3GPP TSG-RAN Meeting #94e   RP-212666

Electronic, 6 – 17 December 2021

Agenda Item: 8A.1

Source: Moderator (Intel)

Title: Moderator's summary for [RAN94e-R18Prep-06] on Expanded and improved positioning

Document for: Discussion and decision

1   Introduction

This document reports on the pre-RAN#94e email discussion on Rel-18 Expanded and improved positioning.

The starting point of the discussion is the result from the pre-RAN#93e email discussion that was reported in RP-211660. This discussion will follow the guidance provided by the RAN chair in RP-212657 and, as indicated in that guidance, the expectation is that the final outcome of this discussion should be text that is appropriate to from the objectives of a WI/SI.

2   Sidelink positioning/ranging

2.1   Initial Round

In the outcome of the previous discussion, the topic on sidelink positioning/ranging was captured as follows:

- Study/specify solutions (including reference signals, measurements, procedures, etc) for sidelink positioning considering the following: [RAN1, RAN2]

  - To include ranging (i.e. relative positioning) and absolute positioning
  - Coverage scenarios to cover: in-coverage, partial-coverage and out-of-coverage
  - Requirements: Based on requirements identified in TR38.845 and TS22.261 and TS22.104
  - Use cases: V2X (TR38.845), public safety (TR38.845), commercial (TS22.261), IIOT (TS22.104)
    - Note: The next phase of discussion will include selection of use cases to be used for evaluation and design. This does not restrict use of the solutions for other use cases.
  - Spectrum: ITS, licensed
  - Coordination with SA2 as required (e.g. architecture aspects)

It was also noted in the outcome of the previous discussion that some aspects were still controversial to some degree. These were:

1. Reference to the word 'sidelink' in the first bullet - one company preferred to remove this as in their view it implied a solution.

2. Reference to the word 'ranging' in the first first bullet - one company preferred to remove the word 'ranging' as they consider that ranging and relative positioning are not necessarily equivalent.

3. Whether to consider unlicensed wan controversial with strong views on both sides

In providing feedback for the initial round, I would like companies to specifically comment on the following:

1. How should the work be structured in terms of study item, work item or a study phase within a work item.

2. Identification of a specific use case (or use cases) from the identified references that will be used for the evaluation and design (noting that this in no way limits the final use of the feature).

3. Sufficiently detailed objectives with clear identification of WG responsibilities.

4. Any further detail regarding anticipated interaction with SA/CT.

5. Views on whether to consider unlicensed spectrum in scope.

Other comments may also be provided.

Feedback Form 1: Sidelink positioning/ranging - initial round comments

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1 – ZTE Corporation

1.   The whole positioning should be a WI, in which sidelink positioning part is a study phase in the first several meetings of Rel-18.

2.   The use cases should at least include V2X (TR38.845), public safety (TR38.845). Some of corresponding requirements captured in 38.845 can be selected as a goal of Rel-18, e.g.

a)   For V2X, 1 – 3 m with 95 – 99 % confidence level (set 2 in 38.845 for V2X) for both absolute and relative positioning (or ranging)

b)   For public safety, 1 m horizontal accuracy, 2 m (absolute) or 0.3 m (relative) vertical accuracy, 95 – 98 % positioning service availability

c) The scenarios should focus on out-of-coverage first, and then consider in-coverage and partial coverage.

3.   It should be led by RAN1, followed by RAN2, RAN3 and coordinated with SA2.

Recommend objectives:

a)   Study evaluation methodology and evaluate SL positioning and SL assisted Uu positioning [RAN1].

b)   Potential enhancement aspects include [RAN1]

    i.   Support absolute positioning and relative positioning (or ranging)

    ii.   Specify SL RS/channel

    iii.   Specify SL signaling including SL PRS configuration, SL location request, measurement report, etc.

    iv.   Support Uu positioning solutions + sidelink positioning solutions for in-coverage and partial coverage scenarios

c)   Enhance LPP, NRPPa, and SA2 protocals [RAN1, RAN2, SA2]

4.   We prefer not to include unlicensed spectrum in this release for sidelink positioning. That's because the regular V2X in unlicensed spectrum could be discussed in Rel-18, SL positioning need to rely on the outcome of that SI/WI.

2 – China Mobile E-Commerce Co.

- On the work structure, we prefer to include a study phase within a work item for the sidelink positioning/ranging part.

- On the identification of specific use case, we believe that since V2X and public safety have already been studied in RAN and have defined clear requirements, it should be the starting point for evaluation. For commercial and IIOT use cases, we think that these indeed are use cases with practical values, and we are open to further include one or both of them.

- On the unlicensed spectrum, we should consider the limited workload and TU. Note that we have no baseline of Uu positioning and also sidelink over unlicensed spectrum, in this sense, we prefer to narrow down the scope to only licensed spectrum.

3 – Nokia France

We support inclusion of out-of-coverage positioning (which is a better term than "sidelink positioning"), provided that there is sufficient capacity to include the improved accuracy topic in the next section. A study phase should be undertaken before beginning any normative work on out-of-coverage positioning.

4 – LG Electronics Inc.

Thanks for initiating discussion. Here are comments from our side regarding the asked points.

1.   How should the work be structured in terms of study item, work item or a study phase within a work item.

As the positioning based on sidelink is a quite new concept, we prefer to have a study phase for SL positioning. Working groups need to study the feasibility of the technical solutions fulfilling the target use cases and relevant requirements. After the study, the detailed work scope of the normative WI can be determined.

The 9-month period of SI followed by the 9-month period of WI is ideal, but we can also consider starting as a work item with the 9-month period of study phase if required for better project management (e.g., to incorporate with the objectives other than SL positioning)

2.   Identification of a specific use case (or use cases) from the identified references that will be used for the evaluation and design (noting that this in no way limits the final use of the feature).

First priority use cases are positioning for V2X and public safety, which have been assumed to use sidelink as a communication link. The details of the use cases, requirements and scenarios are found in TR 38.845.

Commercial use cases can also be considered with the assumption that the same SL positioning solution is applicable.

3.   Sufficiently detailed objectives with clear identification of WG responsibilities.

We suggest the following work scopes for SI/WI phase.

- Define the evaluation methodology for SL positioning [RAN1]
    ○ Existing methodologies used in sidelink and positioning enhancement are maximally reused
- Study potential solutions for both RAT-dependent absolute and relative SL positioning
    ○ SL positioning reference signal (SL-PRS) and channels for signaling [RAN1]
    ○ Resource allocation for SL-PRS [RAN1, RAN2]
        ▪ Support mode-1 (gNB scheduling) and mode-2 (UE autonomous resource selection)
    ○ Procedure to transmit and receive SL-PRS as well as to measure and report UE position [RAN1, RAN2]
        ▪ Support UE-based SL positioning, network-based SL positioning and combination of both
- Study potential solutions for both RAT-independent absolute and relative SL positioning [RAN1, RAN2]

4.   Any further detail regarding anticipated interaction with SA/CT.

Interaction is necessary. Details are TBD.

5.   Views on whether to consider unlicensed spectrum in scope.

Considering the work scopes we suggest above and the on-going discussion whether or not to study the use of unlicensed spectrum for SL enhancement in Rel.18, we're a bit skeptical about finishing the study of using unlicensed spectrum for SL positioning with the timeline we propose for SI period of 9 months. The introduction of unlicensed spectrum for SL positioning may only be feasible only after there are some conclusions on the use of unlicensed spectrum for general SL operations.

In this sense, it would be a better choice to focus on the ITS dedicated and the licensed spectrum for SL positioning in Rel.18, and further extend to use the unlicensed spectrum in later release.

5 – NTT DOCOMO INC.

- SI vs WI: we think either SI or SI within a WI is better since there has been no technical study so far. Direct WI is not reasonable in this situation.
- Use case: as captured in 38.845, this topic can focus on V2X/public safety.
- Objectives: as captured in 38.845, solutions of Uu-based/PC5-based/Hybrid should be included, and both NW-based/UE-based positioning should be included, for study phase. Then which mechanism should be specified can be discussed at the study phase.

- Unlicensed: We do not support to include unlicensed spectrum in this topic. Rel-16/17 SL does not support unlicensed spectrum. To include unlicensed spectrum, fundamental mechanism of SL in unlicensed spectrum, like LBT, shall be specified. The fundamental mechanism should not be made only for SL positioning since the mechanism might be not good for SL communication. We suggest to specify SL positioning in unlicensed spectrum AFTER completing specifying SL communication in unlicensed spectrum.

6 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility :

- **1)** From our side we are supportive of a dedicated SI phase for SL positioning/ranging in Rel-18 to better understand the technical feasibility of different aspects.
- **2)** Generally supportive of all use cases listed including V2X, PS, IIoT and Commercial. The evaluation should consider the following use cases (focus should especially cover the stringent use cases):
  - ○ V2X:
    - ▪ Set 1: 10 – 50 m with 68 – 95 % confidence level. This includes **Group 1 use cases** in [5GAA Reply LS – RP-210040] and Positioning Service level 1 in TS22.186.
    - ▪ Set 2: 1 – 3 m with 95 – 99 % confidence level. This includes **Group 2 use cases** in [5GAA Reply LS – RP-210040], Positioning Service level 2, 3, 4 in TS22.186.
    - ▪ Set 3: 0.1 – 0.5 m with 95 – 99 % confidence level. This includes **Group 3 use cases** in [SAE Reply LS RP-210036], Positioning Service level 5, 6, 7 in TS22.261, the requirements in TS22.186.
  - ○ Public Safety:
    - ▪ The "**1st responders**" use case in TS22.261 with 1 m horizontal accuracy, 2 m (absolute) or 0.3 m (relative) vertical accuracy, 95 – 98 % positioning service availability.
  - ○ IIoT:
    - ▪ The "**Flexible, modular assembly area in smart factories (for tracking of tools at the work-place location)**" relative positioning use case in TS22.104 with <1m horizontal accuracy, 95 – 99 % positioning service availability, positioning latency of 1s.
  - ○ Commercial:
    - ▪ The "**Picture and video sharing based on Ranging results**" use case in TS22.261 with 0.1m ranging/distance accuracy, 2 degrees direction accuracy, positioning latency of 50ms.
- **3)** The following SID objectives are proposed to be considered:
  - ○ a) Study and identify the SL positioning/ranging techniques, (e.g., using timing-based, angular-based positioning techniques, etc.):
    - ▪ Evaluate the design of a new sidelink positioning reference signal(s) (e.g., enable high accuracy, power efficiency) to support sidelink positioning/ranging techniques [RAN1].
    - ▪ Study potential signalling and procedures (e.g., configuration, measurement and reporting) to support the identified sidelink positioning techniques [RAN2]
    - ▪ NOTE: The study should consider both network-based positioning (positioning calculation entity is in the network) and UE-based positioning (positioning calculation entity is in the UE).
  - ○ b) Study enhancements for physical layer procedures to support SL positioning/ranging measurements [RAN1]
  - ○ c) Identify and evaluate potential physical layer procedures and associated signalling to support the transmission and reception of sidelink positioning reference signals [RAN1, RAN2]:

- Study the support for SL positioning/ranging for different cast types
- Study resource allocation enhancements for SL positioning/ranging
        - d) Identify and evaluate enhancements (e.g., configuration, measurements and reporting) for supporting cooperative positioning using a combination of the Uu and PC5 link interfaces for improved positioning [RAN2, RAN1]
        - e) Identify potential architectural impacts to enable SL positioning/ranging [RAN3]
  - **4)** SA2 coordination is required for SL positioning/ranging architectural enhancements. SA2 can decide from their side whether to handle it as a separate SA2 SI or not, with coordination from RAN-side. CT group involvement to be further discussed as well.
  - **5)** Open to consider Unlicensed spectrum but the SL unlicensed operation scope should await the outcome of the parallel email thread on SL enhancements [RAN94e-R18Prep-04] – SL enhancements in order to avoid potential duplicated objectives.

