3GPP TSG-RAN WG2 #111-e *DRAFT* R2-2008261

Electronic Meeting, August 17 - 28, 2020

Agenda Item: 8.11.2

Source: Ericsson

Title: [AT111-e][612][POS] Assumptions for analysis of commercial use cases (Ericsson)

Document for: Discussion, Decision

# 1 Introduction

This document provides templates and eventually summaries for the following email discussion:

* [AT111-e][612][POS] Assumptions for analysis of commercial use cases (Ericsson)

Scope: Align understanding of the RAN2 scope and assumptions for accuracy, latency, and efficiency objectives for commercial use cases. Attempt to capture a summary of proposals to this meeting that can be discussed in RAN2 directly.

Intended outcome: Summary in R2-2008261

Deadline: Wednesday 2020-08-26 1200 UTC

The email discussion is based on the contributions [1]-[13] in agenda item 8.11.2 “Enhancements for commercial use cases”, which is related to the following study item [14] objective:

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| 1. Study enhancements and solutions necessary to support the high accuracy (horizontal and vertical), low latency, network efficiency (scalability, RS overhead, etc.), and device efficiency (power consumption, complexity, etc.) requirements for commercial uses cases (incl. general commercial use cases and specifically (I)IoT use cases as exemplified in section 3 above (Justification)):    1. Define additional scenarios (e.g. (I)IoT) based on TR 38.901 to evaluate the performance for the use cases (e.g. (I)IoT). [RAN1]    2. Evaluate the achievable positioning accuracy and latency with the Rel-16 positioning solutions in (I)IoT scenarios and identify any performance gaps. [RAN1]    3. Identify and evaluate positioning techniques, DL/UL positioning reference signals, signalling and procedures for improved accuracy, reduced latency, network efficiency, and device efficiency. Enhancements to Rel-16 positioning techniques, if they meet the requirements, will be prioritized, and new techniques will not be considered in this case. [RAN1, RAN2] |

**References**:

1. R2-2006672 Discussion on ehancements for commercial use cases, CATT
2. R2-2006578 Discussion on R17 positioning enhancement, Huawei, HiSilicon
3. R2-2006567 Discussion on potential positioning enhancement, vivo
4. R2-2006956 Enhancements for commercial use cases, Ericsson
5. R2-2007049 Discussion on positioning enhancements for commercial use cases, Spreadtrum Communications
6. R2-2007629 NR Positioning Enhancements, Qualcomm Incorporated
7. R2-2006750 Consideration on the support of low latency requirement, Intel Corporation
8. R2-2007587 End-to-end latency reduction for DL/UL positioning, InterDigital, Inc.
9. R2-2007128 On-demand PRS transmission and dynamic PRS resource allocation, Nokia, Nokia Shanghai Bell
10. R2-2007159 Discussion on on-demand DL-PRS, OPPO
11. R2-2007170 Discussion on PRS enhancements, Beijing Xiaomi Electronics
12. R2-2007157 Positioning for UE in RRC Idle and Inactive state, OPPO
13. R2-2007173 Positioning enhancements for RRC IDLE and RRC INACTIVE state UE, Beijing Xiaomi Electronics
14. RP-200928 Study on NR Positioning Enhancements

The contribution proposals have been categorized in the following main categories:

* DL/UL positioning reference signals
* Signaling and procedures
* Latency analysis
* Network and device efficiency

The corresponding contribution proposals are discussed per category in the sections. Please let the email Rapporteur know of any accidental oversights as part of the initial review phase.

# 2 DL/UL positioning reference signals

The proposals related to DL/UL positioning reference signals is strongly related to RAN1, and the corresponding discussions needs to be aligned. Therefore, companies are asked to provide comments regarding what can be discussed in RAN2 independent of RAN1 and what needs RAN1 alignment, in addition to general comments.

