**3GPP TSG-RAN3 Meeting # 112-e *R3-212691***

**17th - 28th May 2021**

Agenda Item: 19.2.1

Source: Ericsson (moderator)

Title: Summary of Offline Discussion on Rel-17 positioning accuracy improvements

Document for: Discussion

# Introduction

**CB: # 51\_Pos\_AccEnhs\_AoD\_LS**

**- (HW)**

**Support AoD calculation at NG-RAN nodes and angle reporting from gNB to LMF in DL-AoD positioning.**

**Liaise RAN1 and RAN2 to confirm the support of angle reporting from gNB to LMF.**

**Introduce a new UL ZoA IE in the TRP Measurement Result IE to support the report of ZoA only for UL AoA positioning.**

**Serving RAN to provide neighbor information to LMF to support the LMF selecting measuring TRPs in order to increase the positioning accuracy.**

**Study enhancement solutions for positioning service continuity for uplink positioning methods and multi-RTT including:**

**- Support cell change indication from NG-RAN to LMF for both intra-gNB and inter-gNB handover.**

**- Support UE positioning related context relocation for SRS transmission for positioning.**

**Discuss how to notify the TRP information update to the LMF.**

**- (E///)**

**Reply to RAN1 informing of the RAN3 previous agreement on DL-AoD computation at LMF**

**Consider the initial set of RAN1 agreements regarding UL AoA and potential specifications impacts. RAN3 to wait for further input form RAN1.**

**- (CATT)**

**introduce a “Linear Array indicator IE” to indicate that linear array antenna is deployed, and correspondingly to add a description: the z-axis of LCS is defined along the linear array axis, and Azimuth Angle of Arrival value shall be ignored in this case.**

**- (E///) (on AoD LS) RAN3 had previously discussed the transmission measurement function for DL-AoD in Release-16 and had communicated to RAN2 in R3-197794 that RAN3 prefers DL-AoD computation at LMF; no changes to arch are foreseen in Rel-17**

**- (CATT) (on AoD LS) Unclear gain of opt2 over opt1; wait for further RAN1 progress**

**- Chair: 1) Specific DL-AoD angle calculation enhancement; 2) General positioning enhancements discussion. On both issues, it’s probably good to recall our previous discussion on DL-AoD in Rel-16; if we decide to move away from that decision, it should be a conscious choice. Once that choice is made, any architecture updates (if any) will come as a consequence. The reply LS to RAN1 (another issue, but connected to the architecture discussion) is also a consequence of our decision. Might attempt st3 TPs if agreeable?**

(E/// - moderator)

# For the Chairman’s Notes

Propose the following:

//To be updated

# Introduction

This is the first e-meeting of RAN3 for the Rel-17 positioning enhancements work item. The WID lists the following objectives related to the Positioning Accuracy Improvements topic [1]:

* Specify methods, measurements, signalling, and procedures for improving positioning accuracy of the Rel-16 NR positioning methods by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays, including [RAN1, RAN2, RAN3, RAN4]
  + DL, UL and DL+UL positioning methods
  + UE-based and UE-assisted positioning solutions
* Specify the procedure, measurements, reporting, and signalling for improving the accuracy of [RAN1, RAN2, RAN3]
  + UL AoA for network-based positioning solutions.
  + DL-AoD for UE-based and network-based (including UE-assisted) positioning solutions.

The following company contributions have been submitted to discuss this topic:

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| [R3-212595](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-212595.zip) | LS on DL-AoD angle calculation enhancement (RAN WG1) |
| [R3-212347](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-212347.zip) | Reply LS on DL-AoD angle calculation enhancement (Ericsson) |
| [R3-211818](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-211818.zip) | Consideration on DL-AoD Positioning Solution (CATT) |
| [R3-211820](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-211820.zip) | [Draft]Reply LS on DL-AoD angle calculation enhancement (CATT) |
| [R3-212237](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-212237.zip) | Discussion on positioning enhancement (Huawei) |
| [R3-212238](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-212238.zip) | Positioning enhancement (Huawei) |
| [R3-212239](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-212239.zip) | Positioning enhancement (Huawei) |
| [R3-212348](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-212348.zip) | Discussion on first aspects related toRel-17 Positioning Accuracy Improvements (Ericsson) |
| [R3-211819](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-211819.zip) | Consideration on UL AOA Positioning Solution (CATT) |
| [R3-212466](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-212466.zip) | Support of UL AoA Positioning enhancement (CATT) |