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7 – ESA

1. SI phase within an WI seems more appropriate given that there is need to discuss technical solutions and evaluation methodology.

2. The V2X and public safety. Requirements collected in TR 38.845 could represent the performance targets for Release 18.

3. Besides the good ideas suggested above, we suggest not to preclude RAT-independent from the study phase (absolute and relative). Generally speaking, we recommend investigating at all methods supported in LPP. Some of them in particular high accuracy GNSS can work both on Uu and PC-5 (i.e., GNSS corrections could be received from LMF but could also be exchanged between vehicles over PC-5).

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8 – Samsung R&D Institute UK

1. Since there was no study for sidelink positioning before, directly go into work time is not desirable. If other item (e.g., Improved accuracy, integrity and power efficiency) is approved finally, to have a study phase within a work time would be good.

2. Since Rel-18 sidelink positioning is an extension of Rel-17 RAN study on scenarios and requirements of in-coverage, partial coverage, and out-of-coverage NR positioning use cases, we prefer to evaluate performance based on target scenario and requirement identified in TR 38.854. Also, we agree that the technical solutions need to be agnostic on specific use-cases.

3. We think the following can be considered for objectives for the sidelink positioning as:

- Evaluate performance based on target scenario and requirement identified in TR 38.845 [RAN1]

- Study/specify sidelink positioning architecture and protocol [RAN2, SA2]

- Study/specify sidelink positioning scheme (e.g., TDOA, RTT) including corresponding reference signal & measurements & reports [RAN1]

- Study/specify sidelink positioning procedure [RAN1, RAN2]

4. For sidelink positioning architecture and protocol, we think that interaction with SA2 is necessary.

5. We are negative to consider unlicensed spectrum in the scope. LBT operation and collision nature of unlicensed band operation could seriously impact the positioning signaling (e.g., reference signal, measurement, report etc) transmission and reception, so it could influence the accuracy and also the latency which should be important for some sidelink use cases. Thus, we think it's natural to take step by step. We need to figure out more on the necessity of sidelink positioning over unlicensed spectrum. If licensed band can already provide qualified positioning accuracy and latency, the urgency for unlicensed may not be that much.

9 – Beijing Xiaomi Mobile Software

1. How should the work be structured in terms of study item, work item or a study phase within a work item?

A study item or a study phase is needed for the performance evaluation of potential SL positioning/ranging technologies in different scenario and parameters. The study item and work item can be both completed in Rel-18.

2. Identification of a specific use case (or use cases) from the identified references that will be used for the evaluation and design (noting that this in no way limits the final use of the feature).

a) Smart Home use case in TS22.261, where a smart phone can perform ranging with multiple smart IOT devices with ranging accuracy :10cm distance accuracy, 2 degree angle accuracy. Power efficient and cost should be taken into account for IoT device.

b) V2X use case in TR38.845, where vehicles on the road can range each other.

3. Sufficiently detailed objectives with clear identification of WG responsibilities.

The objective is to study support of sidelink positioning and ranging. The objective of the sidelink positioning and ranging study includes the following objectives for commercial, V2X and public safety use cases, considering in-network coverage, out-of-network coverage, and partial network coverage:

- Study requirements and corresponding evaluation scenarios/methodologies to enable sidelink positioning and ranging based on requirements defined in TS22.261 and in TR38.845 [RAN1]
    ○ Identify requirements such as accuracy and latency, power efficiency
    ○ Define a number of evaluation scenarios, including indoor and outdoor scenario, LOS/NLOS environment, considering V2X/smart phone/IOT UEs.
    ○ Evaluate the performace of different SL positioning and ranging methods, such as OTDOA/UT-DOA/RTT/AOA/AOD/Carrier Phase.
    ○ Cost and power efficiency evaluation for support sidelink positioning and ranging considering IOT devices.
    ○ Define evaluation methodologies

- Study and evaluate potential solutions for support of sidelink positioning and ranging based on the above identified requirements, evaluation scenarios/methodologies [RAN1/RAN2]
    o Design SL positioning and ranging signals.
    o Design SL positioning and ranging measurements.
    o Design SL positioning and ranging methods and procedures.
    o Bandwidth up to 400MHz are considered.
    o Both licensed band and unlicensed band(up to 71 GHz) are considered.
    o The solution should support power efficient SL positioning and ranging.
    o The solution should support one-hop SL positioning and ranging.
    o The solution should support Redcap UE, support high positioning/ranging signal bandwidth and small communication bandwidth.
    o The solution should support both network initiated and UE initiated SL positioning and Ranging.
    o The solutions should consider supporting control signalling sent over licensed band, and Ranging signal over unlicensed band.

- Study the positioning architecture, functional interfaces and procedures for support sidelik positioning [RAN2 RAN3]

4. Any further detail regarding anticipated interaction with SA/CT.

For sidelink based positioning, it needs to interact with SA.CT. regarding SL positioning/ranging architechture, discovery procedure, security and authorization, etc.

5. Views on whether to consider unlicensed spectrum in scope.

Unlicensed band should be considered in rel-18 for the following reasons:

- V2X can be deployed on ITS spectrum, however, in some country, e.g. china, the available ITS bandwidth is only 20MHz. To support 10cm accuracy, much larger bandwidth is required.

- commercial use case is much sensitive to the cost and is more tolerant to the reliability, unlicensed spectrum has more advantage than licensed spectrum.For the concerns that there is no mechanism supporting unlicensed spectrum so far for SL, our thinking is that proper coordination between SL-U and positioning SI can help to solve the issue. And it is not the first time that 3GPP develop two SI/WI which have impact to each other at the same time. To further reduce the overlap between SL-U and SL positioning/ranging, we can also consider only introducing simple unlicensed solution, e.g: Only positioning/ranging signal is introduced on unlicensed spectrum:
  - may only need to consider one LBT category, e.g. Cat 4 LBT
  - no need to support DRS(SSB)
  - no need to support paging, initial access
  - no need to support data transmission: no PUCCH/PUSCH/PDCCH/PDSCH, no HARQ feedback, no UL/DL scheduling, no CSI
  - no RLM/RRM
  - simplified frame structure
  - no CAPC

For the comments in the previous discussion, we have following response.

1. Reference to the word 'sidelink' in the first bullet - one company preferred to remove this as in their view it implied a solution.

We think majority companies suggest to focus on sidelink, we think we need to reduce the scope to consider SL based positioning and ranging, otherwise the scope would be too large to be reasonable unless we split it into two WIs.

2.Reference to the word "ranging" in the first bullet - one company preferred to remove the word 'ranging' as they consider that ranging and relative positioning are not necessarily equivalent.

For the sidelink positioning, we support current proposal to include ranging. But we can accept a compromise to include both ranging and relative positioning in parallel, i.e. "ranging and relative positioning" since relative positioning refers to a whole coordinate while ranging refers to a component of a coordinate, as defined in TS22.261, relative positioning is to estimate position relatively to other network elements or relatively to other UEs and ranging refers to the determination of the distance between two UEs and/or the direction of one UE from the other one via direct communication connection.

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10 – Guangdong OPPO Mobile Telecom.

Our views for Moderator's questions

1.   It will be good to have a study phase within a work item on sidelink positioning to evaluate the feasibility and identify potential technical solutions.

2.   We suggest to include at least V2X use cases, as these use cases have been studied in RAN and have most stringent requirements in terms of accuracy, service availability and confidence level. We are also interested on commercial use cases. We are open to include other use cases to evaluate some special performance metrics if identified.

3.   The following objectives for SL positioning on licensed spectrum (including ITS) should be included

· Determine evaluation assumptions and evaluate of SL positioning for identified use cases (RAN1)

· Specify reference signals, measurement and reporting to facilitate support of SL positioning techniques, including signal pattern and multiplexing with existing SL signals/channels (RAN1)

· Signaling for configuration, measuring, reporting and architecture of SL positioning (RAN2,RAN1)

· Integrity for SL positioning (RAN2)

· RF/Performance requirement (RAN4)

· Note: SL positioning includes both ranging (i.e. relative positioning) and absolute positioning.

4. The procedure and architecture of SL positioning may have some work in SA.

5. Not support unlicensed spectrum in the scope. For the Uu positioning, 3GPP haven't tried any dedicated work/optimization for unlicensed spectrum. Moreover, the SL on unlicensed is not available so far. Thus, it is premature to specify SL positioning on unlicensed spectrum in the current stage. On the other hand, for the work of SL positioning, it is preferred to keep a manageable scope and only focus on ITS and licensed spectrum. In summary, we don't support SL positioning on unlicensed spectrum in Rel-18 and prefer to defer it to the later release.

11 – Huawei Tech.(UK) Co.. Ltd

1. This work could be structured in terms of study item, and if time allows followed by a WI in the same Release.

2. Use cases from TR38.845, with preference of V2X over PS

3. Study and specify solutions (including reference signals, measurements, procedures, etc) for sidelink positioning (i.e. positioning based on SL measurements) operating in coverage, in partial-coverage and out-of-coverage and under gNB control when applicable (configuration, resource allocation) considering the following: [RAN1, RAN2]

· Relative positioning (including ranging) and absolute positioning

· Use cases and requirements from TR38.845

· ITS and licensed spectrum

Note: to reduce the workload, evaluations of positioning techniques may be conducted for operation in-coverage only, for positioning techniques applicable for in-coverage, partial coverage and out-of-coverage.

