

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

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 protocols [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]
 - o Existing methodologies used in sidelink and positioning enhancement are maximally reused
- Study potential solutions for both RAT-dependent absolute and relative SL positioning
 - o SL positioning reference signal (SL-PRS) and channels for signaling [RAN1]
 - o Resource allocation for SL-PRS [RAN1, RAN2]
 - Support mode-1 (gNB scheduling) and mode-2 (UE autonomous resource selection)
 - o 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):
 - o 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.
 - o 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.
 - o 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.
 - o 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:
 - o 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).
 - o b) Study enhancements for physical layer procedures to support SL positioning/ranging measurements [RAN1]
 - o 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.

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).

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]
 - o Identify requirements such as accuracy and latency, power efficiency
 - o Define a number of evaluation scenarios, including indoor and outdoor scenario, LOS/NLOS environment, considering V2X/smart phone/IOT UEs.
 - o Evaluate the performace of different SL positioning and ranging methods, such as OTDOA/UTDOA/RTT/AOA/AOD/Carrier Phase.
 - o Cost and power efficiency evaluation for support sidelink positioning and ranging considering IOT devices.
 - o 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 sidelink 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 architecture, 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.

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.

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.

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.

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.

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).

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.

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)
 - o Network based sidelink positioning should be considered where LMF collects sidelink measurements from UEs to compute positions of the UEs.
 - o Network can provide assistance data for UE based sidelink positioning in network assisted sidelink positioning.
- Sidelink and network based positioning fusion. (RAN1/RAN2/RAN3)
 - o 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:
 - o Study and specify the positioning techniques that will be enabled in SL e.g. timing, angle, carrier phase, power measurements [RAN1]
 - o Study and specify new positioning signals for SL including potential resource allocation enhancements [RAN1]
 - o 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.

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:*

- o *Evaluation scenarios/methodologies to assess potential solutions for sidelink positioning [RAN1]*
- o *NR Sidelink reference signals and corresponding physical layer measurements and procedures, for enabling ranging, relative positioning, and absolute positioning [RAN1]*
- o *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]
 - o Including both relative positioning (including ranging) and absolute positioning
 - o Coverage scenarios to cover: in-coverage, partial-coverage and out-of-coverage
 - o Requirements: Based on requirements identified in TR38.845 and TS22.261 and TS22.104
 - o Use cases: V2X (TR38.845), public safety (TR38.845), commercial (TS22.261), IIOT (TS22.104)
 - o Spectrum: ITS, licensed
 - o Identify specific target performance requirements to be considered for the evaluation [RAN1]
 - o 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].
 - o 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

<p>1 – Nokia Denmark</p> <p>We propose to limit the use case the use cases based on the RAN lead SI to include only: V2X (TR38.845), public safety (TR38.845).</p>
<p>2 – ZTE Corporation</p> <p>We support moderator’s summary in principle.</p> <p>Just one comment for last bullet ‘Study of positioning architecture and signalling procedures’, we think it should also be studied by RAN1, and then RAN1 send LS to let RAN2 specify the new feature.</p>
<p>3 – Futurewei Technologies</p> <p>Support proposed texts on the objectives’ scope.</p>
<p>4 – InterDigital France R&D</p> <p>We support the moderator’s objective in principle. We agree with ZTE that the last bullet ‘Study of positioning architecture and signaling procedures’ can include RAN1.</p>
<p>5 – MediaTek Inc.</p> <p>We generally support the moderator’s proposed text. Maybe the proponents of including RAN1 in the ‘Study of positioning architecture and signalling procedures’ bullet can elaborate on the reasoning—it’s not obvious to us what the RAN1 action would be.</p>
<p>6 – Qualcomm Incorporated</p> <p>- Comment 1:</p> <p>With regards to the Unlicensed bands, we have the following major concerns for not including it in scope, at least for the V2X use-cases.</p> <ul style="list-style-type: none"> ○ To achieve the V2X positioning accuracy requirements, 3GPP’s design for the sidelink PRS will require a 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 positioning operation. ○ Without support for unlicensed band SL-PRS, out-of-coverage scenario positioning accuracy requirements cannot be met given the limited ITS-band spectrum available. ○ Without support of SL-PRS over unlicensed band, Sidelink Positioning cannot support the V2X use-case, and cannot meet the accuracy requirements.

If the above statements are controversial with regards to the need of PRS in unlicensed bands, we suggest to include a study of the spectrum and bandwidth requirements needed to meet the supported use cases and the SA requirements levied on sidelink positioning. For example:

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 the spectrum and bandwidth requirements needed to meet the supported use cases and the corresponding requirements [RAN1]**
 - Study of sidelink reference signals for positioning purposes, including signal design, resource allocation, physical layer measurements, associated physical layer procedures, etc [RAN1]

Comment 2:

- Regarding the study of potential solutions, we propose adding the following: Study methods to enable support of control signaling for NR V2X and LTE V2X.
- “Study of positioning architecture and signaling procedures (e.g., configuration, measurement reporting, etc.) to enable sidelink positioning **supporting both NR and LTE V2X deployments**: [RAN2 , including coordination with interaction with SA2 as required]”

7 – Apple France

We are supportive of the moderator’s revised objective text.

8 – Guangdong OPPO Mobile Telecom.

Support the updated objectives from moderator.

9 – Beijing Xiaomi Mobile Software

Unlicensed spectrum should not be excluded at this stage. It is clearly that many companies want to support unlicensed spectrum. It is a little harried to exclude unlicensed spectrum based on the workload reason, since we do not know how much TUs are available for positioning, and whether SL positioning & Ranging will have the same or separate SI/WI as positioning enhancement and Redcap positioning. Thus, we suggest not to make the decision at this stage, but decide it at a later stage, e.g. after SI phase.

Besides, we have concern over the wording ” relative positioning (including ranging) ”, as we explained, relative positioning and ranging are not the same at least in SA1 definition. As for now, we suggest to use the wording “relative positioning and ranging”, and leave the clarification or definition of the term to the study phase.

Thirdly, cost and power efficiency should be included in the evaluation and solution part for supporting IOT devices in commercial use case.

10 – vivo Mobile Communication Co.

Fine with the moderator’s latest version. It is important to include commercial use cases in this stuy.

11 – CATT

Q1: Comments to the revised objective text are requested.

[CATT]

Suggest adding “carrier phase” to the 1st sub-bullet, and our preferred 1st sub-bullet as follows,

- study of positioning methods (e.g. TDOA, RTT, AOA/D, carrier phase, etc).

In our point of view, carrier phase positioning may be especially important for V2X scenario due to the limited bandwidth in ITS bands, and the high-positioning accuracy requirements for V2X scenarios.

12 – Intel Corporation (UK) Ltd

In principle, we are supportive revised objectives. Our preference is to have study item followed by R18 work item. In addition, slight revision of the list of objectives may be needed. It seems part of the objectives in the list relate to description of the scenario and/or requirements. In addition, we do not see the need for RAN1 discussion on requirements as those were studied by RAN and endorsed as a part TR 38.845. Therefore, we propose the following structure:

Description of Scenario / Requirements

- 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]~~

Objectives

- 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]

13 – Samsung R&D Institute UK

Thanks for the discussion. For the revised objective text, we think that these bullets and their sub-bullets can be included in the objectives

- 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]

Other bullets before the above bullets can be in the justification.

14 – NTT DOCOMO INC.

We are fine with the revised objective text.

15 – LG Electronics Inc.

We support the revised objective in general with two comments. Regarding the resource allocation for SL positioning, rather than introducing a completely new method, we prefer to reuse NR V2X resource allocation scheme as much as possible. In addition, sidelink positioning should be able to coexist with sidelink communication in the same resource pool. This does not preclude the possibility of sidelink positioning in a dedicated resource pool. Therefore, we suggest to add these clarification to the objective.

- Study of sidelink reference signals for positioning purposes, including signal design, resource allocation, physical layer measurements, associated physical layer procedures, etc [RAN1]
 - o Rel.16/17 NR SL resource allocation method is reused as much as possible
 - o Coexistence with SL communication in the same resource pool as well as SL positioning in a dedicated resource pool is supported

16 – ROBERT BOSCH GmbH

We mainly agree with the moderators revised objectives. We are supportive of the mentioned use cases (V2X, Public Safety, IIOT and Commercial). However, as the study phase is proposed to last 9 month, we believe one should consider studying the unlicensed spectrum for SL positioning. We agree with Qualcomm's opinion that excluding unlicensed spectrum already from the beginning might harm V2X use cases considering the limited bandwidth available in the ITS band. A decision after the study phase seems beneficial.

17 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility

Generally supportive of revised moderator's text. We are also supportive of including an additional sub-objective, which studies the impact of exploiting both Uu and PC5 positioning measurements to assist in improving the overall location performance.

It would be also beneficial to include some possible positioning architectural examples to be studied for further guidance as follows:

- "Study of positioning architecture (e.g. anchor UE selection and maintenance for UE-based and UE-assisted positioning architectures, positioning QoS, location request types, potential core network impacts) and signalling procedures (e.g. configuration, measurement reporting, etc) to enable sidelink positioning [RAN2, including coordination with interaction with SA2 as required]"

18 – Huawei Tech.(UK) Co.. Ltd

The proposed objectives are broadly fine.

We would suggest adding “use cases” to the following bullet point, since both requirements and use cases are quoted from the TRs:

*Identify specific target performance requirements **and use cases** to be considered for the evaluation [RAN1]*

The different calculation entities, i.e. UE-based and network-based positioning, should also be captured in the following objective:

*Study of sidelink reference signals for positioning purposes, including signal design, resource allocation, physical layer measurements, associated physical layer procedures **for UE-based and network-based positioning**, etc [RAN1]*

19 – China Mobile E-Commerce Co.

We are supportive of the revised objective text.

20 – Continental Automotive GmbH

We support moderator’s revised objectives. Also positive with considering unlicensed spectrum.

21 – CEWiT

1. We tend to agree with Qualcomm’s comment on the need for unlicensed band to be considered for positioning. We also see the need of higher bandwidth minimum 100MHz to achieve the V2X use case targets. So inclusion of unlicensed band is necessary.

2. Regarding the “Study of positioning architecture and signalling procedures” we too feel RAN 1 should be included at least in study phase.

3. Regarding overall objective drafting, We feel “Study and evaluate performance of potential solutions for SL positioning” should be main objective line and sub bullet should be shifted one level up. Expected modifications are as follow,

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

Study and evaluate performance of potential solutions for SL 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, **unlicensed**
- ~~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 [RAN1, RAN2, including coordination with interaction with SA2 as required]

22 – Sony Europe B.V.

Generally fine with the moderator proposal. We have some further comments:

- We should prioritize V2X and public safety use-cases.
- We also agree that we need to identify the use-cases. So, we propose: *Identify specific target performance requirements **and use cases** to be considered for the evaluation [RAN1]*
- RAN1 shall not be excluded in signalling procedures (e.g. configuration, measurement reporting, parameters, etc) [RAN2, RAN1].

23 – Ericsson LM

It's a bit unclear to us if FL propose a study item or a study item phase for sidelink positioning. Our proposal is to have a study item after which the scope of the specification work is to be defined by RAN in a WI for sidelink positioning.

We would like to see the following modification of the proposed objective:

- Study and evaluate performance and feasibility of potential solutions for SL positioning: [RAN1, RAN2]

The study item should also have an objective for the leading RAN WG group to recommend identified solutions for specification:

- Recommend sidelink solutions for specification: [leading RAN WG]

Sidelink measurements will typically not be used in isolation, but will rather be fused with other types of measurements. Thus the evaluation should include positioning methods based on fusion of SL based measurements and Uu based measurements. Thus we would like the following modification of the proposed objective:

- Study of positioning methods (e.g. TDOA, RTT, AOA/D, hybrid positioning methods based on SL measurements and e.g. Uu measurements, etc) [RAN1]

24 – Philips International B.V.