As suggested by the chairman, this e-mail discussion document will be structured in two parts:

* Discussing DL-AoD angle calculation enhancement.
* General positioning enhancements discussion:
  + UL-AoA,
  + Other proposed enhancements.

# Discussion

## DL-AoD enhancement discussion

RAN3 received a LS from RAN1 in [2] with initial agreements for Rel-17 DL-AoD enhancements:

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| Agreement:  Regarding support of angle calculation enhancement for DL-AoD:   * Support gNB providing the beam/antenna information to the LMF.   + The gNB beam/antenna information can be provided to the UE for UE-based DL-AoD   + FFS: the details of contents of the beam/antenna information   + FFS: the details of how to provide the beam/antenna information.   + Note: The antenna information is related to reducing the overhead of beam information * Send an LS to RAN2/RAN3 regarding the option of angle report from gNB to LMF for UE-A DL-AoD requesting them to consider this option in Rel-17. |
| **To RAN2, RAN3**  **ACTION:** RAN1 respectfully requests RAN2/RAN3 to consider the option of angle report from gNB to LMF for UE-A DL-AoD in Rel-17. |

Three companies have submitted contributions related to this RAN1 LS and the enhancement support of DL-AoD for Rel-17. The proposals are summarized below:

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| **Company** | **Tdoc** | **Proposal** |
| CATT | [R3-211818](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-211818.zip) [R3-211820](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-211820.zip) | The first set of RAN1 agreements show that Rel-17 DL-AoD calculation has taken the Rel-16 DL-AoD as baseline, where the angle computation is done at LMF. RAN3 to wait further before impacting NRPPa, since the current additions are unclear.  If RAN1 asks RAN3 to consider the option of angle computation to be done at gNB, then additional latency of 26~58ms for the DL-AoD positioning procedure will occur. Reply to RAN1 to inform of the unclear gains. |
| Ericsson | [R3-212347](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-212347.zip)  [R3-212348](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-212348.zip) | As part of RAN assistance information, gNB antenna information can be provided to the LMF over NRPPa for DL-AoD calculation at LMF. The exact content needs further inputs from RAN1/2 to be defined.  RAN3 has previously discussed and agreed that DL-AoD computation is done at LMF and informed RAN2 in R3-197794. RAN3 should inform RAN1 of the Rel-16 agreement since they were not in the Rel-16 LS. |
| Huawei | [R3-212237](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-212237.zip) | The accuracy of AoD calculation is limited because the beam information reported from gNB to LMF is limited. This impacts the overall positioning result.  Therefore, to increase accuracy, the AoD calculation is to be done at NG-RAN nodes via the measurement procedures, and the angle reporting to be supported from gNB to LMF for DL-AoD positioning. Send LS to RAN1 and RAN2 to confirm of this |

**Q1: Companies are invited to comment if they think there is a need to change where DL-AoD is calculated in Rel-17? Keep it at LMF as agreed in Rel-16, or in gNB as new option for Rel-17.**

