Report of email discussion [Post109bis-e][963][NR16] UE capabilities Intel Corporation, NTT DoCoMo
9. R2-2005313 (TS38.331) Release-16 UE capabilities for RAN1 and RAN4 feature list Intel Corporation, NTT DoCoMo
10. R2-2005314 (TS38.306) Release-16 UE capabilities for RAN1 and RAN4 feature list Intel Corporation, NTT DoCoMo
11. R2-2005315 (TS37.355) Introduction of Release-16 UE positioning capabilities Intel Corporation, NTT DoCoMo

# Annex (copied from [8], the report of email discussion 963)

## Positioning Capabilities

### NR ECID

|  |  |  |  |
| --- | --- | --- | --- |
| 13. NR Positioning | [13-12] | [NR E-CID DL SSB RRM measurements with LPP support for NR Positioning] | 1. [NR E-CID DL SSB RRM measurements with LPP support for NR Positioning]
 |
| 13. NR Positioning | [13-12a] | [NR E-CID DL CSI-RS RRM measurements with LPP support for NR Positioning] | 1. [NR E-CID DL CSI-RS RRM measurements with LPP support for NR Positioning]
 |

In current TS37.355, RAN2 has introduced all of them as below, and no new capability is needed.

 nr-ECID-MeasSupported -r16 BIT STRING { ssrsrpSup (0),

 ssrsrqSup (1),

 csirsrpSup (2),

 csirsrqSup (3) (SIZE(1..8)),

**Proposal for discussion**: NR E-CID capability in RAN1 table has been covered in LPP specification, no change is needed.

Companies are requested to provide their view on the proposal.

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Agree/Disagree** | **Company’s comments, if any** |
| OPPO | agree |  |
| vivo | agree |  |
| ZTE | Disagree | No need to introduce this capability.* As RRM measurement information including RRM based on SSB and CSI-RS is reported from UE to gNB, and gNB can transfer it to LMF, it is unnecessary to redundantly support capability signaling from UE to LMF.
* RRM measurement is basic UE feature for UE, it’s not necessary to report in LPP.
* [Rap] this is requested by LMF directly without gNB involvement. If the capabilities are not visible to the LMF, only UL E-CID can be supported.
* In recent RAN1 UE feature discussion, the above UE features are supported. We accept the proposal.
 |
| Samsung | agree | No need further consideration |
| CATT | Agree |  |
| Huawei, HiSilicon | Disagree | rsrp and rsrq report support only need one bit. The definition of the feature group is obvious for this. The bitstring only need two bits instead of four bits.  |
| MediaTek | Agree |  |
| Ericsson | Agree with comments | Yes, this RAN2 can resolve. The remaining part:The capability description should also include that ss\*Sup includes also support for ResultsPerSSB-Index, and csi\*Sup includes also support for ResultsPerCSI-Index. Otherwise, these needs to be separate capabilities, but that should not be necessary |
| Apple | Agree |  |
|  |  |  |

#### Summary and proposals

5 companies agree that we do not need change existing LPP specification to capture ECID capabilities. 1 company comment that we only need 1 bit for SSB based measurement and 1 bit for CSI-RS based measurement, and do not need to distinguish RSRP/RSRQ.

1 company comment that LMF does not need to know the capability.

Based on the above, the rapporteur proposes the below:

**Proposal 14:** to confirm, current LPP specification has covered the E-CID capabilities indicated in RAN1 table.

### DL AoD, DL TDOA, Multi RTT

Based on the features listed in RAN1 table, for DL AoD, DL TDOA, Multi RTT, there are three parts of capabilities:

* PRS resources capability (13.1 Common DL PRS Processing Capability and positioning method specific PRS resources capability 13.2, 13.3, 13.4), QCL capabilities (13.7, 13.7a) and measurement reports capability (13.5, 13.6, 13.11).

**Proposal for discussion:** In LPP, define common DL PRS processing capability for 13.1 and can be indicated under per positioning method capability reporting, e.g. NR-DL-TDOA-ProvideCapabilities

Companies are requested to provide their view on the proposal.