We agree with the revised text by the moderator. The only comment we have is around the use cases: next to the use cases in TR 38.845, we should also consider ranging services in line with the use cases documented for release 18 in the SA1 study on ranging (i.e. TR 22.855), and the proposed work for release 18 in SA2.

2.4 Summary from Intermediate Round

Unlicensed

The main contentious topic of discussion remains whether unlicensed spectrum is within scope.

Some companies still have major concern about not including unlicensed spectrum for SL positioning. One company explained that the V2X accuracy requirements will demand bandwidths of 100MHz and there is no ITS spectrum available that can provide this, only unlicensed spectrum can offer this.

The moderator would like companies to respond directly to this concern. Previous comments against unlicensed have mainly been on the grounds of workload, or that a baseline of unlicensed for SL communication has not yet been discussed. Based on responses we will conclude whether to add a bullet to study the spectrum to be used by SL positioning.

Apart from unlicensed, other comments were more minor in nature or aimed at refining the objective text.

Use cases

2 companies proposes to limit to just the RAN studied uses cases of V2X and public safety. 2 other indicated that commercial use cases are critical for them. One company suggested to not include the objective to identify specific target performance requirements for the evaluation. Not changes to the current objective text is proposed based on these comments

WG roles

4 companies proposed to add RAN1 to the bullet on positioning architecture and signalling. RAN1 has been added in the revised objective text but in the moderator's view this is clearly a more RAN2-centric objective and so RAN2 is kept as the first listed WG. 1 company asked for clarification why RAN1 should be involved at all.

NR+LTE

1 company proposed that the work should cover both NR and LTE V2X deployments. Few comments have been made on this so far and so the moderator would like companies to provide their views on this aspect.

Relative positioning (including ranging)

1 company still some concern over the terminology of relative positioning and ranging. The moderator understands that the definitions of these terms may not be fully clear and suggests another approach to say "relative positioning/ranging" and add a note to say that definitions of these terms are expected to be refined during he work.

Carrier phase for SL

1 company suggested to include carrier phase in scope of SL positioning. The moderator's view is that this is only just being discussed for Uu based positioning and it may be too early, and too much workload, to consider it as a technology for SL as well. However, company are invited to provide their views.

Resource allocation

1 company made a comment that resource allocation for SL communication should be reused as much as possible and that it should be possible for SL communication and SL positioning use the same resource pool. Reuse of existing functionality and ease of operation alongside existing functionality are reasonable requests and so the moderator included the proposed clarification (with a little simplification of the text). Other companies are request to comment.

Other

A number of companies commented that UE based and network based should be explicitly mentioned, and this has been added to the revised objective text.

2 companies commented that it should be possible for Uu and sidelink positioning measurements to be used together. Although only 2 companies commented in this round, this has also been mentioned by several companies in earlier rounds. In the moderator's view, it is reasonable to expect that Uu and sidelink based positioning measurements can be combined at least for the in-coverage and possibly also the partial coverage scenarios. Indeed it has been a long held principle in 3GPP's positioning work that positioning measurements from multiple sources can be combined to provide improved accuracy. A note has been added to the objectives to clarify this point.

Revised Objective Test (revision marks shown are best effort given limitations of NWM)

- Study (for study phase of 9 months) solutions for sidelink positioning considering the following: [RAN1, RAN2]
 - Scenario/requirements [Moderator comment: These could be moved to the justification section in the final WID]:
 - 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 and used cases 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 and feasibility of potential solutions for SL positioning, considering: [RAN1, RAN2]
 - Both relative positioning/ranging and absolute positioning
 - Note: Definitions of relative positioning and ranging are expected to be refined during the study.
 - Study of positioning methods (e.g. TDOA, RTT, AOA/D, etc) including combination of SL positioning measurements with other positioning measurements (e.g. Uu based measurements) [RAN1]
 - Study of sidelink reference signals for positioning purposes, including signal design, control signalling, resource allocation, physical layer measurements, associated physical layer procedures, etc [RAN1]
 - Note: Rel.16/17 NR SL resource allocation method is reused as much as possible, and coexistence with SL communication must be considered
 - Study of positioning architecture and signalling procedures (e.g. configuration, measurement reporting, etc) to enable sidelink positioning covering both UE based and network based positioning [RAN2, including coordination with interaction with SA2 as required]
 - Recommendations for solutions to be specified in the normative phase [RAN1, RAN2]

2.5 Final Round

Feedback Form 3: Sidelink positioning/ranging - Final round comments

1 – Apple France

In our view, the last sub-bullet "Recommendations for solutions to be specified in the normative phase [RAN1, RAN2]" is not needed and either it should be removed or revised to "Recommendations for solutions, if any, to be specified in the normative phase [RAN1, RAN2]". Other than that, we are ok with the moderator's revised text

2 – Guangdong OPPO Mobile Telecom.

Support the updated objectives.

Our views are as below for the questions listed in the summary of intermediate round.

- **Unlicensed spectrum:** In our understanding, it is very challenging (if not impossible) for a single positioning method to meet the V2X requirements. Thus, we expect that hybrid approach of some positioning methods will be used for realistic V2X scenario. Different methods have different requirements for the bandwidth. On the other hand, the positioning RS in the unlicensed spectrum can only be transmitted when the resources are not occupied. As a result, the accuracy and latency cannot be ensured in unlicensed spectrum. In summary, the lack of allocated ITS spectrum should not be a reason to support SL PRS on unlicensed from the beginning, we do not see the urgency here. Rather it should be considered after SL communication on unlicensed are supported, as SL PRS design on unlicensed is related to the design of other SL channels/signals there.
- **NR+LTE:** We do not understand why LTE V2X deployment is related, as the SL positioning methods considered in this topic are based on NR SL only and have nothing to do with LTE SL. Or it is trying to say configuration by eNB/measurement report to eNB should be supported?

3 – Futurewei Technologies

We support the revised objectives as written by the moderator.

4 – Nokia Denmark

We propose to limit the use case the use cases based on the RAN lead SI to include only: V2X (TR38.845), public safety (TR38.845).

5 – Nokia Denmark

For positioning, typically, RAN1 evaluates the positioning technologies, creates evaluation methodologies and evaluates performance offered by the technologies and finally makes recommendations to RAN2/RAN3 to specify support for signalling and procedures. The current SL positioning objectives text is not clear regarding this in that it now allocates that responsibility to both RAN1 and RAN2. RAN2 should be removed from the objective "Recommendations for solutions to be specified in the normative phase".

RAN1 and RAN2 led RAT-dependent and RAT-independent positioning respectively. Given that SL positioning is RAT-dependent, we are not sure why RAN2 is also listed under the objective "Study and evaluate performance and feasibility of potential solutions for SL positioning...". It is better to allocate only the objective "Study of positioning architecture and signalling procedures..." to RAN2. If both RAN1 and RAN2 are to be allocated for the objective "Study and evaluate performance and feasibility of potential solutions for SL positioning...", then RAN1 and RAN2 areas of work must be clearly identified

Regarding NR+LTE, our preference is to focus only on NR to keep the scope manageable. In the end if the specified solutions can be easily ported to LTE specification or made applicable in a common specification, we can revisit the decision to make it applicable for LTE also

Regarding including **unlicensed spectrum in the scope for V2X**, if the study can demonstrate that 100MHz is needed then some specification work may be proposed/needed. If the spectrum and BW requirements needs to be studied in RAN1 as another separate objective then it is fine, provided there is sufficient TU allocated to the study item.

Carrier phase for SL: Once again, to manage the scope and to have clear focus, we can consider carrier phase for SL after the carrier phase for Uu is addressed

Resource allocation: No comments. Moderators proposal is fine.

6 – ROBERT BOSCH GmbH

We are in line with the moderators summary and the updated objectives

7 – ZTE Corporation

We are supportive of the latest moderator’s proposal.

For unlicensed spectrum, we still don’t think it should be included. The spectrum study is unnecessary as well. The main concern is the work procedure rather than work load. As many companies mentioned that regular SL in unlicensed spectrum is not defined yet and would be defined in Rel-18 V2X, it is reasonable to specify SL positioning in next release based on the outcome of Rel-18 V2X. Everything should be done step by step. As the performance requirement, there is not any problem at least for in-coverage and partial coverage scenarios. Moreover, angular based positioning, carrier phase based solution can used without relying on bandwidth.

8 – MediaTek Inc.

We generally agree with the current form of this objective. RAN2 do need to be involved in the recommendation of solutions, because of the architecture/signalling impact—we anticipate that as usual, RAN1 would make recommendations on the positioning method aspects, and in addition, RAN2 would make recommendations on how to handle the signalling and architecture, which could be significantly impacted compared to Uu positioning.

9 – InterDigital France R&D

We support the moderator’s proposal.

Unlicensed

Regarding the use of unlicensed spectrum, we agree with ZTE. It should be done step-by-step and framework for SL in unlicensed spectrum should be established before we consider positioning in unlicensed spectrum in SL. Thus, given limited amount of TUs, we propose not to include the use of unlicensed spectrum in the scope for this item.

Carrier phase

Regarding carrier phase for SL, we don’t support to include in the item. Carrier phase based positioning in Uu should be established first before we can consider the method for SL.

10 – Qualcomm Incorporated

Comment 1:

Regarding the inclusion of unlicensed bands for sidelink PRS (SL-PRS), in our view there are several key points motivating 3GPP to retain this in the Rel-18 study

- To achieve the positioning accuracy requirements defined in TR 38.845, 3GPP's SL-PRS design will require bandwidths of 100MHz or better. To date, no region has allocated this much spectrum for ITS, and there is no indication of operator plans to allow the use of sufficient licensed spectrum for V2X or Public Safety positioning operation. Without unlicensed band SL-PRS support, 3GPP's Sidelink Positioning will be unable to meet these requirements.
- For the out-of-coverage use case, where only ITS and unlicensed spectrum are available, absent support of unlicensed band SL-PRS, the limited ITS spectrum precludes successful Sidelink Positioning operation. Note that that for V2X, vehicles may sometimes be frequently entering and leaving network coverage areas which could damage in-coverage performance as well as out of coverage performance if PRS resources are thereby being constantly added and removed.
- For the V2X use case, transmission of a SL PRS within the ITS band would result in interference with V2X transmissions that were unable to decode the reservation.
- SL-PRS over unlicensed band has no dependence of Rel-18 sidelink over unlicensed. For SL positioning all protocol and control is exchanged over the ITS or licensed band, and only the SL-PRS will be sent over unlicensed. SL-PRS transmission over unlicensed spectrum can reuse existing NR-U channel access, and 3GPP will incur no significant workload as a related to this.
- Although angular methods can also be used which tend to be more robust to limited bandwidth, it is also known that vehicles have very small number of antennas (e.g. 1 or 2 antennas), and therefore it is not evident at all that using angular methods would be sufficient to meet the positioning accuracy requirements.

Thus, our main proposal remains that unlicensed must remain in the scope. If this is not possible at this phase, our recommendation is to include it in the scope of the study via an assessment of spectrum and bandwidth necessary to satisfy the supported use cases and positioning accuracy requirements.

Comment 2

With regards to the following bullet:

- Study of sidelink reference signals for positioning purposes, including signal design, control signalling, resource allocation, physical layer measurements, associated physical layer procedures, etc [RAN1]

We agree that reference signals, signal design, physical layer measurements, physical layer procedures, are expected to be studied in RAN1. However, "control signaling" may be more appropriate as a higher layer topic. So, we suggest to remove it from explicitly including it only in the RAN1 subbullet, and let the study phase in both RAN1, RAN2 make further decisions.

- Study of sidelink reference signals for positioning purposes, including signal design, ~~control signalling,~~ resource allocation, physical layer measurements, associated physical layer procedures, etc [RAN1]

Comment 3

Regarding support for LTE V2X and NR V2X, our view is since a primary use case for 3GPP's sidelink positioning design is V2X, ensuring any design addresses existing deployments, both Release-16 and Release-14, is essential to meeting this use case as positioning will be a needed feature for these deployments.