4. Identify architecture enhancements to support SL positioning in coordination with SA2 [RAN2]

To limit the workload, unlicensed spectrum should not be considered in the scope

12 – vivo Mobile Communication Co.

Q1. How should the work be structured in terms of study item, work item or a study phase within a work item.

A1: we prefer to have a study phase at least. The detailed work scope of the normative WI can be dependent on the progress of the study phase.

Q2. Identification of a specific use case (or use cases) from the identified references that will be used for the evaluation and design (noting that this in no way limits the final use of the feature).

A2: The use case include V2X (TR38.845), public safety (TR38.845), and commercial use cases in TR22.855(ranging), TR22.859(PIN), or TR22.872/22.261, etc. The scenarios should include in/out of/partial of-coverage

Q3.Sufficiently detailed objectives with clear identification of WG responsibilities.

A3. The objectives include:

• Specify positioning enhancements and solutions necessary to support the positioning requirements for NR V2X, public safety and commercial use cases

• Support sidelink based/assisted absolute and relative positioning techniques for in/out of/partial network coverage scenarios and evaluate the achievable positioning accuracy, latency and power consumption for the target use cases

• Identify and specify potential positioning techniques, positioning reference signals, signalling, procedures and architecture

Q4. Any further detail regarding anticipated interaction with SA/CT.

A4. At least the architecture applicable to Sidelink positioning needed to be specified

Q5 Views on whether to consider unlicensed spectrum in scope.

A5. we are okay to discuss the unlicensed spectrum band above 52.6G.

13 – CATT

Q1. How should the work be structured in terms of study item, work item or a study phase within a work item.

[CATT]

Our preference is R18 positioning work starts with a work item, in which there will be a study phase, and then followed by a work phase. There is no need to have a separate study item for carrier phase positioning, carrier aggregation positioning and RedCap positioning, since they are purely based on Rel-16/Rel-17 positioning framework, including the positioning reference signals. The evaluation works for carrier phase positioning and carrier aggregation positioning were already performed in Rel-16/Rel-17 Study Items.

Q2. Identification of a specific use case (or use cases) from the identified references that will be used for the evaluation and design (noting that this in no way limits the final use of the feature).

[CATT]

It needs to at least cover V2X (TR38.845) and public safety (TR38.845) use cases. We also support including the commercial (TS22.261) and IIOT (TS22.104) use cases. The scenarios should at least include out-of-coverage and in-coverage scenarios. Partial coverage scenarios can be considered. The details of evaluation scenarios can be further discussed during the study phase.

Q3. Sufficiently detailed objectives with clear identification of WG responsibilities.

[CATT]

Study and specify the SL-based and SL-assisted positioning solutions to support the absolute and relative positioning (including ranging) for in-network coverage, out-of-network coverage, and partial network coverage scenarios with the consideration of the uses cases of V2X, public safety, IIOT and commercial applications [RAN1, RAN2, RAN3, RAN4].

- Study and specify the use cases and evaluation scenarios for SL positioning [RAN1]
- Define the target positioning performance for SL positioning in Rel-18 [RAN1]
- Study and specify new SL positioning reference signals for SL-based/assisted positioning for ITS and licensed bands in both FR1 and FR2 [RAN1]

- Study and specify new measurements, including timing, angle, carrier phase, and power measurements for SL-based/assisted positioning [RAN1, RAN4]
- Study and specify the procedures and signaling support for SL-based/assisted positioning methods[RAN2, RAN3, RAN1]
- Study and specify the architecture, protocols and messages for integrated positioning with SL and Uu interface information and measurements [RAN2, RAN3, RAN1]
- Define corresponding performance requirements and test cases [RAN4]

Q4. Any further detail regarding anticipated interaction with SA/CT.

[CATT]

SA2 have a new SI for ranging, so coordination with SA2 is expected.

Q5. Views on whether to consider unlicensed spectrum in scope.

[CATT]

Focusing on ITS and licensed spectrum in Rel-18 for SL-positioning. Unlicensed spectrum will be further investigated after unlicensed spectrum is supported for SL.

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14 – ROBERT BOSCH GmbH

1)   We believe that SL positioning imposes different challenges that should be studied first in a study phase. Thus, we propose a 6 month SI followed by a 12 month WI.

2)   In general, we support all use cases related to V2X (TR38.845), public safety (TR38.845) and IIoT.

3)   We think the following objectives can be considered:

[RAN1] Study/specify:

·   sidelink positioning procedure

·   sidelink positioning schemes (e.g., TDOA, RTT)

·   sidelink positioning reference signals

·   sidelink positioning measurement reports

[RAN2] Study/specify:

·   sidelink positioning architecture and protocol

·   sidelink positioning procedure

4)   We think that interaction with SA2 is required.

5)   In general, we agree with other companies' opinions, that considering unlicensed spectrum for sidelink positioning might possibly lead to duplicate objectives with the parallel discussion on sidelink enhancements. Nevertheless, we support considering unlicensed spectrum for sidelink positioning at least in the first study phase to analyze the potential benefits of performing (at least) sidelink ranging in the unlicensed spectrum.

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15 – CEWiT

1. Sidelink positioning work should start with study item phase with clear mentioning of normative phase upon completion of study. Study and work item phase can happen in same release itself (Rel 18).

2. RAN 1 should be responsible group with RAN 2, RAN 3 and RAN 4 as secondary groups.

3. Discussed objective in RAN#93 plenary is sufficient in this case.

4. Use cases should include V2X and public safety as in TR38.845. commercial use case in TS22.261 can be considered as well.

16 – CEWiT

(sorry for staggered input)

5. SA2 should be involved for possible architectural changes anticipated here.

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17 – Futurewei Technologies

1. A Work Item is preferred since there are already existing features on Sidelink and Positioning in Rel-17. A Study phase within the Work Item can be considered if there are issues that require some feasibility studies.

2. Per the guidance as provided by V2X (TR38.845), public safety (TR38.845), commercial (TS22.261), IIOT (TS22.104), we think it is quite sufficient in the sense that V2X use cases and Public safety are the main use cases. There is no need to select specific cases now for the WI. It can be done once the WI starts.

5. Support of unlicensed can be de-prioritized till specification on the support of sidelink in Unlicensed spectrum is available.

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18 – Sony Europe B.V.

- Sidelink positioning is a new concept and has not been properly evaluated. For example, it may require new reference signals, measurements, procedures. Hence, we should start with a study item and the result is to be captured in a technical report.
- Particularly, the study item should cover the use-cases (that can be evaluated by RAN), evaluation methodology, initial performance evaluation, and potential techniques/solutions.
- Note: We can use TR 38.845 as the baseline (e.g. the use-cases).

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19 – Sony Europe B.V.

Furthermore ...

- The study item is then subsequently followed by a work item. Both SI and WI should be within Rel-18 time frame.

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20 – Ericsson LM

1. Work item or study item

Sidelink based ranging and positioning has not been studied in 3GPP before so clearly a study item is needed to evaluate performance and feasibility. There are no solution clearly identified, so a study is needed to scope the WI better.

2. Use cases for evaluation and design

We think it would be interesting to study if sidelink measurements combined with Uu measurements could improve positioning accuracy in IIOT scenarios with low LoS probability (i.e. with lots of machinery/equipment blocking LoS). In such scenarios, measurements over a few LoS sidelinks in addition to the normal measurement over Uu could potentially be useful. Thus we propose to use IIOT scenarios with low LoS probability for the evaluation and potentially also for the design.

3. Detailed objectives

We propose to add the following in the sidelink positioning agenda of Release 18

- Network based/assisted sidelink positioning. (RAN1/RAN2/RAN3)
    - Network based sidelink positioning should be considered where LMF collects sidelink measurements from UEs to compute positions of the UEs.
    - Network can provide assistance data for UE based sidelink positioning in network assisted sidelink positioning.

- Sidelink and network based positioning fusion. (RAN1/RAN2/RAN3)
    - Better positioning performance can be achieved when sidelink positioning related measurements and position estimates are fused with Uu based positioning measurements and estimates.

21 – Philips International B.V.

How should the work be structured in terms of study item, work item or a study phase within a work item.

Since SL positioning/ranging is a relatively new topic we think that a SI is required first followed by a WI.

Identification of a specific use case (or use cases) from the identified references that will be used for the evaluation and design (noting that this in no way limits the final use of the feature).

We think that the 3 sets of requirements in TR 38.845 can be a good starting point for evaluating and designing the WI as long as the commercial use cases are also considered. Those requirements are obviously a good representation for V2X and public safety but also for commercial use cases since the accuracy levels are somewhat summarizing some of the service levels specified in table 7.3.2.2-1 of TS 22.261 and table A.7.2-1 of TS 22.104.

Next to the requirements in TR 38.845, we should also consider ranging services in line with the work done for release 18 in SA1 (i.e. TR 22.855 and TS 22.261) and the proposed work for release 18 in SA2.

Sufficiently detailed objectives with clear identification of WG responsibilities.

- Study the SL positioning techniques including:
    - Study and specify the positioning techniques that will be enabled in SL e.g. timing, angle, carrier phase, power measurements [RAN1]
    - Study and specify new positioning signals for SL including potential resource allocation enhancements [RAN1]
    - Study and specify the signaling require for configuring, measuring and reporting the identified positioning techniques [RAN2]
- Study and specify the procedures and architecture (RAT dependent and RAT independent) to enable Sidelink positioning both UE initiated and network initiated [RAN2]
- Study and specify integrity for SL positioning [RAN2]
- Study and specify performance requirements for SL positioning [RAN4]

Any further detail regarding anticipated interaction with SA/CT.

SA2 should carry out a SI/WI on their side. Such SI/WI should be in sync with the SI/WI defined in RAN

Views on whether to consider unlicensed spectrum in scope.

We do not have a strong preference about whether to include unlicensed spectrum or not but it seems that it makes sense to first support licensed spectrum in SL before we try to define SL positioning for unlicensed spectrum

22 – Intel Corporation (UK) Ltd

(1) Our preference is to start from study item as this is a new topic and study can be beneficial to converge on scope/objectives for the subsequent work item based on analysis/conclusions made during the study item

(2) Our preference is to have focused study on V2X, public safety, IIOT use cases. We are also open for commercial use cases, but consider it as low priority in terms of analysis/evaluations.