## 2.1 Rel 15 reference signals

The use of Rel 15 reference signals for positioning purposes was evaluated in the Rel 16 study phase. These include Rel 15 SRS [2] and SSB/CSI-RS/CSI-RS for tracking (TRS) [4]. These have been discussed in the general positioning context or restricted to specific positioning methods and/or measurements and/or serving/neighbour cell combinations.

Companies are asked to comment on the use of Rel 15 RS for positioning, which RS to consider, possible restrictions to positioning methods, measurements, serving/neighbour cell aspects what can be discussed in RAN2, and what needs to be aligned with RAN1.

**2.1 Rel 15 reference signals**

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## 2.2 Rich reference signal measurements

Rich reference signals measurements were introduced in LTE and in a similar fashion in NR based on relative timing reporting for up to two additional paths, but more detailed rich reference signal measurements were studied and evaluated in Rel 16.

The proposals address

* angle and power information associated with each path, NLOS/LOS identification, channel impulse response (CIR) or channel frequency response (CFR), etc [2]
* further additional paths beyond 2, richer path information including received signal strength per path, relative signal strength per path, indication of the strongest path, phase information per path, line-of sight indication, etc [4]

Companies are asked to comment on a rich reference signal measurement scope as well as what can be discussed in RAN2, and what needs to be aligned with RAN1.

**2.2 Rich reference signal measurements**

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## 2.3 Rx/Tx diversity measurements

Rx diversity was studied by RAN1 and was decided to be up to the UE implementation. The Rx diversity and Tx diversity could be further studied in Rel-17, especially for scenarios with diversity antennas [2].

Companies are asked to comment on a Rx/Tx diversity measurement scope as well as what can be discussed in RAN2, and what needs to be aligned with RAN1.

**2.3 Rx/Tx diversity measurements**

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## 2.4 DL PRS cyclic shifts

Rel 16 supports interference suppression via muting, orthogonal reference signal patterns, beam-based reference signals and reference signal processing gains. Additional orthogonalization can be introduced via DL PRS cyclic shifts [4].

Companies are asked to comment on a DL PRS cyclic shifts scope as well as what can be discussed in RAN2, and what needs to be aligned with RAN1.

**2.4 DL PRS cyclic shifts**

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# 3 Signalling and procedures

Enhancements of signalling and procedures of previous releases needs to be aligned with other RAN and SA groups. Therefore, companies are asked to provide comments regarding what can be discussed in RAN2 independent of other groups and what needs alignments with other groups, in addition to general comments.

## 3.1 Positioning in RRC\_IDLE/RRC-INACTIVE modes

Idle/inactive mode aspects of positioning was not in particular focus in Rel 16. Specific low—complexity device consideration in LTE Rel-14 resulted in support for downlink positioning measurements in idle mode. In an NR context, there are many aspects for positioning in idle/inactive mode [1], [2], [3], [5], [12], [13] such as

* DL-only positioning measurements
* SRS transmission in inactive
* UE-assisted measurement reporting from idle/inactive

Companies are asked to comment on positioning in RRC\_IDLE/RRC-INACTIVE modes as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.1 Positioning in RRC\_IDLE/RRC-INACTIVE modes**

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| Company | Comments |
| InterDigital | RAN2 should study the procedures and signalling for both UE-based and UE assisted positioning methods when operating in RRC idle/inactive state. These may include procedures for PRS measurement/SRS transmission and power efficient transmission of measurement reports in RRC idle/inactive states. An evaluation to compare the performance achievable when applying different positioning methods from device efficiency and latency perspective may be beneficial in the TR. |
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## 3.2 On demand DL-PRS/SRS

On demand DL-PRS was studied in Rel 16 but was not supported. Several contributions [2],[6], [8], [9],[10] proposes to support on-demand positioning support in Rel. 17. The ability to enable DL-PRS when needed implies that DL-PRS can be disabled when there is no UE to be positioning. That leads to requirements on time to DL-PRS enablement, and a need to define signalling. There can be a number of pre-defined DL-PRS levels of intensity, and there can be different network elements and protocols that trigger the configuration and reconfiguration of positioning reference signals.