Comment 4

We share Moderator's view that it may be too early to add carrier phase into the examples, so we prefer to not include it. We are also OK to remove all examples from the positioning method, and let the RAN1 study to make progress.

Comment 5

We prefer not to include the new Note on the resource allocation. During the study phase, these aspects could be studied.

~~Note: Rel.16/17 NR SL resource allocation method is reused as much as possible, and coexistence with SL communication must be considered~~

11 – TOYOTA Info Technology Center

We generally support the proposed objectives.

Regarding unlicensed spectrum, given that the available ITS spectrum is different for different regions, we support adding another objective to study the spectrum and required bandwidth for sidelink positioning to meet the positioning requirements.

12 – Beijing Xiaomi Mobile Software

For unlicensed spectrum, we still think it should be included, and the following two options can be considered:

Option 1: Include unlicensed spectrum together with licensed spectrum and ITS

Option 2: agree QC's suggestions to not include any spectrum, but add a study point: "Study the spectrum and bandwidth requirements needed to meet the supported use cases and the corresponding requirements [RAN1]"

Besides, we strongly suggest that the power efficiency and "Redcap positioning" are also studied in SL positioning & Ranging, as they are equally important for SL positioning. Since SL positioning is not there, there is no need to evaluate the performance of power consumption and RedCap SL positioning, but just take them into account when design solutions. Thus, we suggest to add the following objectives under the bullet:

Study and evaluate performance and feasibility of potential solutions for SL positioning, considering: [RAN1, RAN2]

- Power efficiency and the support of IOT devices(e.g. RedCap UEs) should be taken into account when design the SL positioning & Ranging methods.

13 – Samsung R&D Institute UK

Thanks for the discussion.

For unlicensed band and for the assertion that "V2X accuracy requirements will demand bandwidths of 100MHz", we think that it is not clear. Where is the evidence for this? We think this should belong to the evaluation part of the work. Unless all the potential solutions (including the one on bandwidth aggregation) on licensed and ITS spectrum meets the accuracy requirement, we might go with larger bandwidth on unlicensed spectrum. We don't see the strong need to directly go to the unlicensed band. In addition, currently, Rel-18 sidelink considers including the unlicensed band operation. So, if it is included finally, supporting SL positioning on unlicensed bands creates a dependency on that WI (or SI) which is not desirable. It is better to develop SL positioning techniques for licensed and ITS bands in Rel-18, with a potential to expand to unlicensed bands in a later release.

14 – CATT

Regarding to the revised objectives for SL positioning from the moderator:

[CATT] The modifications look fine to me.

15 – Huawei Tech.(UK) Co.. Ltd

Unlicensed

We agree with the comments from OPPO, ZTE and InterDigital (from initial round), there is an obvious dependency with the work on sidelink in Rel-18, and it would be reasonable to take a step-by-step approach and start with licensed and ITS spectrum in this release.

NR+LTE

It is not clear which aspects of the study should be considered for both NR and LTE V2X deployments. We should focus on NR at this time.

Relative positioning (including ranging)

Relative positioning and ranging are indeed not the same as ranging can be done as part of relative positioning. As it is not clear why the definitions are expected to be refined, we propose to update the note of the corresponding objective as follows, simply keeping relative positioning and ranging separate, and then we think there is no need for the note.

- Relative positioning, ranging and absolute positioning

Carrier phase for SL

We agree with the moderators view, that carrier phase is discussed for Uu based positioning and that it should not be consider for SL to reduce the workload.

Resource allocation

We agree to reuse Rel. 16/17 NR SL resource allocation as much as possible, and that the coexistence with SL communication should be considered.

Other positioning measurements

As the discussion is on combining Uu and sidelink positioning, we suggest the following update below on the corresponding objective (also to limit the workload):

- Study of positioning methods (e.g. TDOA, RTT, AOA/D, etc) including combination of SL positioning measurements with other RAT positioning measurements (e.g. Uu based measurements) [RAN1]

Typo to correct: “used cases” to “use cases”

16 – NTT DOCOMO INC.

- We agree with Apple that the last bullet of recommendations would be unnecessary.
- Regarding unlicensed spectrum, we do not think unlicensed spectrum should be included since SL communication for unlicensed spectrum has not yet been discussed, which is captured in moderator summary. If unlicensed spectrum is included, SL SI/WI workload as well as SL pos will become larger to consider SL pos. Such a situation should be avoided. Note that SL SI/WI would have so wide scope according to the current discussions there.

- For resource allocation, we do not see necessity of the note to reuse existing mechanism since technical part of SL pos is completely unclear now. We will study it to achieve required performance, so no need to say the note in SID. For WID after the SI, such a text might be included based on the study.
- We support the added texts for Uu-based and SL-based.

17 – LG Electronics Inc.

Thanks for the updated objective. We support the revised objective with the following two comments.

Identifying use cases is normally a scope of RAN/SA, not of RAN1. The objective already includes the use cases in the 3rd sub-bullet of the first bullet.

- Use cases: V2X (TR38.845), public safety (TR38.845), commercial (TS22.261), IIOT (TS22.104)

We don't need to further identify the use cases, and suggest to delete identifying the use cases from the objective

- Identify specific target performance requirements ~~and use cases~~ to be considered for the evaluation [RAN1]

Regarding the unlicensed spectrum, the required bandwidth for SL positioning accuracy is available in the licensed spectrum (up to 100MHz in FR1, 400MHz in FR2). Whether or not the commercial band will be allocated for SL positioning is not a scope of 3GPP WG. SL positioning using the ITS and the licensed spectrum should have no issue with the positioning accuracy requirement.

In addition, based on the discussions for SL enhancement in Rel.18, it's more likely that CA between the ITS band and the unlicensed band is not supported in Rel.18. In this sense, SL positioning in the unlicensed band while SL communication in the ITS band will not be feasible in Rel.18. Therefore, SL positioning in the unlicensed band will not be meaningful for V2X positioning in Rel.18. We prefer to study the use of the unlicensed band for SL positioning after the unlicensed band for SL communication including CA with the unlicensed band is studied in a later release.

18 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility :

Generally supportive of the revised objective text. A few additional comments:

Under the study objectives:

- It would be good clarify that the combination of Uu measurements are applicable to in-coverage and partial coverage scenarios by revising the latest objective text as follows:

Study of positioning methods (e.g. TDOA, RTT, AOA/D, etc) including combination of SL positioning measurements with other positioning measurements (e.g. Uu based measurements **for in-coverage and partial coverage scenarios**) [RAN1]

- We would also like give another try regarding our previous comment from the intermediate round on including some possible positioning architectural examples for further guidance as follows: “Study of positioning architecture (e.g. *anchor UE selection and maintenance for UE-based and UE-assisted positioning architectures, positioning QoS, location request types, potential core network impacts*) and signalling procedures (e.g. configuration, measurement reporting, etc.) to enable sidelink positioning [RAN2, including coordination with interaction with SA2 as required]

-We also share the view that the last bullet on recommended solutions for normative work is well understood as the outcome of the SI phase, so perhaps it can be removed.

19 – Sony Europe B.V.

- In principle, we support the revised objective test with further refinements:
 - o Considering the workload and the need to spend more time on the other objectives (e.g, performance requirement, evaluation methodology, evaluation & feasibility) we prefer to prioritize V2X and public safety as those have been evaluated by RAN1.
 - o Recommendations for solutions to be specified in the normative phase should be made only by RAN1 as the SI is led by RAN1.
 - o In this context: Study of positioning methods (e.g. TDOA, RTT, AOA/D, etc) including combination of SL positioning measurements with other positioning measurements (i.e. Uu based measurements) [RAN1] . Should we only consider RAT dependent (e.g. Uu based) or also include RAT independent (e.g, GNSS, sensors measurement)??
- On NR + LTE: We should focus on NR
- On Carrier phase for SL: No need to specifically mention a specific technical solution. It can be included once RAN has established carrier phase in direct link (Uu).

20 – Philips International B.V.

We agree with the revised text.

As for including unlicensed spectrum as part of the SI we think that it may be too early considering the baseline of unlicensed for SL communication has not yet been discussed

As for including LTE Sidelink for positioning/ranging we prefer to limit the workload to NR Sidelink only.

21 – Intel Finland Oy

We support proposal from moderator

One comment is that our preference is to remove the following objective for RAN1 and/or resolve it in RAN:

- Identify specific target performance requirements and uses cases to be considered for the evaluation [RAN1]

After all discussions happened in RAN, we are not fully convinced that RAN1 needs to make a final call. In our view, it is better to provide RAN guidance to RAN1 as a part of SID/WID.

22 – Ericsson LM

Unlicensed and BLE: We think that what 3GPP can give on top of other technologies is the reliability of licensed spectrum. There is already today support for UE reporting of BLE measurements over LPP. Also, unlicensed hasn't yet been studied or specified for SL for communication. Taking also the large work load into consideration we therefore find it un-reasonable to include unlicensed in the SL positioning scope. We think, however, that it would be good to upgrade the support for UE reporting of BLE measurements over LPP to BLE 5.1. This is a very minor RAN2 work and could be done as part of either the SL work or the Redcap work.

Use cases: Keep all use cases. Important to study gains in positioning accuracy from SL in IIOT use cases.

Carrier phase for SL: Don't include carrier phase for SL. The workload is high enough as it is and carrier phase hasn't even been studied for Uu yet. However, the relevance of carrier phase measurements for GNSS

(few, very advanced transmitters with extremely stable clocks, fairly narrowband signals and main error contributions are from satellite orbits and clocks and atmospheric delays) cannot naturally be transferred to cellular (many, advanced transmitters with reasonably stable clocks for communication purposes, wideband signals and main error contributions are from local multipath and NLOS).

NR+LTE: Don't include SL for LTE. The workload is high enough as it is.

Resource allocation method: Rel-16 defines the basic functionality for NR SL resource allocation mode 1 (network-based) and mode 2 and it should be the baseline. Rel-17 includes optimizations for power saving that we think have low priority. Thus, we propose the following modification

- Note: Rel.16/17 NR SL resource allocation method is reused as much as possible, and coexistence with SL communication must be considered

Alignment with SA: Since there is an ongoing SA2 study on ranging and sidelink positioning we think the RAN work should be aligned with the SA work. Thus, we would like to include the following objective

- Alignment with SA groups and in particular with the study Study on Architecture Enhancement to support Ranging based services and sidelink positioning (S2-2108168 https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_147E_Electronic_2021-10/Docs/S2-2108168.zip)

23 – Volkswagen AG

Given that the available ITS spectrum is different in different regions, it is proposed to identify appropriate unlicensed spectrum (FR1 preferred) and to at least study the benefits of using such unlicensed spectrum only and in addition to a sidelink operation in the ITS band. This could be separate, may be less prioritized, objective.

2.6 Summary from Final Round

Unlicensed

This remains the most contentious topic with strong views on both sides. In the moderator's view there is insufficient consensus to include any objective on unlicensed at this time. However, this situation will be reported in the final conclusions of this email discussion.

NR+LTE

Based on the comment received, there seems to be a clear preferences to focus on NR deployments only.

Use cases

While a few repeat comments on use cases continue to be received, it seems clear to the moderator that there is going to be no further refinement of this aspect.

Resource allocation

Comments were received on both sides regarding the note on resource allocation. The moderator assumes that it will anyway be discussed during the work whether existing resource allocation principles can be reused, and as such the note does not add much value. The note is removed in the objective text from the final round.

WG responsibility

In response to some comments, the moderator's view is that RAN2 clearly has responsibilities for the sub bullet on architecture, signalling, etc. Consequently it is appropriate for RAN2 to also be included as responsible in the parent bullet. Similarly, any recommendations from the study phase within the domain of architecture, signalling, etc domain should also involve RAN2.