(3) Sufficiently detailed objectives with clear identification of WG responsibilities.

- Definition of evaluation methodology for analysis of sidelink absolute and relative positioning [RAN1]
- Physical structure of sidelink reference signals for positioning [RAN1]
- Resource allocation and UE procedures for transmission of sidelink reference signals for positioning [RAN1]
- Procedures for reception of sidelink positioning reference signals, sidelink measurements and reporting of measurements [RAN1]
- Signaling protocols and procedures for support of positioning, including potential impact on NR positioning architecture [RAN2, RAN1]
- Positioning methods and location procedures including support of positioning reference units with sidelink air-interface and known antenna coordinates / orientations [RAN2, RAN1]

(4) The potential impact on SA/CT may be dependent on proposed solutions for sidelink positioning, however some general aspects: privacy, authentication, security, authorization may need to be considered including positioning architecture, e.g., entities providing coordinate sharing / estimation.

(5) Our view is that availability of unlicensed spectrum is beneficial to improve accuracy of NR positioning using Uu/PC5 interfaces and avoids impact on spectrum efficiency of licensed spectrum. In addition, the lack of positioning feature on unlicensed spectrum would result in NR being inferior to other RATs (e.g., WiFi), since NR currently does not support RAT-dependent positioning in unlicensed spectrum. Therefore, we propose to consider unlicensed spectrum in scope.

23 – Apple France

In our view, SL-positioning should start as a study item, followed by normative work in Rel-18, where it is led by RAN1 (as the main WG), and RAN2/3.

In terms of use-case, the TR of RANP study on the requirements and scenarios for SL positioning in V2X and Public safety already provide strong justifications for this work.

Also we think SA2 needs to be involved for SL positioning, as it is not clear how it fits into the LCS architecture

24 – MediaTek Inc.

1. Work structure: We think it is pretty clear that a study phase (or short SI followed by a WI) is needed.

2. Use cases: V2X and public safety were examined in the plenary SI and can be carried forward, but we also think commercial/IIoT use cases are important, e.g., the smart factories use cases cited by Motorola Mobility, smart home use case from TS 22.261, PIoT use cases from TR 22.859. In-coverage and out-of-coverage should be considered, but note that out-of-coverage cases pose a special problem for the architecture (see item 4).

3. Objectives and WG leadership: Positioning generally is RAN1-led, with secondary work in RAN2/3/4. Objectives should include the design of sidelink RSs and related measurements, signalling of related assistance data and measurement information, protocol adaptations to the sidelink setting (also see item 4), and integration of sidelink and Uu positioning, with the objectives addressing both absolute and relative positioning.

4. SA/CT interaction: There will be significant interaction with SA2, especially for an architecture usable in out-of-coverage cases, where relying on a positioning server in the network is obviously not applicable. We understand SA2 plan to consider such scenarios, and RAN2 impact should be anticipated to adapt to whatever architectural enhancements they design–e.g., new forms of the LCS procedures could be expected, with a need to carry positioning protocols (LPP/NRPPa) over PC5. We think the out-of-coverage cases are important to pursue, but the SI/WI should be clear about the architectural aspects.

5. Unlicensed: We see unlicensed sidelink generally as important, and the applications would benefit from positioning. However, we also see the complexity in designing the features at the same time, and positioning will already be a large work item. One way forward might be to study the impact of unlicensed spectrum in the study phase, and proceed to normative work on that aspect in Rel-18 only if time and the condition of the SL enhancements work permit.

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25 – Qualcomm Incorporated

- Study Phase within a work item

- We think there is no need to down select the use-cases, and, we actually believe that the focus should be on progressing on the work item description, rather than debating on the use-cases. Focusing on out-of-coverage scenarios would simplify evaluations while enabling solutions applicable to other scenarios as well.

- *Study and specify, solutions to enable sidelink positioning with the following objectives and considerations:*
  - *Evaluation scenarios/methodologies to assess potential solutions for sidelink positioning [RAN1]*
  - *NR Sidelink reference signals and corresponding physical layer measurements and procedures, for enabling ranging, relative positioning, and absolute positioning [RAN1]*
  - *Positioning architecture, higher layer procedures, control signaling, functional interfaces and protocols for enabling [RAN2]*

     i. *Sidelink-only positioning (PC5 interface)*

     ii. *Combination of measurements derived on Uu and PC5 interface*

- *Core requirements for NR Sidelink positioning [RAN4]*
- *The solution development needs to take the follow into account:*

     i. *Coverage scenarios: Focus on out-of-coverage (with the understanding that in-coverage and partial-coverage shall be supported if out-of-coverage is supported)*

     ii. *Requirements: Based on requirements identified in TR38.845 and TS22.261 and TS22.104*

     iii. *Spectrum: ITS, licensed, Unlicensed*

iv.   Position calculation entity: UE-based positioning (In/partial coverage and Out of coverage), and Network-based positioning (In/partial coverage)

v.   Support the positioning operation at least with the existing automotive operations for carrying control signaling, including LTE V2X and NR V2X.

- Design of positioning architecture, higher layer procedures, control signaling, functional interfaces and protocols requires RAN2 to work closely with SA/CT working groups.

- Yes, unlicensed spectrum for PRS transmission needs to be included in scope:

·   For V2X, including out-of-coverage, absolute and relative positioning requirements include set 1, set 2 and set 3 defined in TR 38.845:

-    Set 1: 10 – 50 m with 68 – 95 % confidence level.

-    Set 2: 1 – 3 m with 95 – 99 % confidence level.

-    Set 3: 0.1 – 0.5 m with 95 – 99 % confidence level.

To achieve these positioning accuracy requirements, 3GPP's design for the sidelink PRS will require bandwidth of 100MHz or better. Currently no region has allocated this much spectrum for ITS, and there is no clear indication of plans from operators to allow the use of sufficient licensed spectrum for V2X or Public Safety positioning operation.

·   Without support of SL-PRS over unlicensed band, Sidelink Positioning cannot support the very important automotive market as pointed out by 5GAA.

Transmitting SL-PRS over unlicensed spectrum can reuse existing NR-U channel access. Therefore, 3GPP will incur no significant workload related to this.

26 – InterDigital France R&D

- We propose a study for sidelink positioning since existing/new positioning methods need to be evaluated for sidelink use cases.

- Use cases that should be focused are V2X, public safety, IIoT (e.g., regulating AGV via sidelink). For requirements TR 38.845 can be used. We recommend Set 3 requirement for IIoT and public safety and set 2 requirement for V2X. Out-of-coverage, in-coverage and partial coverage scenarios should be covered in the study. For IIoT, focusing on in-coverage and partial coverage scenarios may be sufficient.

- RAN1 studies evaluation methodologies and potential positioning methods. RAN1 studies reference signals, procedure, measurements for Uu-assisted sidelink and standalone sidelink positioning applicable to both Mode 1 and Mode 2. RAN2 enhances LPP and RRC based on RAN1 inputs. RAN2 studies support of positioning in SL DRX.

- Contact SA2 if LCS and NRPPa enhancements are needed.

- Unlicensed spectrum can be considered at later stage. Focus on licensed spectrum first to build the fundamentals for sidelink positioning.

2.2　　　Summary from Initial Round

1/ Structure of work - It is very clear from all comments received that the work on sidelink positioning needs to start with some study. There were different views as to whether to have a SI followed by a WI, both within Rel-18, or to have a WI with a study phase and a number of companies didn't express a clear preference between the 2 variants. In the view of the moderator, whether to structure the work as a SI+WI or as a WI with a study phase depends also on the other objectives - i.e. if there are some objectives for which normative work can start immediately then it is easier to have a WI with study phase for those objectives that require it. Considering the other objectives, and in particular RedCap positioning which most companies think can start immediately with normative work, the moderators proposal is to structure this work as a WI with a study phases as needed for different items.

2/ Identification of use case - Nearly all companies want to consider V2X and public safety use cases. There was also a high level of interest in commercial and IIoT use cases. Very few companies offered more specific selection use cases to be used in the evaluations, and some companies suggested that it would best if more specific use case selection was left to during the study. While the moderator considers that selection of specific use cases in RAN plenary could help efficient progress of the study, it seems difficult to make any such selection based on this discussion. Therefore, the moderator's proposal is keep the list of uses cases, and reference documents, from the previous discussion.

3/ Detail objectives - Many companies offered suggestions for the wording of the detailed objectives, and in most cases there was a lot of commonality between them. All these have been considered in the updated text below.

4/ Interaction with SA - Interaction with SA is required in particular in relation to the positioning architecture. One company commented that the aspect likely to require the biggest interaction with SA is the out of coverage scenario, when network functions are not available.

5/ Unlicensed - There is a split in views between those who would like unlicensed included in the scope, or at least would be open to including it in the scope, and those that consider it should not be included, mostly for reasons of keeping the workload manageable. Based on these views and also the need to keep the scope reasonable, the moderators conclusion is that unlicensed should not be included in the scope.

Revised objective text:

- Study (for study phase of 9 months) solutions for sidelink positioning: [RAN1, RAN2]

  ○ Including both relative positioning (including ranging) and absolute positioning
  ○ Coverage scenarios to cover: in-coverage, partial-coverage and out-of-coverage
  ○ Requirements: Based on requirements identified in TR38.845 and TS22.261 and TS22.104
  ○ Use cases: V2X (TR38.845), public safety (TR38.845), commercial (TS22.261), IIOT (TS22.104)
  ○ Spectrum: ITS, licensed
  ○ Identify specific target performance requirements to be considered for the evaluation [RAN1]
  ○ Define evaluation methodology with which to evaluate SL positioning for the identified uses cases and coverage scenarios, reusing existing methodologies from sidelink communication and from positioning as much as possible [RAN1].
  ○ Study and evaluate performance of potential solutions for SL positioning: [RAN1, RAN2]
    ▪ Study of positioning methods (e.g. TDOA, RTT, AOA/D, etc) [RAN1]
    ▪ Study of sidelink reference signals for positioning purposes, including signal design, resource allocation, physical layer measurements, associated physical layer procedures, etc [RAN1]

- Study of positioning architecture and signalling procedures (e.g. configuration, measurement reporting, etc) to enable sidelink positioning [RAN2, including coordination with interaction with SA2 as required]

2.3 Intermediate Round

Comments to the revised objective text are requested.