Companies are asked to comment on On demand DL-PRS/SRS as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.2 On demand DL-PRS/SRS**

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| Company | Comments |
| InterDigital | We agree with [2][6] that supporting on-demand PRS/SRS enables improving network efficiency and minimizing end-to-end latency. We propose RAN2 to discuss the impacting aspects related to i) signalling for configuring different PRS/SRS configurations in RAN and/or UE, ii) procedures for transmitting on-demand request for PRS/SRS based on triggering conditions (e.g. coverage) determined at UE, iii) signalling for dynamic activation/deactivation of PRS/SRS configurations. |
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## 3.3 Serving gNB RTT

LTE ECID supports determination of serving cell RTT via UE and gNB RxTx time different reports. However, the corresponding serving gNB RTT was not included in Rel 16 NR ECID. Therefore, it is proposed to support gNB RTT as part of NR E-CID in Rel. 17 [2].

Companies are asked to comment on supporting serving gNB RTT as part of NR E-CID as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.3 Serving gNB RTT**

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## 3.4 Serving cell base Multi TRP for Positioning in IIOT

In NR rel-16, single DCI based Multi-TRP features are specified. In these features, the DCI can be originating from one TRP while different PDSCH may be transmitted from different TRPs. In case multiple TRPs belong to the same serving cell, a DCI transmitted from one TRP can schedule a PDSCH transmission from one or more other TRPs that belong to the same serving cell. This setup can be exploited also for positioning purposes [4], such as to control PRS signals and measurements via efficient, low latency signalling.

Companies are asked to comment on Rel 16 DCI-based multi-TRP features for positioning as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.4 Serving cell base Multi TRP for Positioning in IIOT**

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## 3.5 Positioning continuity during gNB handover,

In LPP, there is support for a cell change event, but there are many relevant positioning aspects for UE transferring from one gNB to the next to analyse [2], including DL-PRS measurements, SRS assignments, configuration updates, etc

Companies are asked to comment on positioning continuity during gNB handover as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.5 Positioning continuity during gNB handover**

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| Company | Comments |
| InterDigital | We agree with [2] that positioning continuity during HO is an important scenario. However, we think that studying solutions intended to meet the objectives in Rel17 SID such as improving network efficiency and minimizing end2end latency (e.g. supporting prioritized PRS/SRS) should be considered with higher priority than solutions for achieving positioning continuity. |
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## 3.6 Finer response time and reporting intervals granularity

Given the focus on low-latency positioning in Rel 17, some attribute representation needs to be refined with finer granularity, including response time and reporting intervals in *CommonIEsRequestLocationInformation*.

Companies are asked to comment on positioning in finer response time and reporting intervals granularity as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.6 Finer response time and reporting intervals granularity**

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## 3.7 Aperiodic positioning measurement reports

In LPP, there is support for a periodic, immediate and triggered reporting. In addition, Rel 17 could support also aperiodic measurement reporting [3], such as a DCI-triggered report request from gNB.

Companies are asked to comment on whether aperiodic positioning measurement reports shall be considered in Rel 17 as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.7 Aperiodic positioning measurement reports**

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## 3.8 Pre-allocated uplink grant

Grant Free UL Transmission enables to reduce UL transmission delays and achieve URLLC Reliability targets. For low latency and reliability requirements, it is required to support UL GF transmission with multiple repetitions. If pre-allocated can be used for positioning periodic report, then signals and multiple configuration latency can be saved, and this pre-allocated grant should adapt to the positioning report period, so the best latency result is performed [3].

Companies are asked to comment on positioning in pre-allocated uplink grants for positioning as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.8 Pre-allocated uplink grant for positioning**

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## 3.9 Measurement gap enhancements

The measurement gaps agreed in Rel 16 does not match the agreed DL-PRS periodicities. the PRS periodicity is:

slots, and the measurement gap periodicity is ms according to the RAN4 conclusion. It is observed that some PRS periodicity (such as 8,16,32, 64 ms) is not matched with MG periodicity [3].