Other comments

A wide range of other more minor comments and wording proposals were received. These are not responded to individually but have been accommodated in the objective text where it seems appropriate. At this stage, it is the moderator's view that significant additions to the text are unlikely to be acceptable to the group and so they have not been added. In addition, it is likely that another round of fine tuning of the text is likely to be needed before it will be ready for approval at RAN#94e.

Revised Objective Test (revision marks shown are best effort given limitations of NWM)

- Study (for study phase of 9 months) solutions for sidelink positioning considering the following: [RAN1, RAN2]
 - Scenario/requirements [Moderator comment: These could be moved to the justification section in the final WID]:
 - 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 ~~and use cases~~ 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 and feasibility of potential solutions for SL positioning, considering: [RAN1, RAN2]
 - ~~Both~~ in-coverage, partial-coverage and out-of-coverage
 - ~~Note: Definitions of relative positioning and ranging expected to be refined during the study.~~
 - Study of positioning methods (e.g. TDOA, RTT, AOA/D, etc) including combination of SL positioning measurements with other RAT dependent positioning measurements (e.g. Uu based measurements) [RAN1]
 - Study of sidelink reference signals for positioning purposes, including signal design, phy layer control signalling, resource allocation, physical layer measurements, associated physical layer procedures, etc [RAN1]
 - ~~Note: Rel.16/17 NR SL resource allocation method is reused as much as possible, and coexistence with SL communication must be considered~~
 - Study of positioning architecture and signalling procedures (e.g. configuration, measurement reporting, etc) to enable sidelink positioning covering both UE based and network based positioning [RAN2, including coordination and alignment with SA2 as required]
 - Recommend solutions, if any, to be specified in the normative phase [RAN1, RAN2]

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 motivated 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 4: Improved accuracy, integrity and power efficiency - initial round comments

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.

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

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.

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

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:
 - o 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.
 - o Study, and if needed, specify procedures, signaling, and reporting for integer ambiguity resolution and cycle slip detection [RAN1/2].
 - o Specify signalling for configuration and reporting [RAN1/2/3]
 - Specify phase measurement request and resource configuration signals
 - o 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.
 - o 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:
 - o **(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].
 - o **(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].
 - o **(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].
 - o **3)** Involvement from SA2 may be required for LPHAP and integrity for RAT-dependent positioning.
 - o **4)** Further accuracy enhancements may be considered subject to work load and TUs of above objectives.
 - o **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.

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.

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].

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.

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.

In 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]

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.

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]

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.

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.

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,*
 - o *Solutions for RAT-dependent NR positioning integrity determination for both UE-based and UE-assisted RAT-dependent NR positioning methods [RAN2, RAN1]*
 - o *Aggregation of multiple Positioning Frequency Layers for DL PRS transmission/reception, and multiple carrier aggregation of SRS for Positioning transmission/reception [RAN1, RAN4, RAN2]*
 - o *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 5: Improved accuracy, integrity and power efficiency - intermediate round comments

1 – ZTE Corporation

Comment 1: For accuracy improvement based on PRS/SRS bandwidth aggregation, we don't think it is reasonable to limit to contiguous carriers. For example, the existing band n78 with two chunks of 100MHz can be used for potential aggregation regardless of contiguous or non-contiguous carriers within this band. As far as we know, such deployment has been considered by some operators. From ZTE perspective, we have upgraded a full range of existing equipment with 200M wide-bandwidth processing, there is no timing error issue between carriers within the band at least from gNB side.

Comment 2: For carrier phase measurements, we also suggest trying to reuse existing PRS/SRS. In such case, 'Reference signal' in the first bullet should be removed.

Comment 3: For LPHAP, the scope is too broad. We suggest to limit the potential evaluation/analysis/enhancement to RRC inactive/idle state as some other companies mentioned. Furthermore, MT-SDT objective will be planned for the Rel-18 SDT scope as discussed in email thread [RAN94e-R18Prep-26] SDT (small data transmission). Hence, **MT-LR for positioning in RRC inactive state should be specified accordingly.**

2 – Nokia Denmark

Nokia supports the objective on accuracy improvements (both carrier-phase (preferred) and bandwidth aggregation) due to market needs and the availability of technically feasible solutions. The accuracy bottleneck which is given by time-delay can be addressed by multi-path separation using time-domain techniques and by performing carrier-phase measurements on wideband reference signals like DL-PRS and UL-SRS instead of narrow-band or single-carrier signals. This enables further improvements beyond the Rel-17 bottleneck.

3 – Futurewei Technologies

There have not been studies on carrier phase measurements in prior releases, hence it is unclear by the third objective that goes directly into 'Specify solutions...'. Instead, as in other objectives, it should be 'Study solutions...'

4 – InterDigital France R&D

We have a concern on specification of NR carrier phase measurements. Feasibility study is needed to investigate whether current reference signals can be used or not (or phase measurements are useful for positioning under a practical scenario). Reference signal design may take significant amount of time for carrier phase measurements. For Rel. 18, we proposed to focus on the study for integrity and LPHAP and specification work for bandwidth aggregation. We don't think limiting bandwidth aggregation to intra-band contiguous carriers only changes the workload. It may limit applicability of BW aggregation.

5 – DanKook University

If the goal of Release-18 positioning is to achieve centimeter level accuracy, of course, the reference symbol design should be discussed again.

The current design of staggered form PRS signal structure is good only for time delay measurements, but it is not efficient for phase measurement. In order for accurate phase measurement, keeping the waveform constant in the frequency domain, i.e. block type design, is more appropriate, similar to the form of PTRS (Phase Tracking Reference Symbol). We need a study on a new reference symbol design advantageous for phase measurement. I believe an extensive discussion process is necessary for performance comparison and evaluation study to introduce this new brand of carrier phase positioning in 3GPP.

As for the application of the carrier phase positioning to sidelink, slightly different issues and discussion will be necessary, such as phase synchronization structure between vehicles, optimal antenna structure, etc. However, it is desirable to discuss it in the same group in the initial stage of the study.

Text of objectives summarized by Moderator is considered suitable for starting point of these discussions.

6 – vivo Mobile Communication Co.

The scope of this bullet is too large. We prefer to have a more limited scope. Thus we have two comments:

1. There are two directions for accuracy improvement. It is better we could focus on one of them.
2. Similar comments as ZTE above, the LPHAP bullet can be limited to study/specification enhancement for idle/inactive state.

7 – MediaTek Inc.

- For RAT-dependent integrity, we think the 9-month study phase is needed. Note that during Rel-17 initial study, RAN2 concluded that the error sources for RAT-dependent positioning methods needed to be studied by RAN1 (agreement of RAN2#111-e), so we assume this bullet should be led by RAN1.
- For bandwidth aggregation, we understand the rationale to focus in intra-band contiguous cases, but we also think this would limit the applicability. We are a bit unsure of the practical importance of this objective.
- For carrier phase, we think an initial study would be better, e.g. to consider the vulnerability of the measurements to NLOS and the suitability of the existing RSs.
- For LPHAP, we are OK with the general approach to start by studying whether existing functionality can meet the requirements.

8 – Qualcomm Incorporated

Comment 1:

For the integrity objective:

- We think it is important to note that the study will include both UE-based, UE-assisted positioning modes. Example:

Study methodologies, procedures, signalling, etc for determination of positioning integrity for both UE-based and UE-assisted positioning modes [RAN2, RAN1]

Comment 2:

- For the PRS/SRS BW aggregation, we are OK to limit to intra-band CA scenario, but we prefer to include both contiguous and non-contiguous scenarios.

- *Limit to case of intra-band contiguous carriers only*

Comment 3:

- For the PRS/SRS BW aggregation, during the previous study Item phase (38.857), the following was noted:

“The following enhancements have been considered during this study:

- Simultaneous transmission by the UE and reception by the gNB of the SRS for positioning across multiple CCs and multiple slots, including
- The scenarios and performance benefits of the enhancement
- The impact of channel spacing, TA and timing offset, phase offset, frequency error, and power imbalance across slots or CCs to the positioning performance for intra-band contiguous/ non-contiguous and inter-band scenarios “

In other words, RAN4 may need to consider implications beyond the timing offset only, so we suggest to generalize it to:

□ *RAN4 to consider implications between carriers for the PRS/SRS Bandwidth aggregation (e.g. timing errors, phase coherency, frequency errors, power imbalance, etc).*

Comment 4:

- For carrier phase measurements,
- OK with the statement in brackets assuming there is an evaluation phase:
- *Evaluate carrier phase positioning performance based on existing DL PRS and SRS for positioning*
- *Focus on reuse of existing PRS and SRS for positioning, with new reference signals only considered if found necessary based on the evaluation*
- The signalling for configuration and measurement reporting also affects RAN3 (for UL carrier phase measurements):
- *Signalling for configuration and measurement reporting [RAN2, RAN3]*

Comment 5:

- We think it is not needed to explicitly note some of the challenges “integer ambiguity resolution, cycle slip detection”, since these are just a subset of those. We prefer to be more generic and at the same time clarify that both UE-based and UE-assisted positioning methods should be considered as well as DL, UL, and DL+UL positioning methods:
 - o *Reference signals, physical layer measurements, physical layer procedures, solutions for ~~integer ambiguity resolution, cycle slip detection, etc~~ to enable positioning based on DL, UL, DL and UL NR carrier phase measurements for both UE-based and UE-assisted positioning modes.*

9 – Apple France

We still think the scope of this objective is quite broad. In addition, we do not think objectives related to improved accuracy can start as a work item. More precisely, for accuracy improvement based on PRS/SRS aggregation, although it was somehow studied and discussed in RAN1 within R17 study phase, it is understood that RAN4 work is required to study and evaluate the feasibility of such solutions. Without RAN4’s input, further progress in RAN1 is not envisioned. For accuracy improvement based on NR carrier phase

measurements, such techniques have not been studied well in RAN1 previously. A comparison between carrier-phase measurements and existing NR positioning techniques, e.g. in terms of achievable accuracy, is missing. Without such study, specifying another positioning solution is not desired.

10 – Guangdong OPPO Mobile Telecom.

The scope is too large and the workload will be too heavy for the group. From our initial assessment, the current scope of this part will need at least 2TU. From our view, the SL positioning and Redcap positioning should be prioritized, and the scope of this part should be kept as small in order to keep a manageable workload for R18 positioning.

We support the 1st and 4th objective (namely, integrity, LPHAP) and still think the 2nd and 3rd should be removed

- The workload is too heavy.
- The benefit is doubtful. Rel-17 study has shown the bottleneck of further accuracy improvement is timing error, NLOS and so on. The two mechanisms cannot address the bottleneck. In Rel-17, the target requirements for IIoT are not met until the parameters of some scenario are changed intentionally for evaluation. PRS/SRS bandwidth aggregation and carrier phase measurement were also the candidate mechanisms in Rel-17 study item. However, they didn't address the accuracy issue in some scenario. Finally, the group changed the parameter of some scenario for evaluation so that the rel-17 evaluation can meet the requirements. If these two mechanisms can improve the accuracy performance, they would have been adopted by Rel-17.
- PRS/SRS bandwidth aggregation: In R17, there were concerns on the performance and feasibility. Nothing is changed since then. We failed to see why we directly go to specify it. If this objective is included in the final WID, there should be a study phase led by RAN4 for the feasibility.
- NR carrier phase measurements: Its priority should be even lower than PRS/SRS bandwidth aggregation. It was proposed from R16 and being discussed in two releases, but no progress at all. It is not constructive for R18 to duplicate the study on the mechanism that doesn't get much support. During R16/17, some concerns were raised on performance and feasibility. Thus, even if it is included in the final WID, there should be a 9-month study phase focusing on the feasibility (RAN4-led) and performance (RAN1-led)

Regarding the bullets in brackets

contiguous carriers only. It is the common understanding in Rel-17 that intra-band contiguous CA is the only potential valid use case for bandwidth aggregation. Thus, if it is included in the final WID, this bullet should be included as well

11 – Beijing Xiaomi Mobile Software

We think LPHAP is a use case, and some potential enhancement solutions should be included for study, such as positioning in RRC Inactive with SDT triggered by network and positioning in RRC IDLE.