Feedback Form 2: Sidelink positioning/ranging - intermediate round comments

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3 Improved accuracy, integrity and power efficiency

3.1 Initial Round

In the outcome of the previous discussion, the topic on improved accuracy, integrity and power efficiency was captured as follows:

- Improved accuracy, integrity, and power efficiency:

    - Study/Specify solutions for Integrity for RAT dependent positioning techniques [RAN2, RAN1, Coordination with SA2 as required]
    - Study/Specify solutions for accuracy improvement based on PRS/SRS bandwidth aggregation and NR carrier phase measurements [RAN1, RAN4, RAN2]
    - Study the requirements on LPHAP as developed by SA1 and evaluate whether existing RAN functionality can support these power consumption and positioning requirements. Based on the evaluation, identify potential enhancements to help address any limitations [RAN1, RAN2]

It was also noted in the outcome of the previous discussion that some aspects were still controversial to some degree. These were:

1. The list of topics in the second sub-bullet may still be controversial

2. A number of companies considered that the LPHAP bullet was not yet sufficiently motivation to be included

In providing feedback for the initial round, I would like companies to specifically comment on the following:

1. How should the work be structured in terms of study item, work item or a study phase within a work item.

2. Sufficiently detailed objectives with clear identification of WG responsibilities.

3. Any further detail regarding anticipated interaction with SA/CT.

4. Further views on the specific accuracy improvements to be considered

5. Further views on whether to include an objective on LPHAP. It may also be helpful to identify a specific use case or use cases from SA1's work on which focus the studies in RAN.

Other comments may also be provided.

Feedback Form 3: Improved accuracy, integrity and power efficiency - initial round comments

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1 – TELECOM ITALIA S.p.A.

Prefer a Work Item with clear objectives and limited scope. There is market request for high accuracy positioning, and a study will lead to further delay in the availability of products.

Ranging solutions should be also specified.

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2 – DanKook University

A new study goal is necessary for the evolution of positioning technology in Release-18. Phase based positioning technology, such as carrier phase positioning, is a strong candidate that can achieve centimeter grade positioning. It can open a new door for accuracy improvement using yet undiscovered tools such as carrier phase or subcarrier phase measurement.

There have been some questions raised for the study of phase-based positioning. We propose to include the following topics in the work scope/objective for accuracy improvement.

- Solution for integer (or angular) ambiguity due to short carrier wavelength

- Signaling, measurement, and reporting method for the extended phase values

- Performance study on the different approaches of phase-based positioning against existing RSTD, AoA/AoD methods.

 Note: there can be a number of phase-based solutions such as single carrier phase, multi-carrier phase, subcarrier phase, angular phase, etc.

- Effective method for suppressing phase noise, error, etc. due to RF imperfection

- Method for maintaining long-term phase synchronization (>24 hours)

The use cases have been well illustrated in GPS carrier phase or Bluetooth group (R1-2104844). Note that the phase-based technology can work well by utilizing relatively narrower bandwidth. Therefore, it can also be successfully applied in Sidelink, Redcap, and LPHAP with consuming a small amount of resources yet providing higher positioning accuracy.

Some examples are for sidelink positioning, vertical positioning accuracy improvement for public safety such as E911, very precise indoor positioning for applications of AR/VR, pedestrian/robot navigation, LBS, etc

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3 – ZTE Corporation

1. We think Integrity, accuracy improvement based on PRS/SRS bandwidth aggregation and NR carrier phase measurements should be specified as a normative work without study phase. Those aspects have been discussed in Rel-17, the potential enhancement points are very concrete, no need to further study.

2.   We are open to include LPHAP objective, but it should be a study phase because all of use cases, requirements are not clear yet. Considering the Rel-18 positioning scope has been very large, and potential enhancements are also not clear, we suggest to focus on one of use cases and requirement in TS 22.104.

a)   Rel-18 should mainly focus one evaluation work to check if the existing positioning methods/procedures can satisfy the requirement or not.

b)   The potential enhancement aspects should be concrete, otherwise, the scope may be out of control.

        i.   As many companies mentioned before, positioning enhancement in RRC inactive and/or idle state is a good candidate for power saving. We suggest focusing on this aspect if the enhancement is needed.

3.   This should be led by RAN1. And coordinate with RAN2, RAN3 and SA2.

Recommend objectives:

a)   Specify multiple PFLs aggregation for joint DL PRS transmission/reception and specify multiple carriers aggregation for joint UL SRS transmission/reception [RAN1, RAN4]

b)   Specify positioning integrity for RAT-dependent positioning methods [RAN2]

c)   Study and evaluate the performance for LPHAP [RAN1, RAN2].

Based on the evaluation, specify positioning enhancement in RRC inactive and/or idle state if necessary.

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4 – China Mobile E-Commerce Co.

- We prefer to structure the work to be a work item, some evaluations (e.g., for the LPHAP) can be included as a study phase of the work item.

- Regarding the 2nd sub-bullet that are controversial, to further improve the positioning accuracy, the enhancement should not be limited to only SRS/PRS BW aggregation, and as proposed by CATT, MTK, Nokia, Xiaomi, and Fraunhofer in the last email discussion, we are supportive of the carrier phase positioning as well.

- From our perspective, the LPHAP is a critical objective that should be included within the scope. Specifically, according to the feedback from the automotive industry market, the following requirement is observed, which we believe is a typical example area of LPHAP, and should be enhanced in Rel-18 phase:

    ○ Accuracy for indoor scenario (NLOS dominant): **0.1m (Horizontal) @ 90%, 0.5m (Horizontal) @ 99.99%**
    ○ Battery life: **1 year**

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5 – Nokia France

The highest priority for Rel-18 positioning is accuracy enhancement, especially with carrier phase positioning which was already studied in the Rel-16 SI and uniquely has the potential to bring a substantial step-change in achievable accuracy, especially in indoor scenarios, which is essential for services such as IIoT. This should begin directly with normative work. We also see some support for RAT-dependent integrity and LPHAP, so we are OK with the objectives as described above. The TU allocation for the WI should be sufficient to ensure that these items can be covered in addition to out-of-coverage positioning.

The objectives for positioning accuracy enhancement by carrier-phase positioning could be as follows:

- Specify terrestrial carrier-phase positioning for NR:
    ○ Specify positioning reference signal for carrier phase positioning method [RAN1/2]

- Focus on reuse of existing PRS and/or SRS as first priority; other reference signals or new reference signal may be considered as second priority.
  - Study, and if needed, specify procedures, signaling, and reporting for integer ambiguity resolution and cycle slip detection [RAN1/2].
  - Specify signalling for configuration and reporting [RAN1/2/3]
    - Specify phase measurement request and resource configuration signals
  - Specify carrier phase measurements and requirements [RAN1/4]
    - Define UE carrier phase measurement accuracy and measurement period requirements, including study of impacts from phase discontinuity/distortion.
    - Include gNB carrier phase measurements.
  - Study and specify the use of OTA measurements (e.g., using a reference device/PRU) for mitigation of Tx/Rx (time and) phase errors [RAN1/4]

6 – Spreadtrum Communications

Regarding carrier phase based positioning technique, since the positioning accuracy has been well justified in GNSS-based positioning methods, we think it can be included in Rel-18 positioning scope. As a new positioning technique in 3GPP, a study phase is required to evaluate the achievable gain in NR network and identify the spec impact.

For LPHAP, UE power consumption evaluation for positioning is needed in R18. Positioning enhancement in RRC inactive and/or idle state can be considered to enhance UE power efficiency of positioning.

7 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility :

- **1)** Supportive of a work item for the Rel-17 carryover items (first 2 bullets) and LPHAP work. Alternatively, the LPHAP work could have a short study phase within a work item that targets energy efficient positioning.
- **2)** Proposed WI/SI objectives could include:
  - **(WI Objective)** Study/Specify solutions for Integrity and reliability of assistance data for RAT-dependent positioning information [RAN2, RAN1]:
    - Identify the error sources, threat models, occurrence rates and failure modes requiring positioning integrity validation and reporting [RAN2, RAN1].
    - Study methodologies for network-assisted and UE-assisted integrity [RAN2, RAN1].
  - **(WI Objective)** Specify solutions for accuracy improvement based on PRS/SRS bandwidth aggregation at least in terms of the following:
    - Simultaneous transmission by the gNB and reception by the UE of intra-band one or more contiguous carriers in one or more contiguous PFLs [RAN1, RAN4, RAN2].
    - Simultaneous transmission by the UE and aggregated reception by the gNB of the SRS for positioning in multiple contiguous intra-band carriers [RAN1, RAN4, RAN2].
  - **(SI Objective within WI)** Study solutions to support Low Power High Accuracy (LPHAP) in terms of the following:
    - Study and specify the physical layer enhancements (e.g. PRS design), including physical layer signalling procedures and measurements [RAN1].
    - Study and specify the protocols and messages to support LPHAP [RAN2, RAN3].
    - Determine LPHAP performance requirements and test cases [RAN4].

  ○ **3)** Involvement from SA2 may be required for LPHAP and integrity for RAT-dependent positioning.

  ○ **4)** Further accuracy enhancements may be considered subject to work load and TUs of above objectives.

  ○ **5)** Regarding LPHAP objectives, there are set of use case requirements outlined in TS22.104, which require support by RAN. The LPHAP should aim to cover use cases that range from "**Process automation Dolly tracking (outdoor)**" with 10m horizontal accuracy a battery life or minimum operation time of 24 months to use cases such as "**Flexible modular assembly area: Tool assignment (assign tool to vehicles in a production line, left/right) in flexible, modular assembly area in smart factories**" with 0.3 m horizontal accuracy, 250 ms duty cycle and battery life of 18 months.

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8 – Samsung R&D Institute UK

1. In case of improved accuracy and integrity, we think that work time is desirable since these are considered as further enhancements of Rel-17 positioning.

2. For improved accuracy and integrity, we think that the outcome of the previous discussion can be good starting point in regarding objectives and WG responsibilities. However, on carrier phase measurements for improved accuracy, this can be considered for sidelink positioning. For Uu positioning, the benefit from NR carrier phase measurements is not clear since LOS cannot be guaranteed in cellular communication environments.

- Study/Specify solutions for integrity for RAT dependent positioning techniques [RAN2, RAN1, Coordination with SA2 as required]

- Study/Specify solutions for accuracy improvement based on PRS/SRS bandwidth aggregation and NR carrier phase measurements [RAN1, RAN4, RAN2]

3. For integrity for RAT dependent positioning, we think that interaction with SA2 is necessary.

4. We can consider the left over from Rel-17 positioning if it is manageable within work scope.

5. This can be included depending on allocated time for Rel-18 positioning. If included, we need to study the requirements on LPHAP as developed by SA1 at first and then we need to identify what potential enhancement is required.