Companies are asked to comment on positioning measurement gap enhancements as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.9 Measurement gap enhancements**

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## 3.10 Reference point measurements for error reduction

GNSS RTK is based on reference station GNSS measurements at precisely known geographical positions. The same technique could be considered also for NR RAT-dependent positioning, where detailed NR measurements at precisely known geographical positions are harvested, processed and shared to enable error reductions [3]

Companies are asked to comment on NR Reference point measurements for error reduction as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.10 Reference point measurements for error reduction**

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## 3.11 Prioritized DL-PRS reception/SRS transmission

In Rel-16, both PRS and SRSp are assigned with low priorities. As a result, PRS is not received or SRSp is not transmitted when either transmission of data in DL/UL or other reference signals are scheduled.

In Rel-17, it can be envisioned that supporting prioritized positioning based on the assignment and indication of higher priority for the reception/transmission of PRS/SRS may enable to satisfy the low latency positioning requirements [8].

Companies are asked to comment on prioritized DL-PRS reception/SRS transmission as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.11 Prioritized DL-PRS reception/SRS transmission**

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| Company | Comments |
| InterDigital | Our proposal in [8] is intended to show that prioritized PRS/SRS enables achieving low end2end latency positioning. As such, different aspects that can be studied with potential RAN2 impacts are: i) signaling for indicating the priority assigned for the reception of PRS and transmission of SRS ii) handling of prioritized PRS/SRS transmission and data when priority level assigned to positioning is comparable to or higher than data reception/transmission and iii) triggering of positioning measurement reports with low latency for prioritized positioning. |
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## 3.12 Measurement gap enhancements

The measurement gaps agreed in Rel 16 does not match the agreed DL-PRS periodicities. the PRS periodicity is:

slots, and the measurement gap periodicity is ms according to the RAN4 conclusion. It is observed that some PRS periodicity (such as 8,16,32, 64 ms) is not matched with MG periodicity [3].

Companies are asked to comment on positioning measurement gap enhancements as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.9 Measurement gap enhancements**

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## 3.12 Beam shape information for UL measurements

In Rel 16 it was agreed that LMF will determine angle of arrival based on UL beam measurements provided to LMF. Therefore, the LMF needs beam shape information associated to the UL beams in order to estimate AoA. Such information can be provided via OAM or NRPPa, or the decision in Rel 16 can be changed and the UL beam information can be provided to gNB for AoA determination [2].

Companies are asked to comment on beam shape information handling for AoA estimation as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.12 Beam shape information for UL measurements**

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## 3.13 Assistance data/enhancements for UE-based positioning

There are several enhancements proposed for UE-based, and they are gathered under the same subsection here, while there are separated tables for comments for the different proposals.

DL-PRS beam measurements can be used to determine AoD in the UE. Currently, the UE-based assistance data includes beam directions for beams in a beam set (associated to a DL-PRS resource set) but no information about beam shape is defined [6].

Companies are asked to comment on beam shape information in the UE-based assistance data as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.13a Beam shape information for UEB assistance data**

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UE-based DL-PRS timing measurements together with the TRP relative time difference (RTD) information is used by the UE for estimating the position in Rel 16. Enhancements includes the timing drift rate per TRP and RTD per DL-PRS resource [6].

Companies are asked to comment on enhanced RTD information in the UE-based assistance data as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.13b Enhanced RTD information for UEB assistance data**

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UE-based DL-PRS timing measurements together with the TRP relative time difference (RTD) information is used by the UE for estimating the position in Rel 16. Enhancements includes the timing drift rate per TRP and RTD per DL-PRS resource.

Companies are asked to comment on enhanced RTD information in the UE-based assistance data as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.13b Enhanced RTD information for UEB assistance data**

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UE-based assistance data includes TRP and DL-PRS resource set/resource location information in relative geodetic coordinates. In Rel 16 it was also discussed to support Cartesian coordinates which more naturally represents IIoT scenarios [4]. Cartesian coordinated was agreed in RAN3 in Rel 16 for communicating TRP location information via NRPPa from gNB to LMF.