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| **Company** | **LMF/gNB** | **Comment** |
| Ericsson | LMF | We have already discussed these two options during Rel-16 NR Positioning WI (part of TMF) and agreed to proceed with DL-AoD calculation at LMF. We think that the latency impact on NRPPa and the added complexity on gNB for calculating the angle position outweigh any potential accuracy optimization. |
| Huawei | gNB | The LS on RAN1 agreement is clear. There is a new paradigm in Rel-17 with the intention to improve the measurement accuracy (see WI definition). Then we also understand that RAN1 LS is the agreement on supporting angle report from gNB. |
| Nokia | LMF | We have the same understanding as Ericsson - it was already discussed and agreed in RAN3 (during R16) that DL-AoD calculation is performed at LMF. The first bullet of the RAN1 LS is aligned with DL-AoD calculation at LMF.  For DL-AoD calculation at gNB, there is no need to have a 2nd option for essentially the same functionality, and 2nd option was not agreed in RAN1 (agreement was only to send an LS). |
| CATT | LMF | We share understanding with Nokia, in RAN1 only 1st option is agreed as baseline solution. So we support to keep location calcution at LMF as agreed in Rel-16. |
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**Moderator’s conclusion:** to be updated considering the companies input. A draft reply LS to RAN1 will be proposed.

## General positioning enhancements discussion

### UL-AoA enhancement:

In contributions [3], [4] and [5], companies have highlighted some RAN1 agreements related to Rel-17 UL-AoA enhancements:

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| Agreement: (#1)   * The following option is supported to enhance signaling of UL-AOA measurement report in case of a linear array   + Option 2: The z-axis of LCS is defined along the linear array axis. gNB reports only the ZoA relative to z-axis in the LCS, and the LCS-to-GCS translation function is used to set up the specific z-axis direction * UL-AOA signalling details for support of Option 2 are left up to RAN WG3   Agreement: (#2)  Reporting to LMF of M > 1 UL-AOA (AoA/ZoA) measurement values associated with the first arrival path and corresponding to the same timestamp is supported. |

For the first agreement on the of report of ZoA relative to z-axis only, the following encodings options have been proposed:

1. Introduce a new IE in the *TRP Measurement Result* to support the report of ZoA only for UL AoA positioning [3][5]
2. Introduce a “*Linear Array indicator* IE” to indicate that linear array antenna is deployed, and correspondingly to add a description: the z-axis of LCS is defined along the linear array axis, and AOA value shall be ignored in this case [4]
3. Other options? considering nbc changes, etc.

**Q2-1: Companies are invited to provide their views on how to encode in NRPPa (and F1AP) UL-AoA measurement in case of linear array.**

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| **Company** | **Option** | **Comment** |
| Ericsson | Too early to assess | We are fine with option 1 as we proposed, but we think it’s too early to capture anything now and we should wait for further agreements on UL-AoA from RAN1 (communicated via LS, as usual) |
| Huawei | 1 | We support 1, could be capture with FFS if some companies have doubt |
| Nokia | 1 | Option 1 seems much cleaner than Option 2. But we are also fine to postpone a decision pending further details from RAN1. |
| CATT | 2 | The option 2 have minimal standardization work. But we are open with option 1 or 2. We are also OK to wait for further agreements on UL-AoA from RAN1. |
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**Q2-2: Do companies have any view on the second agreement from RAN1 on having many UL AoA measurements that can be associated with a time stamp in the first arrival path?**

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| **Company** | **Option** | **Comment** |
| Ericsson | - | As for now NO. RAN3 can wait on further details from RAN1 on this. |
| Huawei |  | We did not identify major RAN3 drawback related to this agreement …. |
| Nokia |  | No view yet, pending further details from RAN1. |
| CATT |  | Pending further details from RAN1. |
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**Moderator’s conclusion:** to be updated with potential stage 3 agreement(s) according to the companies inputs.

### Other proposed enhancements:

Three other enhancements for Rel-17 positioning have been proposed in [5]:

1. It is claimed that a UE may detect several neighbouring cells, where the best neighbouring cells may not be the ones being the closest to the serving TRP and are appropriate for positioning. The proponents propose to address this by letting the serving gNB provide the neighbouring information (RRM, cell ID) to the LMF, as response to when LMF requests SRS information from the serving gNB.