For bandwidth aggregation, we think both intra-band CA and inter-band CA can be included. And for inter-band CA, the impact introduced by the gap between two adjacent bands should be considered. In addition, it is beneficial to consider unlicensed band to improve accuracy by CA. For carrier phase measurements, we prefer to reuse of existing PRS and/or SRS to control the workload.

12 – Spreadtrum Communications

We have two comments:

1. For NR carrier phase measurements, it is a bit too early to directly say reuse of existing PRS and/or SRS will control the workload, as the main objective is to improve positioning accuracy comparing with Rel-17 positioning techniques. A study phase to evaluate and compare the achievable gain could be a balance.
2. For LPHAP, we are fine to limit study/specification enhancement for idle/inactive state as some companies mentioned.

13 – CATT

Q1: The revised objective text.

[CATT]

We support including NR carrier phase positioning, PRS/SRS bandwidth aggregation, LPHAP and Integrity for RAT dependent positioning, in the WI.

Additional comments:

- RAN3 needs to be included in work for related to PRS/SRS bandwidth aggregation and NR carrier phase positioning. The signaling exchanges between LMF and gNB are most likely needed to be enhanced to support these features.
- For RAT dependent positioning techniques, the work of “identify the error sources, failure modes” should be led by RAN1.

Suggested modifications (marked with **bold**):

- Study (for study phase of 9 months) solutions for Integrity for RAT dependent positioning techniques [RAN2, RAN1]:
 - o Identify the error sources, failure modes, etc [~~RAN2~~, RAN1, RAN2]
 - o Study methodologies, procedures, signalling, etc for determination of positioning integrity [RAN2, RAN1]
 - o Coordination with SA2 as required.
 - Specify solutions for accuracy improvement based on PRS/SRS bandwidth aggregation for intra-band contiguous carriers only [RAN1, RAN4, RAN2, RAN3]:
 - o RAN4 to consider implications of timing errors between carriers.
 - Specify solutions for accuracy improvement based on NR carrier phase measurements [RAN1, ~~RAN4~~, RAN2, RAN3]
 - o 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]
- **Note: Focus on reuse of existing PRS and/or SRS, with new reference signals only considered if found necessary**
 - o Signalling for configuration and measurement reporting [RAN2, RAN3]

- 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]

Q2: 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.

[CATT]

- For PRS/SRS bandwidth aggregation, we support limiting PRS/SRS bandwidth aggregation to intra-band contiguous component carriers only.
- For NR carrier phase positioning, we are fine to focus on the reuse of existing PRS and/or SRS. New reference signals will only be considered if it is found to be necessary.

14 – Samsung R&D Institute UK

Thanks for the discussion. For the revised objective text, we suggest the following additional revision (marked with **bold**) as

- **Study and** specify solutions for accuracy improvement based on PRS/SRS bandwidth aggregation [RAN1, RAN4, RAN2]:

.....

- **Study and, if beneficial,** 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 **applies to both Uu interface and SL interface** [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]

At first, we think that study is needed before specifying solutions for the above listed accuracy improvements. Especially for carrier phase measurement, performance gain should be verified. As we mentioned in the initial round discussion, for Uu positioning, the benefit from NR carrier phase measurements is not clear since LOS cannot be guaranteed in cellular communication environments. For sidelink positioning, we can consider this feature but a study is needed to identify if deemed feasible and beneficial.

For the first bracket, we think this can be added to limit the scope. On the other hand, for the second bracket, it should be removed, since that can be discussed further during the RAN1 discussion.

15 – Intel Corporation (UK) Ltd

Integrity

RAN2 agreed that error sources for RAT-dependent solution should be studied by RAN1, so it is proposed to remove RAN2 from sub-objective on identification of error sources or at least change the order of working groups, see below agreements made in RAN2#111

Proposal 2: Error source for RAT-dependent positioning methods should be studied under RAN1. Send an LS to RAN1 to trigger the study on error sources for RAT-dependent positioning methods for positioning integrity

In addition, for RAT independent integrity, so far RAN2 did not contact/coordinate with SA/CT. At this stage it is unclear for RAT dependent integrity, whether and what kind of coordination is foreseen with SA2? We suggest to remove “Coordination with SA2 as required.”

PRS/SRS aggregation

We suggest agreeing on intra-band contiguous aggregation, and trigger normative work directly in RAN2/RAN4, without RAN1 involvement.

Carrier phase positioning

We disagree with current form of proposal due to the following reasons:

(1) At first, study is needed as there was no technical conclusion made by RAN1 as well as sufficient performance analysis for this objective. The proposed technique was mentioned as one of the potential enhancements for NR positioning as cited in TR 38.855 Section 9.4.7 (Rel.16) together with many other proposed enhancements:

- “The NR carrier-phase based positioning technique was proposed in [51]-[52]. It refers to the positioning method, where the transmitter (either the gNB or the UE) transmits the positioning reference signals at the pre-configured carrier frequency, and the receiver (either the UE or the gNB) obtains the carrier phase measurements by tracking reference signals.
- In [53], phase measurements are derived from the complex correlations at the receiver side. The measurements combined with TDOA are used to estimate user position”

(2) At second, if carrier-phase solution is considered for analysis in R18, the first step should be analysis of phase measurements for the first arrival path and its report from UE/gNB. It was shown in R17 by multiple sources that enabling per path phase measurement provides accuracy improvements and thus this should be included in R18 scope for NR positioning methods.

(3) Finally, considering comments above we suggest revising objective as follows:

Study feasibility and benefits of utilizing carrier-phase and per path phase measurements of channel impulse response (including first arrival path and additional paths) for NR positioning [RAN1, RAN4]

It is preferred to focus on existing reference signals defined for positioning in R16.

LPHAP

- In our view, it can be a lower priority for R18 study/work. Study phase is needed for it since we should identify the requirement, and evaluate the gap between requirement for LPHAP and Rel.17 solutions, e.g., IDLE/INACTIVE, SDT, eDRX, etc. It seems the objective is RAN2-centric as it is relevant to SDT transactions, RRC states, eDRX. Clear objective still needs to be better understood.
- We are OK to study LPHAP related objective in R18 if it is marked as low priority and study is done by RAN2.

16 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility

1. Generally supportive but it now seems that the workload is higher than the previous iteration of the objective text. Coupled with a SL positioning study phase and a RedCap positioning WI, this is a concern from our side.

2. The bullets in square brackets can potentially reduce the workload, although the degree to which it can reduce the workload remains unclear.

17 – Huawei Tech.(UK) Co.. Ltd

For PRS/SRS CA, the first sub-bullet should be for RAN4 to investigate about phase discontinuity not about timing errors between carriers. We agree focusing on intra-band contiguous CA.

For carrier-phase based positioning, we suggest that the first sub-bullet be formulated as a study on reference signals, etc, since those aspects were not studied in the past. In this case, both sub-bullets can be merged into a single sub-bullet leaving it open whether to reuse existing RS or design new RS. This study phase should also involve RAN4 for the consideration of the timing/phase errors of gNBs/TRPs.

For LPHAP, the study phase should target completion in 9 months (including the identification of potential enhancements), to be consistent with the other study phase and to leave time for possible normative work. The current formulation implies that the entire item will only be a study phase for LPHAP in the entire Rel-18, even if necessary enhancements are identified.

18 – China Mobile E-Commerce Co.

We are fine with in general, with the following comments:

- On carrier phase measurements, since R17 SI does not include any evaluations on this feature, we prefer to revise the objective as “**Study and specify solutions** for accuracy improvement based on NR carrier phase measurements”. In addition, considering the limited TU allocated for positioning (keep in mind that it is including sidelink positioning), it is reasonable to limit the solutions to reuse existing PRS/SRS as much as possible.
- On the PRS/SRS aggregation, considering the limited TUs, we think that it is reasonable to focus on intra-band contiguous CA.

19 – CEWiT

We support the first two objective.

For PRS/SRS bandwidth aggregation, we can restrict for intra band but he non-continuous band should not be preclude .

Other topics are low priority.

20 – Sony Europe B.V.

We support the first bullet items (on positioning integrity). However, it is unclear to us whether the output is captured in a TR or it is a study within a work item? If it is a study with a duration of 9 months, we prefer the output is captured in a TR.

Considering Rel-18 positioning also needs to cover both sidelink positioning, and redcap positioning, as the others/remaining items, we propose to focus on the left over from Rel-17 WI (to be decided after RAN1 #107e meeting).

21 – Philips International B.V.

We agree with the revised text

22 – Ericsson LM

Integrity

We support this objective

Improved accuracy

We cannot accept going directly to specification phase for PRS/SRS bandwidth aggregation and NR carrier phase measurements. Clearly a study item is needed to evaluate performance and feasibility of these techniques.

PRS/SRS bandwidth aggregation was cursorily studied in the Rel-17 study item on positioning enhancements. The conclusion was that further studies are needed. In the NR positioning enhancement TR 38.857 it's stated that:

- From both gNB and UE perspective, the applicability and feasibility of this enhancement for different scenarios, configurations, bands and RF architectures, can be further studied

The carrier phase technique isn't even mentioned in TR 38.857.

Further more, as indicated in the first round, we think the scope of the Rel-18 position area is already far too large and does not really address the bottle necks we see for achieving high accuracy in realistic use cases and scenarios. Hence the improved accuracy objective can be dropped. If companies insist on keeping 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 addressing the problems with NLOS conditions, resulting excess delays for timing measurements and erroneous angular measurements.

Power efficiency

Due to the already large scope of this work, we also suggest dropping this objective

In summary our view is that

1. The objective on RAT based integrity should be kept
2. The objectives on improved accuracy and power efficiency can be removed
3. Start with a study item.

3.4 Summary from Intermediate Round

This topics area of "Improved accuracy, integrity and power efficiency" still receives many diverse comments and consequently is the least stable.

Integrity

Of all of the objectives, this one is the most stable receiving only comments aimed at refining the detailed wording, and WG responsibilities.

Aggregation

Regarding the question from the moderator whether this could be limited to intra-band contiguous only, there were a number of comments that this would be too restrictive. The moderator's proposal for the final round is to keep the intraband limitation but remove the contiguous limitation.

2 companies expressed the view that this objectives should start with a study phase, but given this was only 2 companies this has not been implemented in the proposal for the final round.

Various other wording proposals have been included.

Carrier phase

Quite a number of companies (7) continue to propose that the carrier phase work should start with a study, based on the argument that it was not fully studied in Rel-17 and nothing captured in the TR. Based on these comments the moderator's view is that it would be responsible to start this work with a study phase and this has been added to the proposal for the final round.

Regarding the question from the moderator whether this work should first focus on reuse of PRS/SRS, there were views on both sides. Given that the carrier phase work is now proposed to start as a study, and that the 'reuse of PRS/SRS' note also states that 'new reference signals only considered if found necessary' it seem clear nothing is excluded at this time but will instead have to be concluded by the study. Consequently this has been left in the proposal for the final round (although it could also be argued that it is not critical either way)

Various other wording proposals have been included.

LPHAP

Not so many comments were received on LPHAP. Some comments were received that the focus should be on enabling positioning in Idle/Inactive and that the study could be a RAN2 led activity. This change has been captured in the proposed objective for the final round.

General

Many companies expressed concern over the size and workload of the Rel-18 positioning item and of the "Improved accuracy, integrity and power efficiency" topic area in particular. With the exception of Integrity, the objectives under this topic have the lowest level of support, and all have received proposals that they could be removed in order to help keep control of the overall workload. From this perspective they are all still contentious.

The moderator tends to agree that the scope of the positioning work is very large and that downscoping is likely to be necessary before final approval for the Rel-18 package in December. The moderator also agrees that the likely candidates for downscoping come from the objectives under the "Improved accuracy, integrity and power efficiency" topic area. At the same time there is no very clear candidate (at least to the moderator) which item(s) could be removed. The moderator encourages all companies to carefully consider this and offer constructive proposals for the way forward.