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Agree/Disagree** | **Company’s comments, if any** |
| OPPO | Agree |  |
| vivo | Agree |  |
| ZTE | Disagree | As we have already agreed following UE features for concurrent methods, * 13-13 Simultaneous DL-AoD and DL-TDoA processing
* 13-14 Simultaneous DL-AoD and Multi-RTT processing

So the DL PRS processing capability should be method common rather method specific.It’s too early to have the summary, we don’t see the strong view to put 13.1 under per positioning method capability. |
| Samsung  | Disagree | if multiple different positioning methods are used at the same time, and this common part can be used commonly for those methods, then there needs to be the way to omit the repeated one. So prefer to define common DL PRS capability not under each positioning method capability reporting. Same view with ZTE |
| CATT | Agree | We can capture UE capabilities per positioning method so far. |
| Huawei, HiSilicon | Agree | 13.1, 13.7 and 13.7a can be grouped under common capability. Furthermore, 13.2, 13.3, 13.4, 13.5, 13.6, 13.11 can be put under each positioning method capability reporting.  |
| MediaTek | Agree |  |
| Ericsson | Disagree/clarification needed | Seems most appropriate to have a common DL-PRS capability, and indicate what is supported there, and not per positioning method for these common parts. Common is common across positioning methodFor LTE there is a capability if the UE supports additionalNeighbourCellInfoList, meaning that the save NRARFCN can be set for multiple frequency layers, extending the number of TRPs the UE can handle for a frequency layer beyond 64. Also in NR?Also, in LTE, there is a capability for motionMeasurements. Common or per positioning method?  |
| Apple | Agree |  |
|  |  |  |

#### Summary and proposals

5 companies agree to define common DL PRS processing capability for 13.1 and can be indicated under per positioning method capability reporting.

2 companies would like to put common DL PRS processing capability for 13.1 as common capability and not put under each positioning method.

Based on the above, the rapporteur proposes the below:

**Proposal 15:** to confirm, define common DL PRS processing capability for 13.1 and it is indicated under per positioning method capability reporting.

**Proposal for discussion:** In LPP, define QCL capability for 13.7, 13.7a and can be indicated under per positioning method capability reporting, e.g. NR-DL-TDOA-ProvideCapabilities

Companies are requested to provide their view on the proposal.

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Agree/Disagree** | **Company’s comments, if any** |
| OPPO |  | Not sure since RAN1 has not decide on this one |
| vivo | Agree |  |
| ZTE | Disagree | QCL capability is is irrelevant to what kind of method. |
| Samsung  | agree |  |
| CATT | Agree | QCL capabilities can help select proper positioning method and TRPs. |
| Huawei, HiSilicon | Disagree | Can be put under common capability. |
| MediaTek | Agree |  |
| Ericsson | Agree | These multi-option capabilities would be best represented by a BIT STRING with a bit per support, see nr-ECID-MeasSupported above |
| Apple | Agree |  |
|  |  |  |

#### Summary and proposals

4 companies agree to indicate QCL capabilities under per positioning method.

2 companies think it is irrelevant to positioning method and therefore QCL capability should be put as common capability and not put under each positioning method.

Based on the above, the rapporteur proposes the below:

**Proposal 16:** to discuss, whether QCL capabilities should be put as common capability or put under each positioning method.

**Proposal for discussion:** In LPP, define separate capabilities for positioning method specific DL PRS capability for 13.2, 13,3 and 13.4

Companies are requested to provide their view on the proposal.

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Agree/Disagree** | **Company’s comments, if any** |
| OPPO | agree | 13-2 DL PRS Resources for DL AoD => this is only for AoD13-3 DL PRS Resources for DL-TDOA => this is only for TDOA13-4 DL PRS Resources for Multi-RTT => this is only for multi-RTT  |
| vivo | Agree |  |
| ZTE | Agree | Different methods may have different requirements of DL PRS capability (e.g. DL AOD only work for high frequency) |
| Samsung  | agree | Different methods can have different DL PRS processing requirement for each method. |
| CATT | Agree | We can capture UE capabilities per positioning method so far. |
| Huawei, HiSilicon | Agree | See the above response.  |
| MediaTek | Agree |  |
| Ericsson | Agree | Since RAN1 has separated these per positioning method, then RAN2 needs to introduce per positioning method capabilities |
| Apple | Agree |  |
|  |  |  |

#### Summary and proposals

All companies agree to define 13-2, 13-3 and 13-4 as positioning specific method, i.e. 13-2 for AoD, 13-3 for TDOA, 13-4 for Multi-RTT.