**Q3-1: companies are invited to provide their view on this proposal:**

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| **Company** | **Comment** |
| Ericsson | We are not convinced by this proposal, especially where the proponents mention that the LMF mainly utilizes “the geographical coordinates when selecting the neighbouring TRPs”. Looking at the *TRP Information* IE in TS 38.455 9.2.25, there are several other information such as: SSB and PRS configuration information, which the LMF can rely on for the TRP selection.  Besides, in case of e.g. a Xn configuration update, then all of the neighboring cell information would have very well turned obsolete and will cause failure of the positioning procedure. |
| Huawei | Well as explain in [5] the intention is to provide more information to the LMF because an UE may have a number of neighboring cells and the best neighboring cells may not be those ones that are closest to the serving TRP. Such improvement is in line with the accuracy improvement.  Can Ericsson clarify “there are several other information such as: SSB and PRS configuration information, which the LMF can rely on for the TRP selection”. How do you use it? How do you know UE see it? |
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1. It is claimed that UE handover can cause an UL/Multi-RTT positioning failure; the LMF cannot timely update or abort the positioning procedure, which can cause positioning service delay and may cause wastes of resources and power consumptions at measuring gNBs. It is proposed by the proponents to study the enhancement solutions for positioning service continuity for uplink positioning methods and multi-RTT including:
   1. Support cell change indication from NG-RAN to LMF for both intra-gNB and inter-gNB handover.
   2. Support UE positioning related context relocation for SRS transmission for positioning.

**Q3-2: companies are invited to provide their view on this proposal:**

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| **Company** | **Comment** |
| Ericsson | Regarding UE mobility in connected mode, it follows the Handover resource allocation procedure as defined in TS 38.423. The source gNB is aware whether the handover has been accepted or rejected by the target node. We agree that UE mobility will cause failure of the on-going positioning procedure and we propose to add a specific cause value in the error message. See our proposal in [R3-212348](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_112-e/Docs/R3-212348.zip)  We do not agree on P2.2 for inter-gNB handover, that impacts XnAP and makes it a signalling transport for NRPPa messages. |
| Huawei | We would like Samsung in R3-211984, open the discussion on mobility for RRC connected mode. We are open to discuss different solution in this direction. |
| Nokia | It is not clear to us that mobility / service continuity is in scope of the WID. It was not discussed at all in RAN1/RAN2 during the study phase. |
| CATT | Agree with Nokia, it is out of the WID scope. |
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1. It is proposed to let the LMF be **timely aware** of TRP information changing, by letting the RAN node notifying the TRP information change to the LMF

**Q3-3: companies are invited to provide their view on this proposal:**

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| **Company** | **Comment** |
| Ericsson | Disagree.  By “timely aware” does it mean here dynamic update? If so, this proposal makes NRPPa stateful, while it is a stateless protocol by definition (there is no NRPPa setup nor NRPPa configuration update procedures!) We have strong concerns as network vendors on the complexity impacts on NRPPa, which is a slow protocol, not like XnAP.  Also, please note that there will be impact on the gNB-CU who will have to reject the requested positioning procedure if such TRP info is no longer accurate. |
| Huawei | There is a fact that the TRP information can be changing, such as the PCI reallocation, ARFCN adjustment, SSB configuration update, etc. But the LMF is not able to identify the changes timely. We do not want necessary to force the RAN to of regular update compare today, but give an opportunity to LMF to have accurate inputs for accurate positioning …  We also understand that the impact of inaccurate TRP information is huge, because it does not impact a single UE, it will impact the positioning for all UEs in the cell and neighboring cells. |
| CATT | The dynamic management of resources at NG-RAN side via NRPPa procedure would introduce more complexity and therefore it requires more study in RAN3 for this aspect. |
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**Moderator’s conclusion:** to be updated with potential stage 3 agreement(s) or WA according to the companies inputs.

# Conclusion, Recommendations [if needed]

If needed

# References

1. RP-210903, Revised WID on NR Positioning Enhancements.
2. R1-2104089 LS on DL-AoD angle calculation enhancement
3. R3-212348 Discussion on first aspects related to Rel-17 Positioning Accuracy Improvements, (Ericsson)
4. R3-212466, Support of UL AoA Positioning enhancement (CATT)
5. R3-212237, Discussion on positioning enhancement (Huawei)