Revised Objective Test (revision marks shown are best effort given limitations of NWM)

- 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, [RAN2, RAN1, RAN2].
 - Study methodologies, procedures, signalling, etc for determination of positioning integrity for both UE-based and UE-assisted positioning [RAN2, RAN1]
 - ~~Coordination with SA2 as required.~~
 - Specify solutions for accuracy improvement based on PRS/SRS bandwidth aggregation for intra-band carriers[RAN1, RAN4, RAN2, RAN3]:
 - RAN4 to consider implications of PRS/SRS bandwidth aggregation (e.g. timing errors, phase coherency, frequency errors, power imbalance, etc).
 - Study (for study phase of 9 months and, if found beneficial, specify solutions for accuracy improvement based on NR carrier phase measurements and per path phase measurements [RAN1, RAN4, RAN2, RAN3])

- 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 for both UE-based and UE-assisted positioning [RAN1]
 - Focus on reuse of existing PRS and/or SRS, with new reference signals only considered if found necessary
 - Signalling for configuration and measurement reporting [RAN2, RAN3]
- 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 with focus on solution to enhance position in idle/inactive [RAN1, RAN2]

3.5 Final Round

Feedback Form 6: Improved accuracy, integrity and power efficiency - final round comments

1 – vivo Mobile Communication Co.

We share the feeling the scope is too large and need downselection.

We also prefer to put study on PRS/SRS bandwidth aggregation since the Rel -16 study conclusion is to ask RAN4 to study the feasibility.

2 – Apple France

Overall, we prefer (at least) objectives related to improved accuracy are down-scoped in R18 package. On PRS/SRS aggregation, although we understand that our view is in minority, we would like to emphasize that there are couple of open aspects requiring further study before any specification work. As it is evident from comments by different companies within this email discussion, there is no consensus whether the solution is applicable to intra-band only or inter-band as well (such valid question was not well studied/addressed before in RAN1 within R17 study phase). In addition, as mentioned before, it is commonly understood that the feasibility/requirement of such solutions, even for intra-band, needs RAN4 input. Although we prefer anything related to further improve accuracy is down-prioritized in R18, if PRS/SRS aggregation is included in R18 package, it will be more realistic to start it as a study item, and if feasibility of solutions are identified, they can be next specified.

3 – Guangdong OPPO Mobile Telecom.

We support the 1st bullet.

For the 2nd bullet, we failed to why a study is not needed. In Rel-17, the conclusion is the aggregation of PRS and SRS can be studied further, without any other conclusion. Moreover, the R17 conclusion is only for intra-band contiguous carriers. There is no any further work on this topic after the completion of TR 38.857. Thus, we don't think it is technically justified to suggest to specify the aggregation of PRS/SRS.

In TR 38.857, the related parts are captured as below:

*Simultaneous transmission by the gNB and reception by the UE of **intra-band one or more contiguous carriers** in one or more contiguous PFLs **can be studied** further and if needed, specified during normative work*

- From both gNB and UE perspective, the applicability and feasibility of this enhancement for different scenarios, configurations, bands and RF architectures, can be further studied

*Simultaneous transmission by the UE and aggregated reception by the gNB of the SRS for positioning in multiple **contiguous intra-band carriers** can be **studied further** and if needed, specified during normative work.*

- From both gNB and UE perspective, the applicability and feasibility of this enhancement for different scenarios, configurations, particular bands and RF architectures, can be further studied.

For the 4th bullet

- In this bullet, “with focus on solution to enhance position in idle/inactive” should be removed. What we should do will depend on the study and evaluation (the 1st part of this bullet). We cannot restrict the solution for some specific cases in current stage.
- Based on the above reason, WG RAN1 should be also kept .

As moderator and many companies commented, the scope is very large. Regarding the down-scoping of this part, we view is as below

- Support the 1st and 4th bullets
- Remove the 2nd and 3rd bullets for down-scoping
 - o If the 2nd bullet is included in the final WI/SI, there should be a study phase led by RAN4 for the feasibility.

4 – Futurewei Technologies

In general, supportive of the revised objectives and we think all items should start as a Study, even for PRS/SRS aggregation which we disagreed had been studied adequately during Rel 17.

5 – Nokia Denmark

The comment about carrier phase not being captured in “the TR” is not correct; it was already studied in Rel-16 and is captured in TR38.855. On that basis, carrier phase can start directly with a work item, because it has already been studied.

6 – ZTE Corporation

We are supportive of moderator’s latest update. Carrier aggregation should directly go to normative work. As we explained before, if transmitter/receiver uses a full range of equipment with wide-bandwidth processing, there is no timing/phase error at all. Our product has implemented such equipment already. Based on this, Carrier aggregation will be a very useful feature for higher accuracy positioning.

If there are still some concerns on workload, we prefer to make LPHAP more specific, i.e. specify MT-LR positioning in RRC inactive state. Then, there is no need to evaluate/study others in this Release.

For Integrity, we think error sources, failure models should be discussed in RAN2. Actually, the same thing is on-going in Rel-17 RAN2. The agreement companies mentioned was a very early one, the situation changes now. It is noted that in Rel-17 RAN1 never discuss error source and failure models so far.

7 – MediaTek Inc.

- **Integrity:** We agree that this should start with a study phase. The scope of any normative work should be contingent on how the impact looks after study (as usual). On the error sources and failure modes, we understand that these have been discussed in RAN2 in Rel-17 because of the involvement

of companies with GNSS expertise (which anyway would not be in RAN1 scope), but RAN2 considered that RAN1 would be better positioned to evaluate these issues in the context of RAT-dependent positioning.

- **Bandwidth aggregation:** Limiting to intra-band is better than limiting to intra-band contiguous only, but we are still unsure how useful this will be. We see this as lower priority.
- **Phase measurements:** We are OK with this objective, and we think the initial study phase is needed.
- **LPHAP:** We support this objective.

8 – InterDigital France R&D

We support the moderator’s objective.

9 – Qualcomm Incorporated

We are generally OK with the moderator’s suggestions on the integrity, carrier phase and BW aggregation objectives, with the following comment on carrier phase objective (remove the “or”):

- Focus on reuse of existing PRS and/or SRS, with new reference signals only considered if found necessary

We have one main comment with regards to the LPHAP objective:

Comment 1:

Since we are going to have a study phase, we prefer to not restrict the solutions to only RRC idle/inactive enhancements, and let the study come up with the enhancements needed. Also, we believe that evaluation of power consumption is expected to happen in RAN1 and not in RAN2, and therefore, it makes sense to keep RAN1 as a WG that is going to do the power evaluation. Note that also in NR Rel-17, the power consumption study was performed in RAN1, and then, the selected enhancement was mainly RAN2-centric, and the WID was structured accordingly.

10 – Beijing Xiaomi Mobile Software

We support the moderator’s objectives. Regarding the solutions for accuracy improvement, the PRS/SRS aggregation is to construct larger bandwidth and the carrier phase based measurement can be worked within small bandwidth. So we think both solutions can be included.

11 – Samsung R&D Institute UK

At first, we have one question for carrier phase measurement as

Q: Does the carrier phase measurement target only for Uu positioning?

According to moderator’s response in the section of sidelink positioning, moderator’s understanding is ‘Yes’ for the above question. However, we want to make clear this is common understanding. If ‘Yes’ it should be clearly captured in the WID to avoid misunderstanding. However, we do not support this limitation. We think that carrier phase positioning can be studied both for SL and Uu. As we mentioned before, we expect that it can be more beneficial in SL if reference UE is properly selected. Specifically, the carrier phase method requires LOS conditions, which can be achieved when the distance between the two devices involved in positioning is short. This is more likely to happen in SL positioning e.g. between cars or between people in close proximity to each other than it is to happen on the Uu interface, when the base station and the UE might not be relatively close to each other. Therefore, we support considering the carrier phase method for SL positioning. Anyway, if the common understanding is that carrier phase can be

considered both for SL and Uu, we suggest to delete the second sub-bullet and add a note as below (marked with **bold**) since this bullet considers only existing reference signal in Uu.

- Study (for study phase of 9 months and, if found beneficial, specify solutions for accuracy improvement based on NR carrier phase measurements and per path phase measurements [RAN1, RAN4, RAN2, RAN3])

> 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 for both UE-based and UE-assisted positioning [RAN1]

> ~~Focus on reuse of existing PRS and/or SRS, with new reference signals only considered if found necessary~~ **Note: the carrier phase measurements based method could be considered for sidelink positioning as well.**

> Signalling for configuration and measurement reporting [RAN2, RAN3]

Secondly, for LPHAP, we think that RAN2 to be lead is fine, but RAN1 should be involved. In addition, the limitation for idle/inactive is not necessary, the LPHAP is not mentioned for idle/inactive state. Therefore, we suggest the following modification (marked with **bold**) as

- 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 ~~with focus on solution to enhance position in idle/inactive~~ [RAN2, RAN1,]

12 – CATT

1 Regarding to the revised objective for “Integrity part” from the moderator:

[CATT] The modifications look fine to me.

2 Regarding to the revised objective for “PRS/SRS bandwidth aggregation part” from the moderator:

[CATT] Suggest also adding “Study (for study phase of 9 months) and, if found beneficial,...” since we are considering study phase of 9 months for Improved accuracy, integrity, and power efficiency.

3 Regarding to the revised objective for “carrier phase measurements part” from the moderator:

[CATT] We are fine to add the study phase of 9 months, and also adding “for both UE-based and UE-assisted positioning”.

One comments:

It is unclear to us about the motivation of adding “per path phase measurements” in this objective. Per path phase measurements are currently under discussion for multipath mitigation in RAN1 for Rel-17 WI, as shown in the following agreement, but RAN1 has not reached an agreement to support it yet. Is the intention of adding “and per path phase measurements” to continue R17 work of R17 multipath mitigation? If so, it should be proposed as a separate objective. For carrier phase positioning for cm-level accuracy, our understanding is that it requires the use of the carrier phase measurements from the 1st path of the LOS signals, but not per path phase measurements, even under multipath environment.

The related Agreement in RAN1#105-e as follows,

For multipath reporting enhancements, study reporting from TRP to LMF, angle, timing, phase (of additional paths) and power for the additional N paths (value of N is part of the study).

- *Note: Companies are not obligated to provide inputs for all parameters in their study*

4 Regarding to the revised objective for “LPHAP part” from the moderator:

[CATT] The modification is fine to us in principle, and we prefer the word of “position” may be changed into “positioning” and other changes in the added words as follow (Marked with **bold**):

“with focus on solution to enhance positioning for UEs in RRC_IDLE/INACTIVE ~~idle/inactive state~~”

13 – Huawei Tech.(UK) Co.. Ltd

For LPHAP, we are OK to limit it IDLE/INACTIVE mode or not to put a limitation.

Two additional comments:

1. The study phase should target completion in 9 months (including the identification of potential enhancements), to be consistent with the other study phases in other objectives and to leave time for possible normative work. The current formulation implies that the entire item will only be a study phase for LPHAP in the entire Rel-18. If necessary enhancements are identified, then they should also be specified in Rel-18.
2. It is not clear how RAN2 alone can conduct the power consumption evaluation, since this is primarily RAN1 business. We suggest to add RAN1 back and keep RAN1 as a responsible WG.

14 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility

Generally agree with the moderator’s view than some down scoping needs to occur. From our side we would tend to prioritize the following aspects: Integrity, PRS/SRS bandwidth aggregation and LPHAP. However, considering the divergent views, current downscoping may be a challenging task.

15 – Sony Europe B.V.

We still consider the scope is too broad with many objectives, some limitations are required.

- We support integrity.
- We should also consider some potential left-over from Rel-17 WI.
- On bandwidth aggregation, we could start with a short study phase within a work item.
- On carrier phase, we prefer to drop this objective considering the workload.
- We are OK to study LPHAP.