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9 – ESA

2. Objectives: The work on GNSS integrity will need continuation in the next releases. We recommend including this topic on the list of objectives [RAN2].

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10 – Telia Company AB

As stated by TIM, there is already now market request for high accuracy positioning especially in IIoT as stated by Nokia. We see that Carrier Phase Positioning should be the main item in Release 18 and to start with a WI directly if possible.

For LPHAP it is fine to start with a SI initially.

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11 – Guangdong OPPO Mobile Telecom.

1. Support the integrity part:

 - In R17, the integrity for RAT-independent positioning approach has been agreed to be introduced. For the next release, it is a reasonable evolution to consider to introduce integrity for the RAT-dependent positioning approach.

2. Not support the PRS/SRS bandwidth aggregation and carrier phase measurement

- The current bottlenecks of further improvement for accuracy are the timing delay/error and NLOS. These two proposals cannot address the bottleneck of accuracy improvement.

- PRS/SRS bandwidth aggregation: The phase offset and time delay between different chain at both gNB and UE side does not enable aggregating PRS and SRS in different BW. There were throughout discussions in Rel-17. However, its feasibility was not justified. Nothing is changed so far. Thus, we don't think it should be in the scope.

- Carrier phase based method: It was discussed in Rel-16 and Rel-17, but not get much supporter. It is not constructive to further study a proposal that was not attracting sufficient support in the last two releases. Moreover, the feasibility for cellular systems is not justified so far and the benefits in terrestrial scenarios are doubtable as well.

3. Support LPHAP. From UE perspective, power consumption is a key aspect for further enhancement. Thus, we propose to study and specify (if necessary) lower power mechanism for positioning.

Ins summary, we propose to include the following objectives:

- Specify solutions for Integrity for RAT dependent positioning techniques [RAN2, RAN1, Coordination with SA2 as required]

- Study the requirements on LPHAP as developed by SA1 and evaluate whether existing RAN functionality can support these power consumption and positioning requirements. Based on the evaluation, identify potential enhancements to help address any limitations [RAN1, RAN2]

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12 – Beijing Xiaomi Mobile Software

We think this part should be started with a study phase within a work item. We are general fine to the current objectives, for LPHA, the power efficiency is very important for UE and should be considered for all types of UEs including commercial UE, RedCap UE and IoT UE.

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13 – Huawei Tech.(UK) Co.. Ltd

1. This work could be structured in terms of a WI with a study phase.

2. On the detailed objectives,

For integrity work for RAT-dependent solutions, suggest to keep it in RAN2 only. The objectives should include the study on feasibility of LMF-based integrity calculation and potential signaling flow to support integrity result calculation by the LMF, including the error source identification. Related RAN1 work should be minimized and triggered by RAN2 LS. We do not see a need to interact with SA/CT even if the WI phase. For integrity, we understand what is specified in Rel-17 in SA/CT is sufficient to be directly used for signaling transfer to support RAT-dependent integrity.

For LPHAP, RAN1 should study the UE power consumption evaluation to see if any enhancements to Rel-17 RRC_*INACTIVE state positioning or extension to RRC*_IDLE state positioning can meet the LPHAP requirements, defined by e.g. the use case 6 in TS 22.104, or some consolidated set of requirements covering several use cases, such as 1 year battery life with 50 cm@90% accuracy and 15-second positioning interval. It should be led by RAN1.

For PRS/SRS bandwidth aggregation, since RAN1 already conducted evaluation in Rel-17, the study for this objective can led by RAN4, with RAN1 as secondary WG.

For carrier-phase based positioning, RAN1 could evaluate whether the phase reporting for the first path is sufficient to enable the feature. It should be led by RAN1, and RAN4 as the secondary WG.

14 – vivo Mobile Communication Co.

Q1: Support a study phase for power, accuracy and integrity enhancements for better evaluating positioning performance and identifying suitable techniques.

Q4: For improved accuracy, the enhancement should also include positioning based on bands from 52.6GHz to 71GHz. In our view, the frequency ranges above 52.6 GHz potentially contain larger spectrum allocations and larger bandwidths that are not available for bands lower than 52.6 GHz.

For PRS/SRS aggregation, we are open to further study it in Rel-18 based on the conclusion in Rel-17. But it is better for RAN4 to lead this topic to study the feasibility and applicability first, then other groups can conduct potential works.

Q5: For improved power efficiency, we believe that the potential work of Rel-18 should not be limited to a specific use case (e.g. LPHAP), even for a normal UE, power efficiency is strongly needed. Therefore, positioning with DRX and idle/inactive positioning enhancement can be considered.

15 – CATT

Q1. How should the work be structured in terms of study item, work item or a study phase within a work item.

[CATT]

Our preference is R18 positioning work starts with a work item, in which there will be a study phase, and then followed by a work phase. There is no need to have a separate study Item for carrier phase positioning, carrier aggregation positioning and RedCap positioning, since they are purely based on Rel-16/Rel-17 positioning framework, including the positioning reference signals. The evaluation works for carrier phase positioning and carrier aggregation positioning were already performed in Rel-16/Rel-17 Study Items.

Q2. Sufficiently detailed objectives with clear identification of WG responsibilities.

[CATT]

- Define the use cases and evaluation scenarios and target positioning performance for Rel-18 further positioning enhancements [RAN1]
  - o Note: The use cases and evaluation scenarios defined in Rel-16 or Rel-17 can be reused.
- Evaluation of the carrier phase positioning performance based on existing DL PRS and UL positioning SRS in FR1 [RAN1]
- Study and specify new positioning reference signals for NR carrier phase positioning if necessary [RAN1]
- Study and specify the methods for resolving potential challenging issues related to NR carrier phase positioning, such as the impact of network time/frequency synchronization errors, the integer ambiguity resolution, and the cycle slip detection, etc.[RAN1, RAN4]
- Define the new carrier phase measurements [RAN1]
- Specify the procedures and signaling support for NR carrier phase positioning [RAN2, RAN3]
- Define the target performance requirements on LPHAP [RAN1, RAN4]
- Study and specify the physical layer enhancements, including physical layer signaling, measurement, procedures, and the UE capability to support LPHAP [RAN1]
- Study and specify the protocols and messages to support LPHAP [RAN2, RAN3]

- Feasibility study of carrier aggregation positioning on the impact of timing alignment error, phase continuity, etc. [RAN4]
- Specify the measurements, the procedures and the signaling support for carrier aggregation positioning [RAN1, RAN2, RAN3]
- Define corresponding performance requirements and test cases [RAN4]

Q3. Any further detail regarding anticipated interaction with SA/CT.

[CATT]

None.

Q4. Further views on the specific accuracy improvements to be considered.

[CATT]

None.

Q5. Further views on whether to include an objective on LPHAP. It may also be helpful to identify a specific use case or use cases from SA1's work on which focus the studies in RAN.

[CATT]

As we proposed in Q2, we support the following objectives for LPHAP:

- Define the target performance requirements on LPHAP [RAN1, RAN4]
- Study and specify the physical layer enhancements, including physical layer signaling, measurement, procedures, and the UE capability to support LPHAP [RAN1]
- Study and specify the protocols and messages to support LPHAP [RAN2, RAN3]

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16 – CEWiT

1. We feel Integrity and accuracy improvement based on PRS/SRS bandwidth aggregation should be taken up as a normative/work item phase or small study phase in work item phase.

2, NR carrier phase measurements needs study phase to see the impact on accuracy and possible specification impact analysis for better TU management during normative phase. Moreover multi paths scenario in RAT based positioning is cause of worry to directly adopt carrier phase from GNSS systems.

3. For support of LPHAP,we propose to study phase with clear objective and use cases.

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17 – Futurewei Technologies

1. A Work Item is preferred since there are already existing features on Sidelink and Positioning in Rel-17. A Study phase within the Work Item can be considered if there are issues that require some feasibility studies.

2. Agree with the current WG responsibilities in the draft text above.

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18 – Sony Europe B.V.

1)   We can immediately start with a work item. Some aspects, such as LPHAP can be a study within a work item.

2)   Most of the items are RAN1-led, except integrity (RAN2-led).

3) In addition to the list above, we should consider the potential left-over from Rel.17 (e.g. on accuracy, and latency improvements). Due to limited time in Rel-17, some aspects in latency improvements may not be completed. Hence, it would be beneficial to continue in Rel-18.

4) On bandwidth aggregation, we need to thoroughly study the impact of phase error in bandwidth aggregation. Mitigating phase error in bandwidth aggregation is essential. Otherwise, the gain is limited.

5) On carrier phase-based positioning, we have some concerns, such as on potential significant spec impact (that may require significant amount of TUs during WI) and whether it may affect the existing HW.

19 – Ericsson LM

We think the scope of the Rel. 18 position area is already far too large. The proposed techniques for enhancing positioning accuracy are not really addressing the bottle necks we see for achieving high accuracy in realistic use cases and scenarios, rather any improved accuracy would only happen in artificial scenarios with ideal line of sight conditions. PRS/SRS bandwidth aggregation requires pico-second level coherency between carriers resulting in a significant increase in complexity and cost with several operators being skeptical to PRS/SRS bandwidth aggregation due to lack of spectrum availability. Furthermore, power efficiency can be handled under Redcap positioning. Therefore, we propose that the objective for improved accuracy and power efficiency is removed.

If the objective for improved accuracy is anyway kept, it should be formulated as a study for accuracy improvement techniques based on realistic use cases and scenarios. The big bottle neck for positioning is the problem with NLOS conditions, resulting excess delays for timing measurements and erroneous angular measurements. Accuracy improvements in scenarios with low LoS probability, and with realistic modelling of NLOS excess delays/angular errors are of biggest importance. There are clearly many other techniques than PRS/SRS bandwidth aggregation and carrier phase measurements that will give better improvements in accuracy for important use cases in realistic environments. As an example, DL AoA could give significant improvements in positioning accuracy in vehicular scenarios where UE antennas suitable for DL AoA are realistic. DL AoA would be useful in scenarios with low LoS probability, and could also be used to estimate UE orientation. Another example is continued work on LoS detection and rich reporting where work started towards the very end of Rel. 17 and where there is more to do.