Based on the above, the rapporteur proposes the below:

**Proposal 17:** define 13-2, 13-3 and 13-4 as positioning specific method, i.e. 13-2 for AoD, 13-3 for TDOA, 13-4 for Multi-RTT.

**Proposal for discussion:** In LPP, define separate capabilities for positioning method specific Measurement Report capability for 13.5, 13,6 and 13.11

Companies are requested to provide their view on the proposal.

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Agree/Disagree** | **Company’s comments, if any** |
| OPPO | Agree | 13-5 DL PRS Measurement Report for DL-AoD => this is only for AoD[13-6] [DL PRS RSTD/[RSRP] Measurement Report for DL-TDOA] => this is only for TDOA[13-11] [UE Rx-Tx Measurement Report for Multi-RTT] => this is only for multi-RTT |
| vivo | Agree |  |
| ZTE | Agree | Measurement report capability should be method specific. |
| Samsung  | Agree  | Obviously measurement report should be method specific |
| CATT | Agree |  |
| Huawei, HiSilicon | Agree | See the above response.  |
| MediaTek | Agree |  |
| Ericsson  | Agree |  |
| Apple | Agree |  |
|  |  |  |

#### Summary and proposals

All companies agree to define 13-5, 13-6 and 13-11 as positioning specific method, i.e. 13-5 for AoD, 13-6 for TDOA, 13-11 for Multi-RTT.

Based on the above, the rapporteur proposes the below:

**Proposal 18:** define 13-5, 13-6 and 13-11 as positioning specific method, i.e. 13-5 for AoD, 13-6 for TDOA, 13-11 for Multi-RTT.

13.5a, 13.6a and 13.11a, Support of inter-frequency measurement, can be covered by the number of positioning layer UE supports in 13.2, 13.3 and 13. 4.

**Proposal for discussion:** 13.5a, 13.6a and 13.11a are not needed since they are covered by 13.2, 13.3 and 13.4.

Companies are requested to provide their view on the proposal.

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Agree/Disagree** | **Company’s comments, if any** |
| OPPO | agree | 13-5a Inter-frequency measurement for DL-AoD => this is only for AoD13-6a Inter-frequency measurement for DL-TDOA => this is only for TDOA13-11a Inter-frequency measurement for Multi-RTT=> this is only for multi-RTT |
| vivo | Agree |  |
| ZTE | Disagree | * We should wait RAN4 for the definition of inter-frequency measurement.
* From our understanding, two capabilities are different. Take DL TDOA for example, the number of positioning frequency layer only means DL PRS can be transmitted from more than one positioning frequency layer, inter-frequency measurement may refer to the reference TRP (DL PRS) and neighbor TRP (DL PRS) are transmitted in different positioning frequency layer.
 |
| Samsung  | Agree  |  |
| CATT | Agree |  |
| Huawei, HiSilicon | Disagree | The definition of inter-frequency measurement is still unclear. WE may need to wait for RAN4 progress on the definition of inter/intra-frequency measurement. The measurements on multiple positioning frequency layers can all be intra-frequency measurement.  |
| MediaTek | Agree |  |
| Ericsson | Disagree | Inter-frequency support is not satisfactory indicated by 13.2-13.4, which can be defining frequency layers separated from the frequency band the UE is currently served by. A UE indicating support for only one frequency layer can also support inter-frequency measurements. Hence, 13.5a, 13.6a and 13.11a are all needed like in LTE |
| Apple | Disagree | Wait for RAN4 progress first. |
|  |  |  |

#### Summary and proposals

4 companies agree to 13-5a, 13-6a and 13-11a are not needed since they are covered by 13.2, 13.3 and 13.4.

3 companies would like to wait for RAN4 inputs since it is related to the definition of inter frequency measurement, e.g. whether measurement on multiple positioning frequency layers are also considered as intra frequency measurement.