16 – Spreadtrum Communications

For the revised objective on “carrier phase measurements part”, we are fine with the update by moderator on adding “the study phase of 9 months” and “for both UE-based and UE-assisted positioning” for carrier phase measurements. However, we share the same view with CATT that no need to add “per path phase measurements” in the objective.

17 – Philips International B.V.

We agree with the moderator in that the scope is too large. We propose to leave out RS/SRS bandwidth aggregation and NR carrier phase and keep integrity and LPHAP

18 – Intel Finland Oy

We are supportive of the latest revision from moderator.

We think scope reduction is important, but it can be discussed next time.

19 – Ericsson LM

Integrity: We are essentially fine with this objective, but would like to include the aspect raised by ESA that there will be GNSS integrity discussion leftovers from Rel 17 that need to continue in Rel 18.

- Improved accuracy, integrity, and power efficiency:
 - o GNSS integrity enhancements [RAN2]
 - o Study (for study phase of 9 months) solutions for Integrity for RAT dependent positioning techniques [RAN2, RAN1]

Aggregation: Our preference is to remove this objective. If included, we still think a study phase is needed for this work. There are critical RAN4 aspects that have not been studied. This was also the view of RAN1 after the Rel. 17 study on NR positioning enhancements as expressed in TR 38.857:

- From both gNB and UE perspective, the applicability and feasibility of this enhancement for different scenarios, configurations, bands and RF architectures, can be further studied

We prefer to limit this work to intraband contiguous, since this limitation would lead to somewhat more reasonable level of complexity and cost.

Power efficiency (LPHA)

RAN2 as part of Rel-17 WI already addresses the low power high accuracy use case by supporting RRC Inactive mode positioning and Small data transmission for reporting positioning measurements. We do not see the need to further work on this. Further, RAN2 has already performed study on idle mode positioning as part of Rel-17 study item, TR 38.857 section 10.9, where RAN1/RAN2 already drew the conclusion. Hence in order to not repeat the same discussion and to minimize the study work load, we should drop this objective from both RAN1/RAN2 perspective.

On working item scope: We agree with FL that the overall positioning scope is too large. Our proposal is to remove the objectives for accuracy and power efficiency. We note that the techniques proposed for accuracy improvement address only peak performance under ideal LoS conditions and will give no gains for realistic use cases.

3.6 Summary from Final Round

Integrity:

2 comments were made regarding whether the discussion of error sources was a RAN1 or RAN2 activity. No change to the objective text is made based on these comments.

One comment in this round and one, from a different company, in the intermediate round that a Rel-17 leftover for GNSS Integrity should be included. No change to the objective text is made based on these comments. The moderator's view is that it is still possible that some Rel-17 leftovers could be discussed and added to the WI when the Rel-17 work is completed and the situation about leftovers is clear.

PRS/SRS aggregation:

A significant number of comments (7 companies) continue to be made that PRS/SRS aggregation should include a study phase. The moderator proposes to change the objective wording so that this also starts with a

study phase.

In addition, some companies express the view that this objective is a candidate for downscoping.

Carrier phase

2 companies expressed the view that the phrase "and per path phase measurements" proposed to be added in the intermediate round should not be included as it was part of Rel-17 discussions. The changes proposed from the intermediate round are not included in the objective text from this round.

1 company commented that carrier phase study should cover both Uu and sidelink. The moderator proposes to add clarification text to limit the carrier phase study to Uu only, with this proposal made primarily on the grounds of keeping the scope reasonable. However, it is acknowledged that could be beneficial for some of the sidelink use cases. Companies may choose to comment in this in the next phase of discussion.

In addition, some companies expressed the view that this objective is a candidate for downscoping.

LPHAP

A number of companies expressed the view that this study should not be limited to or focused on enhancements to idle/inactive, and that the study should involve. RAN1. The changes proposed from the intermediate round are not included in the objective text from this round.

One company expressed the view that this objective is a candidate for downscoping.

Revised Objective Test (revision marks shown are best effort given limitations of NWM)

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, [RAN1, RAN2].
 - Study methodologies, procedures, signalling, etc for determination of positioning integrity for both UE-based and UE-assisted positioning [RAN2, RAN1]
- Study (for study phase of 9 months) and, if found beneficial, specify solutions for accuracy improvement based on PRS/SRS bandwidth aggregation for intra-band carriers[RAN1, RAN4, RAN2, RAN3]:
 - RAN4 to consider implications of PRS/SRS bandwidth aggregation (e.g. timing errors, phase coherency, frequency errors, power imbalance, etc).
- Study (for study phase of 9 months and, if found beneficial, specify solutions for accuracy improvement based on NR carrier phase measurements ~~and per path phase measurements~~ [RAN1, RAN4, RAN2, RAN3]
 - Reference signals, physical layer measurements, physical layer procedures to enable positioning based on NR carrier phase measurements for both UE-based and UE-assisted positioning [RAN1]

- Focus on reuse of existing PRS and/or SRS, with new reference signals only considered if found necessary
- Signalling for configuration and measurement reporting [RAN2, RAN3]
- Study (for study phase of 9 months) 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 with focus on solution to enhance position in idle/inactive [RAN2, RAN1]

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 7: Redcap positioning - initial round comments

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]

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.

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.

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.

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

<p>18 – Intel Corporation (UK) Ltd</p> <p>(1) At least study phase within work item seems needed to complete performance evaluation and determine needed enhancements</p> <p>(2) Identify potential enhancements to help address possible limitations associated with RedCap UEs, e.g., bandwidth limitations [RAN1, RAN4]</p>
<p>19 – Verizon UK Ltd</p> <p>Agree with the moderator’s proposal. We think RedCap positioning is needed, preferably on par with regular NR UE.</p>
<p>20 – MediaTek Inc.</p> <p>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.</p>
<p>21 – Qualcomm Incorporated</p> <ol style="list-style-type: none"> 1. Work Item 2. Details on a potential WI description: <ul style="list-style-type: none"> · <i>Define performance requirements for positioning by RedCap UEs [RAN4]</i> · <i>Evaluate performance of existing Rel-17 positioning procedures and measurements with RedCap UEs [RAN1, RAN4]</i> <p><i>Based on the evaluation, identify, and specify potential enhancements to help address possible limitations associated with RedCap UEs [RAN1, RAN2]</i></p>
<p>22 – InterDigital France R&D</p> <ul style="list-style-type: none"> - A study is needed for RedCap positioning to identify potential enhancements. - RAN1 leads identification of potential enhancements, discussion on evaluation assumptions and evaluations.

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 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 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 8: Redcap positioning - intermediate round comments

1 – ZTE Corporation

We think this should be led by RAN4. As we don’t know what the requirement is for RedCap UE positioning yet, we suggest the order as

First, RAN4 defines the positioning requirement for RedCap UE

Second, RAN1 does evaluation to check if the existing positioning methods can satisfy the requirements defined by RAN4.

Third, specify if needed some potential enhancements based on the evaluation results.

2 – Futurewei Technologies

Propose to delete the word “Define” in the main bullet. The main bullet w/o the word ‘Define’ would reflect the sub-bullets better since whether or not further work is needed depends on first the evaluation.

On the WG that should do the evaluation, our view is still RAN4 should take the lead. This SI now already consists of 2 major component on Sidelink and Improved Accuracy/Integrity/Power efficient for RAN1.

3 – InterDigital France R&D

For target system requirements, Rel. 17 latency and accuracy requirements can be used. We should select the solution that can nearly achieve the target at reduced capability or yield the best performance among several candidates at reduced capability.

4 – vivo Mobile Communication Co.

From scope control perspective, we don't see the need for the following considering there are already a lot of work in sidelink positioning and improved accuracy/integrity/power efficiency. We can consider them in future releases when there are more commercial needs.

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

5 – Qualcomm Incorporated

- It could be added as RAN1 responsibility, during the evaluation phase in RAN1, to:

o *Identify specific target performance requirements to be considered for the evaluation [RAN1]*

- The objective text looks good.

6 – MediaTek Inc.

We generally agree with the moderator's description in the last paragraph. Our understanding is that this item should be RAN4-led to determine the requirements.

7 – Apple France

The work structure should be determined, if RedCap positioning is included in R18 positioning package. In our view, this work if included, should be started as a study item given that identifying potential enhancement for RedCap UE is pending to further evaluation of RAN4 and RAN1 based on current positioning techniques for a UE with reduced capability. With a large scope of R18 positioning, we prefer out of "Improved accuracy, integrity and power efficiency", and "Redcap positioning", at least one is de-prioritized in R18

8 – Guangdong OPPO Mobile Telecom.

Support the revised objectives from Moderator

9 – Beijing Xiaomi Mobile Software

We general fine to the revised objectives, for the target system requirements, we think it can be identified by RAN1 during the positioning performance evaluation phase.

10 – CATT

Q1: The need to define target system requirements for positioning by RedCap UEs

[CATT]

Whether to define new target positioning performance requirements for RedCap UEs may depend on the evaluation. Thus, suggestion adding a sub-bullet under the 1st main bullet, saying that:

- **define target system requirements for positioning by RedCap UEs if necessary**[RAN1]

Q2: The revised objective text, aimed at ensuring clarity.

[CATT]

To reduce the impact of the WI to the work load, we don't see the need to have both RAN1 and RAN4 to evaluate the positioning performance of existing positioning procedures and measurements with RedCap UEs. If the concern is RAN4 may not be able to evaluate the positioning performance, then we can let RAN1 to do the evaluation as we have done for R16 and R17.

Suggested modifications (marked with **bold**):

- Evaluate positioning performance of existing positioning procedures and measurements with RedCap UEs [RAN1, ~~RAN4~~]
- Based on the evaluation,
 - **define target system requirements for positioning by RedCap UEs if necessary**[RAN1]
 - 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]

11 – NTT DOCOMO INC.

We are fine with the revised objective text.

12 – Samsung R&D Institute UK

At first, we think that down-scoping is necessary if two TUs are allocated for Rel-18 positioning. As many companies have commented in the initial round discussion, target requirements and specification impacts for RedCap positioning are not clear currently. Therefore, if down-scoping is considered, RedCap positioning needs to be de-prioritized at first. So, we suggest to add square brackets for this item and discuss further. In addition, we suggest the revised objective text (marked with **bold**) as:

- **Define**Study positioning support for RedCap UEs:]
- > **Define core and performance requirements for positioning measurements performed by RedCap UEs** [RAN4]
- > Evaluate positioning performance of existing positioning procedures and measurements with RedCap UEs [~~RAN4~~, RAN1, ~~RAN4~~]
- > **If positioning requirements are not satisfied** 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]~~

13 – Intel Corporation (UK) Ltd

- We do not see the strong need to define/agree on accuracy requirements for positioning of RedCap UEs. Accuracy analysis can be an outcome of the study rather than input requirement. Based on this accuracy analysis, RAN1/2 can have the discussion whether anything more is needed to improve positioning by RedCap UEs.
- We are fine with the revised objective by moderator

14 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility

Supportive of the latest revised objective text

1. Due to the redcap hardware limitations, there is a need to define the target system requirements.

15 – VODAFONE Group Plc

Agreed with moderator's revised objectives with the understanding that indoor use cases without GNSS as the primary use case that can benefit for potential enhancements

16 – Huawei Tech.(UK) Co.. Ltd

The second sub-bullet of the objective is unclear in our view. The "possible" limitations (maximum bandwidth of 20 MHz, 1 Rx) are already known. We think that this second sub-bullet should be about studying and identifying enhancements to overcome the known limitations of RedCap UEs that impact positioning accuracy, while limiting the potential complexity increase of RedCap UEs. The goal should be to achieve (if possible) or approach the positioning accuracy of devices that don't have such limitations (i.e. devices with 100 MHz BW).

17 – Spreadtrum Communications

We are general fine with revised objectives.