Integrity is an important part of positioning enabling applications to make the correct decision based on the reported position. E.g., to monitor a robotic arm to decide whether its arm movement are within allowed limit to ensure safety distances to humans and other objects it's not enough with a position estimate. There is a need to know whether the desired integrity KPIs of the position estimate can be met to ensure the safety distances. There are still some components missing to enable RAT based positioning estimates with integrity. We therefore propose to keep this objective.

A study item is needed to evaluate performance and feasibility of the proposed techniques.

In summary

1. The objectives on accuracy and power efficiency should be removed.

2. RAT based integrity should be kept.

3. Start with a study item.

20 – Philips International B.V.

We agree with Oppo. It is good idea if both RAT-dependent position integrity and LPHAP start with a study first. Please note that the topic of RAT-dependent position integrity was agreed before to be included for release 17, but insufficient TUs were allocated to address both RAT-dependent and RAT-independent

position integrity. This time in release 18, we need to make sure sufficient TUs are allocated to complete the study.

21 – Intel Corporation (UK) Ltd

(1) Our preference is to have:

Items with higher priority

- Study phase on integrity for RAT dependent positioning
- Work item for intra-band contiguous DL PRS / SRS for positioning aggregation. We think that this can start directly with normative work as it was already studied during Rel-17, and we are proposing to limit the scope to the most straightforward case of intra-band contiguous

Items with lower priority

- Study on feasibility / benefits of carrier-phase positioning method in cellular networks
  Note that even basic phase measurements per channel path are still not supported by NR positioning due to feasibility concerns. In our view, carrier phase measurements have even more challenges for practical implementation. If group would like to prioritize this study, then our suggestion is to include per path phase measurements into the scope as well.
- Study on LPHAP
  Further discussion/analysis is needed to motivate this work in terms of radio-layer solutions vs functionality to be enabled in Rel.17 (e.g., support of NR positioning by RRC_INACTIVE, RRC_IDLE UEs)

(2) Objectives for higher priority items:

- Study phase on integrity for RAT dependent positioning [RAN1, RAN2]
  Identify error sources and integrity metrics suitable for RAT dependent positioning solutions including Uu air-interface to support reliable NR positioning
- Specify intra-band contiguous DL PRS / UL SRS for positioning aggregation [RAN2, RAN4, RAN1]
  Define signaling, measurements and UE/gNB measurement reports for corresponding frequency bands, where PRS/SRS aggregation is suitable

(3) We do not see immediate impact on SA/CT groups for the proposed above objectives. There may be potential impact identified for integrity objective, but it can be analyzed / decided at a later stage

(4) In our view, accuracy requirements discussed in previous NR Positioning releases are applicable and positioning accuracy can be further improved if additional enhancements are introduced

(5) Further justification / motivation from proponents is needed to include LPHAP objective in Rel.18 scope (i.e., which enhancement directions need to be further pursued considering the status of Rel.17 work)

22 – Apple France

We prefer a precise objective in R18 positioning. Given that the current scope is already broad with three objectives, we suggest to down-select to up to two objectives (SL positioning and possibly RedCap positioning). Given that proponents of Improved accuracy have different (somehow contradicting) views on the areas/techniques for further accuracy enhancement (e.g. whether it is PRS/SRS aggregation or it is carrier-phase-based enhancements), we prefer this objective is deprioritize in Rel-18.

23 – Verizon UK Ltd

Agree with Nokia etc. We think better accuracy is important for e.g., industry IOT cases. We see the market need, if the technology is available.

24 – MediaTek Inc.

This area is a bit heterogeneous. Bandwidth aggregation was discussed in Rel-17 and has the issue of requiring close timing alignment between carriers, but the details were contentious, and if we want to pursue it some further initial analysis would be required–also, intra-band CA (especially contiguous) may not be a common scenario, and on balance we do not see this as a top priority. Signal phase measurements (including antenna phase difference as well as carrier phase measurements) seem valid to pursue, possibly requiring some initial evaluation in a short study phase in RAN1. And for RAT-dependent integrity, we have some concern, because RAT-independent integrity had the benefit of significant existing work from the GNSS community (and has still brought a significant workload in Rel-17); there is no such prior work for the RAT-dependent case, meaning that RAN1 would need to do significant work e.g. to define error sources and failure modes at the beginning of the work. Furthermore, GNSS integrity may require some alignment work in the Rel-18 time frame due to different timelines between 3GPP and RTCM, so the general area of integrity could expand to a large workload. Finally, the relation between the LPHAP aspects and RedCap positioning may need some further discussion; Rel-17 already offers some power saving techniques such as positioning in RRC_INACTIVE, which can be applicable to general non-RedCap UEs, and we think some clarity is needed as to whether there are requirements that go beyond both Rel-17 enhancements and RedCap.

So on balance, we would prefer to prioritise the signal phase measurements in this area, give RAT-dependent integrity some scrutiny in a study phase before committing to specify it, and further discuss whether LPHAP enhancements separate from RedCap positioning and from Rel-17 power saving enhancements are needed.

25 – Qualcomm Incorporated

- Study phase within a Work Item
- *Study/Specify,*
    - *Solutions for RAT-dependent NR positioning integrity determination for both UE-based and UE-assisted RAT-dependent NR positioning methods [RAN2, RAN1]*
    - *Aggregation of multiple Positioning Frequency Layers for DL PRS transmission/reception, and multiple carrier aggregation of SRS for Positioning transmission/reception [RAN1, RAN4, RAN2]*
    - *Reference Signals, signaling, procedures, UE and gNB measurements, and reporting for NR carrier phase positioning for UE-based and UE-assisted timing and angular positioning methods [RAN1, RAN2, RAN4]*
- No significant interaction with SA/CT is anticipated.
- Keep both accuracy enhancements (bandwidth aggregation and carrier phase) in scope.
- OK to study the requirements on LPHAP as developed by SA1 and evaluate whether existing RAN functionality can support these power consumption and positioning requirements. Based on the evaluation during a study-within-work-item phase, identify potential enhancements to help address any limitations [RAN1]

26 – InterDigital France R&D

- We support a study item for integrity, bandwidth aggregation and LPHAP to identify enhancements needed.

- Integrity : RAN2 leads the study to Identify KPIs, error sources, necessary assistance information to derive integrity results. RAN2 also leads a study on reporting and procedure for integrity results delivery and determination, respectively.
- Bandwidth aggregation : RAN1 leads assisted by RAN2 : RAN1 studies evaluation methodologies, procedure, assistance information and measurements for bandwidth aggregation.
- LPHAP : RAN1 leads a study on identification of potential enhancements. If Rel. 18 SDT SI/WI is included, impact on SDT enhancements for INACTIVE positioning may be investigated during Rel. 18.
- Contact SA2 if LCS and NRPPa enhancements are needed.
- Further views : Whether to include unlicensed band for bandwidth aggregation can be studied.

3.2   Summary from Initial Round

The views on Improved accuracy, integrity, and power efficiency are quite diverse. For every potential objective there are many supporting companies and at least a few companies expressing concerns. There were 2 companies that felt that no work on Improved accuracy and power efficiency was necessary at all. Based on this feedback there is not clear view that any of the items can be removed.

Several companies offered proposals for the wording of the objectives and these have all been considered in the updates below. Note that in 2 cases, a sub-bullet has been included in square brackets together with a moderator comment. These 2 bullets were commented by very few companies but the moderator thinks they could both be useful in order to try to control the workload of this item.

Revised objective text:

– Improved accuracy, integrity, and power efficiency:

  ○ Study (for study phase of 9 months) solutions for Integrity for RAT dependent positioning techniques [RAN2, RAN1]:

    ▪ Identify the error sources, failure modes, etc [RAN2, RAN1]
    ▪ Study methodologies, procedures, signalling, etc for determination of positioning integrity [RAN2, RAN1]
    ▪ Coordination with SA2 as required.

  ○ Specify solutions for accuracy improvement based on PRS/SRS bandwidth aggregation [RAN1, RAN4, RAN2]:

    ▪ RAN4 to consider implications of timing errors between carriers.
    ▪ [Limit to case of intra-band contiguous carriers only] [Moderator comment: Only 2 companies mentioned this but the moderator wonders if this could be a useful approach to control the workload]

  ○ Specify solutions for accuracy improvement based on NR carrier phase measurements [RAN1, RAN4, RAN2]

    ▪ Reference signals, physical layer measurements, physical layer procedures, solutions for integer ambiguity resolution, cycle slip detection, etc to enable positioning based on NR carrier phase measurements [RAN1]
    ▪ [Focus on reuse of existing PRS and/or SRS, with new reference signals only considered if found necessary] [Moderator comment: Only 1 company mentioned this but the moderator wonders if this could be a useful approach to control the workload]

- Signalling for configuration and measurement reporting [RAN2]
  - Study the requirements on LPHAP as developed by SA1 and evaluate whether existing RAN functionality can support these power consumption and positioning requirements. Based on the evaluation, identify potential enhancements to help address any limitations [RAN1, RAN2]

3.3 Intermediate Round

For the intermediate Round, comments are invited for:

1. The revised objective text

2. The 2 bullets in square brackets which the moderator considers could be useful limitation to control the workload but were only proposed by very few companies.

3. Others

Feedback Form 4: Improved accuracy, integrity and power efficiency - intermediate round comments

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4 Redcap positioning

4.1 Initial Round

In the outcome of the previous discussion, the topic on improved accuracy, integrity and power efficiency was captured as follows:

- Define positioning support for RedCap UEs, considering the following:
  - Evaluate performance of existing positioning procedures and measurements with RedCap UEs[RAN1, RAN4]
  - Based on the evaluation, identify potential enhancements to help address possible limitations associated with for RedCap UEs [RAN1, RAN2]
  - Define performance requirements for positioning by RedCap UEs [RAN4]

In providing feedback for the initial round, I would like companies to specifically comment on the following:

1. The moderator's assumption is that the RedCap work is suitable to be handled as a work item objectives but companies may comment if they consider that any study is required.

2. Sufficiently detailed objectives with clear identification of WG responsibilities.

Other comments may also be provided.

Feedback Form 5: Redcap positioning - initial round comments

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1 – ZTE Corporation

1.   Redcap positioning should be led by RAN4 as a normative work phase. RAN4 needs to define the requirements first. After that, RAN1 can do evaluation and check if the existing positioning methods/procedures can satisfy the requirements. If not satisfy, then RAN1 can do some enhancements.

2.   Similar as LPHAP, the potential enhancement aspects are not clear yet, we suggest limiting the number of potential enhancement points to control the scope.