Companies are asked to comment on representing TRP location information in Cartesian coordinates as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.13c TRP and DL-PRS location information in Cartesian coordinates**

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Rel 16 introduced support for DL-only UE-based positioning, and this can be extended to also include support for multi-RTT UE-based positioning [6].

Companies are asked to comment on supporting multi-RTT UE-based positioning as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.13d Multi-RTT UE-based positioning**

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Rel 16 discussed positioning performance observability for UE-based positioning, but no features or measurements were agreed. Among the contributions, there are two proposals for such positioning observability and calibration:

* Positioning performance observability and positioning measurements to enable positioning (re)configuration [4]
* UE and network assistance for positioning calibration [6]

Companies are asked to comment on supporting positioning performance observability and calibration as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.13e Positioning performance observability and calibration**

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IIoT scenarios may feature constrained movements of objects which constitute important information for the positioning engine. Such information could be considered available in some application layer and could be shared in assistance data [6].

Companies are asked to comment on supporting kinematics constraints in assistance data as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**3.13f Kinematics constraints in AD**

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# 4 Latency analysis

Latency is one of the key requirements to consider and analyse in Rel 17. Therefore, it is important to understand what parts of the end 2 end latency between LMF and device to include in the RAN2 analysis, and how much signalling delays per each part contribute to the end2end latency, see details in [1], [2], [7], [8].

For snapshot positioning, the end2end latency should be determined as the time from when LMF triggers the positioning via LPP until the device reports measurements via LPP, while for periodic measurements, the latency is the latency that the device provides measurement results [7]. In the first case, the signalling includes capability exchange and assistance data provisioning, but can be excluded in the latter case. What needs to be included and what can be omitted depends on the use case.

Moreover, the end2end could also include signalling between LMF and some application layer, which seems to be outside the RAN2 scope [7], and the focus should be on procedures between UE, LMF, AMF and gNB.

Therefore, it is important to discuss what parts of the end2end latency that should be considered in RAN2.

Companies are asked to comment what parts of the end2end latency that shall be analysed in RAN2 as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**4.1 Parts of end2end latency to be analysed in RAN2**

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| Company | Comments |
| InterDigital | We are of the opinion that at the initial phase, the different parts/components that contribute to end2end latency for different positioning methods (e.g. UE-based, UE-assisted, DL, UL, UL+DL) should be identified and determined on the basis of different impacting working groups. For RAN, all latency components from a start time duration (e.g. sending of location request) to an end time duration (e.g. reception of measurement report), excluding PHY components (e.g. PRS measurement/SRS transmission and L1 processing), should be identified. Such an evaluation would be beneficial to identify the parts that are common/different for different positioning methods and to determine end2end latency model.  For RAN2, we propose to study the latency components with potential impacts such as i) signalling related to provisioning of PRS/SRS configurations, ii) procedures related to scheduling of PRS reception/SRS transmission and iii) signalling related to transmission of measurement reports. |
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The contributions [1], [2], [7], [8] have analysed latency contributions per part of the end2end procedure.

Companies are asked to comment on the analysis in [1], [2], [7], [8], and what can be concluded for the TR as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**4.2 Comments to latency analysis per part in [1], [2], [7], [8]**

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| Company | Comments |
| InterDigital | The latency analysis considered in [1] for both Rel16 architecture (LFM in CN) and Local LFM based architecture (LFM in RAN) provides good insight into the parts that impact the end2end latency. Similarly, [7] provides a good overview of end2end latency for multi-RTT based positioning, assuming Rel16 architecture. While [2] provides a comprehensive analysis of end2end latency for different positioning methods, it is unclear how the values of each of the components are determined (e.g. 0.5ms for a transmission segment in network). Our analysis in [8] provides a breakdown of different components for DL/UL based positioning and describes the latency parts/components that fall under the domain of RAN2.  For end2end latency analysis for different positioning methods, a latency model that identifies the different latency parts/components between a start time duration (e.g. sending of a location request) and end time duration (e.g. reception of measurement report) should be considered. |
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# 5 Network and device efficiency