Based on the above, the rapporteur proposes the below:

**Proposal 19:** Continue the discussion on whether 13.5a, 13.6a and 13.11a are covered by 13.2, 13.3 and 13.4.

### SRS capabilities

As indicated in RAN2 list, SRS capabilities are split into

|  |  |
| --- | --- |
| 13-8 | SRS Resources for Positioning |
| 13-8a | Support of Aperiodic SRS Resources for positioning |
| 13-8b | Support of Semi-persistent SRS Resources for positioning |
| 13-9 | OLPC for SRS for positioning based on PRS from the serving cell |
| 13-9a | OLPC for SRS for positioning based on SSB from neighbouring cells |
| 13-9b | OLPC for SRS for positioning based on PRS from the neighbouring cells |
| 13-9c | OLPC for SRS for positioning based on CSI-RS from serving cell |
| [13-9d] | [OLPC for SRS for positioning based on SSB from serving cell] |
| [13-9e] | [PathLoss estimate maintenance] |
| 13-10 | Spatial relation for SRS for positioning based on SSB from the serving cell |
| 13-10a | Spatial relation for SRS for positioning based on CSI-RS from the serving cell |
| 13-10b | Spatial relation for SRS for positioning based on PRS from the serving cell |
| 13-10c | Spatial relation for SRS for positioning based on SRS |
| 13-10d | Spatial relation for SRS for positioning based on SSB from the neighbouring cell |
| 13-10e | Spatial relation for SRS for positioning based on PRS from the neighbouring cell |
| [13-10f] | [Spatial relation maintenance] |

**Proposal for discussion:** In RRC, group capabilies for SRS resources (13.8, 13. 8a, 13.8b), OLPC (13.9, 13.9a....) and spatial relation (13.10, 13.10a...) separately, i.e. separate SRS resources capability, OLPC SRS capability and spatial relation SRS capability.

Companies are requested to provide their view on the proposal.

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Agree/Disagree** | **Company’s comments, if any** |
| OPPO | agree |  |
| vivo | Agree |  |
| ZTE | Agree |  |
| Samsung  | Agree  |  |
| CATT | Agree |  |
| Huawei, HiSilicon | Disagree | Not clear how the grouping can be done. Not possible to put the current feature group under one feature group. So in our understanding, it would be good to first clarify the “group capabilities”, and whether there is any relationship/dependence between SRS resources, OLPC and spatial relation capability. |
| MediaTek | Agree |  |
| Apple | Agree |  |
| Ericsson | Agree | However, final decision should be made after ASN.1 review on how it appears. If it is possible to combine or split further can be checked there.Example ASN.1 reference for SRS-Resource Capability is provided here.FeatureSetUplink-v16xy ::= SEQUENCE { supportedSRS-PosResources-r16 SRS-PosResources-r16 OPTIONAL,}SRS-PosResources-r16 ::= SEQUENCE { maxNumberAperiodicSRS-PerBWP-r16 ENUMERATED {n1, n2, n4, n8, n16, n32, n64}, maxNumberAperiodicSRS-PerBWP-PerSlot-r16 ENUMERATED (n1, n2, n3, n4, n5, n6, n8, n10, n12, n14), maxNumberPeriodicSRS-PerBWP-r16 ENUMERATED {n1, n2, n4, n8, n16}, maxNumberPeriodicSRS-PerBWP-PerSlot-r16 INTEGER (1..6), maxNumberSemiPersistentSRS-PerBWP-r16 ENUMERATED {n1, n2, n4, n8, n16}, maxNumberSemiPersistentSRS-PerBWP-PerSlot-r16 INTEGER (1..6), maxNumberSRS-Ports-PerResource-r16 ENUMERATED {n1, n2, n4}} |

#### Summary and proposals

5 companies agree to , group capabilities for SRS resources (13.8, 13. 8a, 13.8b), OLPC (13.9, 13.9a....) and spatial relation (13.10, 13.10a...) separately, i.e. separate SRS resources capability, OLPC SRS capability and spatial relation SRS capability.

1 company wonder whether there is any relationship/dependence between SRS resources, OLPC and spatial relation capability.

Based on the above, the rapporteur proposes the below:

**Proposal 20:** group capabilities for SRS resources (13.8, 13. 8a, 13.8b), OLPC (13.9, 13.9a....) and spatial relation (13.10, 13.10a...) separately, i.e. separate SRS resources capability, OLPC SRS capability and spatial relation SRS capability.