Recommend objectives:

a)   For RedCap UEs, define new positioning requirement/capability [RAN4]

b)   Evaluate and check if the existing positioning methods can satisfy the requirements. If necessary, specify a limited number of new positioning methods, or RS or signaling. [RAN1]

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2 – China Mobile E-Commerce Co.

During the last email discussion, majority companies are supportive of positioning enhancements for Redcap UEs.

From our point of view, except for the preliminary topic area concluded in RAN#93e, RAN1 should additionally determine the **use cases and requirements of Redcap positioning** before evaluation of the performance, and based on which, if a performance gap is identified, then the specification enhancements can be further studied.

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3 – Nokia France

We agree that RedCap positioning can proceed directly with a normative objective. It could be RAN4-led, although it may also have RAN1/2 impact.

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4 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility :

- **1)** Agree with Moderator's assumption that this could be handled as a work item
- **2)** The above captured objectives and WG responsibilities from the previous meeting serve as a good basis for further discussions.

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5 – Spreadtrum Communications

In our understanding, the performance requirements for positioning by RedCap UEs are not clear for now. In this regard, what we need to do first is to define the requirements, and then check whether the existing methods/procedures can meet the requirements. If the answer is no, then we can further specify new methods for RedCap. Based on this, we suppose that:

1.   A study phase is needed to define the requirements and identify the possible performance gap. If the gap is identified, then we can specify detailed schemes in WI. If we handle it as a work item directly, and find that the existing methods/procedures can meet the requirements, then WI may not be able to achieve anything new.

2.   The order of these three sub-bullet can be changed as follows:

-     Define performance requirements for positioning by RedCap UEs [RAN4]

- Evaluate performance of existing positioning procedures and measurements with RedCap UEs[RAN1, RAN4]

- Based on the evaluation, identify potential enhancements to help address possible limitations associated with for RedCap UEs [RAN1, RAN2]

6 – Samsung R&D Institute UK

Since the scope of Rel-18 positioning is quite huge when sidelink positioning and improved accuracy/integrity are included, we think that study of positioning for RedCap UEs can be postponed to next release. At this stage, target requirements and specification impacts for RedCap positioning are not clear.

7 – Beijing Xiaomi Mobile Software

We think RedCap positioning can be started with a work item and the following objectives can be considered.

- Evaluate performance of existing positioning procedures and measurements with RedCap UEs[RAN1, RAN4]
  - Identify positioning measurement requirements for the RedCap UE [RAN4]
  - Evaluate performance of existing positioning procedures based on the limited bandwidth and antenna of the RedCap UE [RAN1]
  - Idenify the positioning requirements e.g. accuracy and latency based on the evaluation [RAN1]
- Based on the evaluation, identify potential enhancements to help address possible limitations associated with for RedCap UEs [RAN1, RAN2]
  - Identify the positioning enhancements to meet the positioning requirements [RAN1]
  - Define the signalling procedures with the enhancements [RAN2]
- Define performance requirements for positioning by RedCap UEs [RAN4]

8 – Guangdong OPPO Mobile Telecom.

We are general fine with this part and support to handled it as a work item.

9 – Huawei Tech.(UK) Co.. Ltd

1. This work could be structured in terms of a WI with a study phase.

2. For the UE with 20MHz bandwidth capability, solutions to improve the accuracy via e.g. frequency hopping can be evaluated.

3. The study could only involve the following objectives.

○ Evaluate performance of existing positioning procedures and measurements with RedCap UEs [RAN1, RAN4]

○ Based on the evaluation, identify potential enhancements to help address possible limitations associated with RedCap UEs [RAN1, RAN2]

○ Define performance requirements for positioning by RedCap UEs [RAN4]

10 – vivo Mobile Communication Co.

RedCap positioning should mainly be RAN4's work to define positioning performance requirement considering UE complexity reduction features, such as with limited bandwidth and antenna number. For example,

o   Define positioning performance requirement (in RAN4) considering UE complexity reduction features, such as

Ø   Limited bandwidth: FR1:20MHz, FR2:100MHz

Ø   Limited antenna number: 1Rx,2Rx

11 – CATT

Q1. The moderator's assumption is that the RedCap work is suitable to be handled as a work item objectives but companies may comment if they consider that any study is required.

[CATT]

RedCap work can be handled directly in work item without the need of the study phase.

Q2. Sufficiently detailed objectives with clear identification of WG responsibilities.

[CATT]

- Evaluate the positioning performance of existing positioning procedures and measurements for Red-Cap UEs and determine whether to define new target positioning performance requirements for Red-Cap UEs [RAN4]

  o   If needed, study and specify physical layer procedures enhancements to support RedCap positioning [RAN1]

- Specify the messages and capability signaling to support RedCap positioning [RAN2/RAN3]

- Define corresponding performance requirements and test cases [RAN4]

12 – Futurewei Technologies

1: A Study is required to evaluated existing Positioning performance for RedCap and RAN4 should be the lead WG with RAN1 secondary.

2: Similar to the reply to question 1 above.

13 – Sony Europe B.V.

1) RedCap positioning shall be started immediately as a work item (WI), and this should be RAN1-led. The work can start with identifying the expected use-cases for both FR1 & FR2, initial positioning requirements, and potential techniques (RAN1/RAN2) to fulfill the positioning requirements.

2) In the later stage, RAN4 can further continue the details of requirement aspects.

14 – Ericsson LM

We are fine with the above proposal for RedCap as is.

However, we also would like to complement with a slight addition to improve the support for lower complexity device positioning in industrial use cases by adding some protocol support for Bluetooth 5.1 direction finding DL-AoD/UL-AoA in RAN2 LPP 37.355. Currently, there is already support for Bluetooth-based positioning in LPP, so this addition is only about RAN2 extending the support to include the recent parts in Bluetooth 5.1

15 – Philips International B.V.

We agree with several other companies that Redcap positioning can be carried out as WI led by RAN4 (in collaboration with RAN1 and RAN2).

16 – VODAFONE Group Plc

For us, indoor situations where GNSS is not available are the primary use case for Redcap positioning. We support 3GPP work to solve the indoor case.

17 – Apple France

RedCap Positioning, if included, it should be part of the SI, where it is led by RAN4 on determining performance requirements and led by RAN1/4 to evaluate achievable performance for RedCap UE based on existing procedures. If within the SI, it is identified that further enhancement is needed, potential enhancements can be led by RAN1/2.

18 – Intel Corporation (UK) Ltd

(1) At least study phase within work item seems needed to complete performance evaluation and determine needed enhancements

(2) Identify potential enhancements to help address possible limitations associated with RedCap UEs, e.g., bandwidth limitations [RAN1, RAN4]

19 – Verizon UK Ltd

Agree with the moderator's proposal. We think RedCap positioning is needed, preferably on par with regualar NR UE.

20 – MediaTek Inc.

We think RedCap positioning is useful to pursue and should be included in Rel-18. It could benefit from a study phase led by RAN4 for initial performance evaluation. Some clarity on the assumptions may be useful in developing the objectives, e.g., do we confine the PRS measurement bandwidth to 20 MHz? If the study phase concludes that enhancements are needed for RedCap UEs, normative work can proceed in RAN1/2.

21 – Qualcomm Incorporated

1. Work Item

2. Details on a potential WI description:

· *Define performance requirements for positioning by RedCap UEs [RAN4]*

· *Evaluate performance of existing Rel-17 positioning procedures and measurements with RedCap UEs [RAN1, RAN4]*

Based on the evaluation, identify, and specify potential enhancements to help address possible limitations associated with RedCap UEs [RAN1, RAN2]

4.2   Summary from Initial Round

Fewer comments were received regarding RedCap positioning than for the other topic areas. This suggests that the RedCap positioning is closer to convergence.

Some companies comment that there are currently no target system requirements for the positioning by RedCap UEs and that some consideration of use cases, etc is required first in order to determine these requirements. It is only with clear target system requirements that it will be possible to identify if there are an " limitations associated with positioning for RedCap UEs " that need to be addressed. For the Intermediate Round, the moderator would like to receive views from companies as to whether there needs to be some initial work to determine the target system requirements for positioning by RedCap UEs.

Based on the comments received the moderator thinks that different companies may have some different interpretations of the existing text, in particular whether references to performance/requirements are referring to the determination of the position estimate by the system, or referring to the individual positioning measurements performed by the RedCap UEs (and defined in RAN4). To try to ensure common understanding for all, some rewording of the text has been proposed. Regarding the first sub-bullet, the moderator's understanding is that RAN4 would be responsible to evaluate how the RedCap limitations (BW, number of receivers) would impact positioning measurements, and RAN1 would be responsible for evaluating how this translates into overall positioning performance. Further clarification can be added to the text if companies think it would be useful.

Revised objective text:

– Define positioning support for RedCap UEs:

  ○ Evaluate positioning performance ofexisting positioning procedures and measurements with RedCap UEs [RAN1, RAN4]
  ○ Based on the evaluation, identify potential enhancements to help address possible limitations associated with RedCap UEs [RAN1, RAN2]
  ○ Define core and performance requirements for positioning measurements performed by RedCap UEs [RAN4]

4.3   Intermediate Round

For the Intermediate Round the moderator request comments on:

1. The need to define target system requirements for positioning by RedCap UEs

2. The revised objective text, aimed at ensuring clarity.

3. Others

Feedback Form 6: Redcap positioning - intermediate round comments

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5   Other comments

5.1   Initial Round

Companies are invited to make any other comments that do not fall into the scope of the earlier sections. This might include views on the overall lead WG of the WI/SI if different from RAN1 as indicated in RP-212608.

Feedback Form 7: Other comments - initial round

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1 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility :

In a parallel [RAN94e-R18Prep-13][NTN] email thread, there is an ongoing discussion on network-based UE location without reliance on GNSS measurements for NTN supported networks. The open issue is whether this item should be handled within the positioning item or NTN item, given that it seems to be a non-controversial Rel-18 topic among companies in that thread and that there may be potential impacts to the current positioning framework, further coordination may be needed on how to handle this aspect.

5.2   Summary from Initial Round

Only comment received was in relation of the discussion on network based positioning for NTN and whether this should be handled in the NTN or Positioning enhancements item. The moderator agrees that this is a valid question for the final WIs/SIs to be approved in December. However, for these Rel-18 email discussions the guidance from the RAN chair [RP-212657] was not to change the organisation of topics, and hence the discussion on positioning for NTN should remain within the NTN thread.

5.3   Intermediate Round

Feedback Form 8: Other comments - intermediate round

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