Network and device efficiency need to be aligned with other RAN and SA groups. Therefore, companies are asked to provide comments regarding what can be discussed in RAN2 independent of other groups and what needs alignments with other groups, in addition to general comments

## 5.1 DL-PRS Reconfiguration

Overtime and context, there are most probably different optimal DL-PRS configurations depending on positioning requirements and device activity. There are different ways to reconfigure DL-PRS:

* Via OAM as in LTE
* LMF to decide [3],[9] or suggest [4] to gNB new DL-PRS configurations
* gNB to reconfigure DL-PRS [4],[9]

Important questions concerns the signalling between network elements, the adequate measurements

Companies are asked to comment on DL-PRS reconfiguration and suitable signalling, measurements and procedures as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**5.1 DL-PRS Reconfiguration**

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| Company | Comments |
| InterDigital | DL-PRS reconfiguration should be considered and discussed from the perspective of both Rel16 architecture (i.e. LMF-based PRS configuration) and RAN-based architecture with local LFM functionality. On-demand or dynamic DL-PRS, where the DL-PRS can be reconfigured based on request from UE, is beneficial from the perspective of network efficiency. We propose RAN2 to discuss the signalling and procedures associated with supporting on-demand DL-PRS. |
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## 5.2 LMF-based SRS pooling

There can also be reasons to coordinate the use of UL SRS for positioning to manage interference and also support mobility. The coordination could be via the LMF [1].

Companies are asked to comment on LMF-based SRS pooling and coordination as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**5.2 LMF-based SRS pooling**

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| Company | Comments |
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## 5.3 RRC-based positioning procedures

Most of the positioning applications require that localization be done spontaneously. Latency is critical factor. LMF-based control over positioning implies multiple hop routing of LPP messages. However, the existing RRC protocol is essentially tailored to enable timely handling of configurations and measurements. RRC-based procedures should therefore be considered for positioning [4].

Companies are asked to comment on RRC-based positioning procedures as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**5.3 RRC-based positioning procedures**

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| Company | Comments |
| InterDigital | RAN2 should discuss procedures and RRC signalling related to configuration of DL-PRS and UL-SRS from the perspective of both Rel16 architecture (i.e. LMF-based PRS configuration) and RAN architecture supporting local LFM functionality. |
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## 5.4 Local LMF/LSS

The architecture change with a local LMF was discussed in Rel 16, and the consideration of a local LMF is addressed in [5][6]

Companies are asked to comment on the applicability of a local LMF as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**5.4 Local LMF/LSS**

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| Company | Comments |
| InterDigital | Supporting local LMF functionality in RAN architecture enables satisfying the low latency positioning requirement and provides more control/flexibility to RAN for provisioning of positioning RS. In light of this, procedures and signalling which have RAN2 impacts, such as provisioning of PRS/SRS configurations, scheduling of PRS reception/SRS transmission and fast transmission of measurement reports, should be further discussed. |
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## 5.5 Management of simultaneous LPP and SIB AD distribution

In Rel 16 it is possible to provide AD via both unicast/LPP and broadcast/RRC-SIB. In case these are in conflict, there could be reasons to analyse the conflicts and define suitable conflict handling [11].

Companies are asked to comment on management of simultaneous LPP and SIB AD distribution as well as what can be discussed in RAN2, and what needs to be aligned with other groups.

**5.5 Management of simultaneous LPP and SIB AD distribution**

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# 6 Missing aspects

Some aspects raised in contributions might have been overlooked in this summary. Below, companies are asked to provide comments about any additional aspects raised in contributions together with a reference to the contribution

**6.1 Missing aspects**

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# 7 Conclusion

TBD