One question is still open in LPP discussion, i.e. whether SRS capabilities are needed in LPP. To our understanding, it can help the LMF to know what level of resources the UE can support for UL related positioning methods, and can make proper decision accordingly.

Proposal for discussion, what SRS capabilities are needed for LMF:

* + Part 1: SRS resources capabilities (13.8, 13. 8a, 13.8b); and/or?
	+ Part 2: OLPC capabilities (13.9, 13.9a....); and/or
	+ Part 3: spatial relation capabilities (13.10, 13.10a...)
	+ Part 4: others?

Companies are requested to provide their view on twhat SRS capabilities are needed for LMF?

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Part 1, 2, 3, 4** | **Company’s comments, if any** |
| OPPO | 1, 3 | Since LMF can recommend the SRS resources and spatial relation, part-1 and part-3 needs to be known by LMF. |
| ZTE | Part 2 and Part 3 | RAN2 has agreed that spatial relation of SRS is recommended by the LMF and decided by the gNB. It is up to gNB implementation whether to follow the LMF recommendation. The gNB informs the LMF of its decision.Therefore, it’s better that LMF can have the OLPC capabilities and spatial relation capabilities from UE for better reception in gNB side. |
| Samsung  | Part 1, and 3, unclear for part 2 | Already RAN2 understanding on using SRS is that, LMF recommends and serving gNB will determine on which TRP, and resources will be used for measureing SRS. Therefore, the information preferred to be given to the LMF as much as possible since there is no critical harm due to final serving gNB’s decision.  |
| CATT | Part 1, Part 3 | Since LMF can recommend the SRS resources and spatial relation in UL positioning methods, part1 and 3 are required.  |
| Huawei, HiSilicon | / | This needs further discussion. Generally LMF does not need to know the AS capability, so we are not sure why SRS capabilities are needed for LMF. If companies think it is needed, we prefer to report a lite version of the SRS capability than that is reported to the gNB via RRC. More specifically. For part 1, we only need single bit to indicate the UE capability for SP positioning SRS; for part 3, we need two bits to indicate 13-10d and 10e for the spatial relation for SSB and DL-PRS for neighbouring cell, respectively. Part 2 is not needed |
| MediaTek | 1,3 | Same comment as OPPO.  |
| Apple | Part 1, Part 3 |  |
| Ericsson | Only a simplified capability is provided to LMF | As gNB needs to configure the SRS, thus it should know the UL SRS capability. If UE has to send the same capability info to LMF this will increase significant load in LPP. The signaling required would be per UE and would be required to be sent every time when UL related positioning method is to be used. It is better if a simplified UE capability requiring few bits is used such asmulti-RTT-measurementSupport ENUMERATED {supported},aperiodicSRS-Support ENUMERATED {supported},aperiodicSRS-NeighborCellSupport ENUMERATED {supported},semi-persistentSRSSupport ENUMERATED {supported}, As the final decision for SRS configuration (including spatial relations) are done by gNB; gNB can assess based upon LMF recommendations on configuration needed to fulfil Positioning QoS and for spatial relations.Thus, there is no need for the UE to send UE capability to both gNB and LMF. To simplify signalling, the existing mechanism for gNB to retrieve the capability from AMF can be used. UE may send a simplified capability to LMF to understand which sort of measurements UE supports and whether UE supports aperiodic or semi-persistent SRS configurations. |

#### Summary and proposals

Necessary SRS capability in LPP:

* + Part 1: SRS resources capabilities (13.8, 13. 8a, 13.8b); and/or?: 4 companies
	+ Part 2: OLPC capabilities (13.9, 13.9a....); and/or: 1 companies
	+ Part 3: spatial relation capabilities (13.10, 13.10a...): 5 companies
	+ Part 4: part 1, 1 bit on SP positioning, part 3 2 bits to indicate 13-10d and 10e for the spatial relation for SSB and DL-PRS for neighbouring cell: 1 company

Based on the above, the rapporteur proposes the below:

**Proposal 21:** Add part 1 SRS resources capabilities and part 3 spatial relation capabilities in LPP. Whether to report full set or simplified capability for part 1 and part 3 can be further discussed.