Regarding the target system requirement, we think some initial work is needed to determine it. Reuse the Rel.17 latency and accuracy requirements may not suitable, since the capabilities and the target use cases are quite different between RedCap and Non-RedCap. In addition, there are three different use cases with quite different characteristics for RedCap, whether to define different positioning performance requirements for these three use could be considered if it is found necessary.

18 – China Mobile E-Commerce Co.

We are supportive of the revised objective text.

Regarding the target system requirements, we think that it should be identified in the first place by RAN1 during the performance evaluation.

19 – Sony Europe B.V.

In principle we support the moderator proposal.

However, we have some further refinement, such as we suggest to modify the first bullet point so that it is clear what to be evaluated. Furthermore, it is sufficient by RAN1 only.

- *Identify the scenario(s) and evaluate positioning performance of existing positioning procedures and measurements with RedCap UEs(RAN1, RAN4).*

20 – Philips International B.V.

We agree with the revised text

21 – Ericsson LM

We are supportive of the moderator's proposal.

4.4 Summary from Intermediate Round

Target Requirements for RedCap UEs

Fewer than half of companies responded to the moderator's question on whether there was a need to start the work by defining target system requirements for positioning by RedCap UEs. Of those that did respond explicitly, 7 thought that there was a need to do so and 2 thought that this was not necessary or that existing Rel-17 requirements should still apply. In addition, there were a further 7 companies that indicated that they were happy with the objectives as proposed. Based on this rather inconclusive response, the moderator has proposed an additional objective in square brackets. Companies are requested to comment on whether this is required.

WG roles

Various comments on the WG roles were received. The moderator's understanding is that RAN4 is the best group to assess how the RedCap UE limitations of bandwidth and number of receive chains, etc impact on positioning measurement accuracy within the UE. RAN1 is the best group to assess how the RedCap UE limitations translate into accuracy of the eventual location determination. RAN4 is the only group appropriate to define performance requirements on measurement accuracy and delay for the various different positioning related measurements (i.e. the requirements that will be included in 38.133).

If it is concluded that the work should start with defining target system requirements for positioning by RedCap UEs, then it is the moderator's understanding that this would be a RAN1 role, not RAN4.

Finally, the moderator does not consider that it would be appropriate to shift responsibility between WGs just to balance workload - tasks should be given to the appropriate WG based on their expertise and not for other reasons.

Based on these understandings, no changes to the WG roles have been made. Further comments are of course welcome in the final round.

Other comments

There were a number of other comments such as a proposal to not consider any solutions to address RedCap UE limitations, a proposal to remove RedCap in order to reduce overall size of the WI, a proposal to start with a study. Given that each comment was only made by a single company, no change has been made.

Some more minor wording suggestions have also been included.

Revised objective text:

- ~~Define~~ Positioning support for RedCap UEs, considering the following:
 - o [Identify specific target positioning performance requirements (location accuracy, latency, etc) to be considered for the evaluation [RAN1]]
 - o Evaluate positioning performance of existing positioning procedures and measurements with RedCap UEs[RAN1, RAN4]
 - o Based on the evaluation, identify potential enhancements to help address ~~possible~~ limitations associated with for RedCap UEs [RAN1, RAN2]
 - o Define core and performance requirements for positioning measurements performed by RedCap UEs [RAN4]

4.5 Final Round

Further comments on the revised objective text is invited. In particular comments are requested on the new bullet in square brackets.

Feedback Form 9: Redcap positioning - final round comments

<p>1 – vivo Mobile Communication Co.</p> <p>Thanks moderator for the efforts. We would like to first assess whether there is any need to study the potential enhancement after evaluation and thus the following update is preferred:</p> <p>Based on the evaluation, assess the necessity and if needed identify potential enhancements to help address possible limitations associated with for RedCap UEs [RAN1, RAN2]</p>
<p>2 – Apple France</p> <p>We also think to keep the work manageable, besides objectives related to improved accuracy, Redcap positioning can be down-scoped in R18. If it is included in the package, we prefer to add the first bullet (remove brackets) but the work has to start as study item. While requirements for positioning measurements by RedCap UE is not known (pending to RAN4 input), the impact of such measurements to positioning accuracy, etc is not known (pending to RAN1 evaluation based on RAN4 input on the existing positioning techniques), and even target positioning performance numbers for a RedCap UE is not identified (RAN1), the work can NOT start as a WI.</p>
<p>3 – Guangdong OPPO Mobile Telecom.</p> <p>Support the revised objectives from Moderator, including the current assement of WG roles for each objective. We don't agree the whole work of RedCap is led by RAN4.</p>
<p>4 – Futurewei Technologies</p> <p>We support the revised objectives as written by the moderator.</p>

5 – ZTE Corporation

We are fine with the moderator's revision. However, if there is concern on workload, we prefer not to include RedCap positioning in this Release SI/WI since all the current requirement and potential enhancements are unclear. It will be a high burden for Rel-18 work.

6 – MediaTek Inc.

We generally agree with this version of the objective. The description of the work sounds a bit like an initial study phase: understand the requirements, see if existing mechanisms can meet them, and identify potential enhancements.

At the beginning of the objective, the word "Define" has been deleted, but it needs to be replaced with another verb, either "Study" or "Specify". The objectives seem more congruent with "Study" in our view.

7 – InterDigital France R&D

We support to have discussion to agree on the target requirements. Even we agree to reuse the Rel. 17 requirements, identification of requirements needs to happen to evaluate techniques and how close their performances are to the target. Thus we support to remove the square brackets from the 1st bullet.

8 – Qualcomm Incorporated

We are OK with the proposed objective

9 – Beijing Xiaomi Mobile Software

We agree with the revised objectives.

10 – Samsung R&D Institute UK

Thanks for the discussion. According to the revised text, an additional objective in square brackets was added which seems necessary since the target requirements for RedCap positioning is not clear. However, it increases RAN1 work. As we commented in the previous round of discussion, currently a scope of the WI is huge and considering allocation of two TUs for Rel-18 positioning, we think that down-scoping is necessary and RedCap positioning needs to be de-prioritized at first. So, we suggest to add bracket to main bullet.

~~Define~~ Positioning support for RedCap UEs, considering the following:]

> [Identify specific target positioning performance requirements (location accuracy, latency, etc) to be considered for the evaluation [RAN1]]

> Evaluate positioning 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 core and performance requirements for positioning measurements performed by RedCap UEs [RAN4]

We think that the positioning for RedCap UEs can be postponed to next release or if only RAN4 requirement is considered (for reduced BW UE, 1Rx), Rel-18 RedCap could handle this. Otherwise, it might require more TUs for Rel-18 positioning.

11 – CATT

Regarding to the revised objectives for RedCap positioning from the moderator:

[CATT] We are fine to add the bullet “[Identify specific target positioning performance requirements (location accuracy, latency, etc)]”, which may be needed to decide whether there is a need for potential enhancements. W/o target positioning performance requirements, we may not know what kinds of enhancements are needed after the evaluation.

12 – Huawei Tech.(UK) Co.. Ltd

We can accept leaving the consideration of the positioning targets for RedCap UEs to RAN1. One question we still have is whether the fourth objective implies that there will be no positioning requirements for Rel-17 RedCap UEs, or whether RAN4 will also define requirements based on Rel-17 positioning techniques (i.e. without the potential enhancements) and if so whether those requirement can apply to Rel-17 UEs in a release independent manner?

13 – NTT DOCOMO INC.

Regarding the target positioning performance requirements, we don't think any new requirement is necessary for RedCap UEs, but it should be clarified whether Rel-16 requirements or Rel-17 ones are reused for RedCap UEs.

14 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility :

According to the current revised RedCap positioning objectives, the listed objectives can be interpreted as a SI due to the need for identification of positioning performance requirements and an evaluation component of the existing procedures and measurements for RedCap UEs. In any case, we are fine with the revised objectives occurring during the proposed WI phase, since we would need to perform the aforementioned study aspects before deciding on any potential enhancements to be introduced.

15 – Sony Europe B.V.

We support the moderator proposal.

16 – Philips International B.V.

We agree with the revised text

17 – Intel Finland Oy

We are supportive of the latest revision from moderator and prefer to remove objective in bracket.

18 – Ericsson LM

Target Requirements for RedCap UEs: We don't think the RedCap work should start by defining target requirements. The whole idea with RedCap UEs is that they should have low complexity and low cost. The design of positioning techniques for RedCap thus has to be based on balancing cost and complexity with positioning accuracy rather than on pre-defined target requirements for positioning accuracy. The positioning accuracy should be as good as possible without significantly increasing RedCap UE complexity.

4.6 Summary from Final Round

Target Requirements for RedCap UEs

5 companies supported that the work should start by identifying the target requirements and 3 companies supported to not include this activity. Other companies did not provide any explicit comment on this topic (similar to the intermediate round). One of the companies supporting not to start by identifying requirements commented that "The positioning accuracy should be as good as possible without significantly increasing RedCap UE complexity". This suggests a slightly different approach to the work. After completing the evaluation of the positioning performance, instead of comparing that performance with hard set of target requirements, there will have to be a judgement whether the performance is 'good enough' given the cost/complexity constraints of RedCap UEs, and whether any additional enhancements are justified. In the moderator's view, this seems like a reasonable way to address this question of target requirements for RedCap UEs and so the bullet in square brackets has not been kept.

Need for enhancements

1 company raised the point that the evaluation could conclude that no enhancements for Redcap UEs are required. The moderator agree that this is of course a possible outcome. Text has been proposed to the "Based on evaluation..." bullet to address both this point and aspect on target requirements.

Other comments

There are 3 companies proposing RedCap positioning to be downscoped and 4 companies suggesting that it should start with a study phase. Based on this the moderator considers that RedCap is still a contentious item and this will be reported in the conclusions.

There was a valid question raised about whether the RAN4 requirements for positioning measurements performed by RedCap UEs (as defined in the final bullet) would apply to Rel-17 RedCap UEs. In the moderator's view this is a topic that will have to be discussed by RAN4 as part of the work, although, in general, it does not make sense for Rel-17 UE implementations to have to comply with performance requirements that may not be finalised for 2 years. Of course, it could still be an implementation choice for a R17 UE implementation to meet those performance requirements. No objective text change has been proposed for this point.

Revised Objective Test (revision marks shown are best effort given limitations of NWM)

- Positioning support for RedCap UEs, considering the following:
 - [~~Identify specific target positioning performance requirements (location accuracy, latency, etc) to be considered for the evaluation [RAN1]~~]
 - Evaluate positioning performance of existing positioning procedures and measurements with RedCap UEs[RAN1, RAN4]
 - Based on the evaluation assess the necessity of enhancements and, if needed, identify enhancements to help address limitations associated with RedCap UEs [RAN1, RAN2]
 - Define core and performance requirements for positioning measurements performed by RedCap UEs [RAN4]

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 10: Other comments - initial round

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 11: Other comments - intermediate round

1 – Intel Corporation (UK) Ltd

Based on current discussion and list of objectives, the NR positioning scope for R18 is quite broad and it is recommended to have some discussion on prioritization/down-selection to come up with final scope.

5.4 Summary from Intermediate Round

Only comment receive was related to the wide scope of the WI. Several other companies had similar comments within the "Improved accuracy, integrity, and power efficiency" section and the moderators has responded in intermediate summary of that section.

5.5 Final Round

5.5.1 Views on overall structure of the work

Based on the discussion so far it has been identified that a number of elements of the Release 18 positioning work (SL positioning, Integrity for RAN dependent positioning, LPHAP) need to start with some study, and other elements (PRS/SRS aggregation, RedCap positioning) can start immediately with normative work, with discussion continuing for carrier phase positioning. There are different ways that this could be structured into SI/WIs:

1. Single WI in which the items requiring study start with a study phase of, e.g., 9 months. The WI will be updated at the end of 9 months with new objectives coming from conclusions of the studies. Those objectives not requiring study can start immediately on the normative work. In the moderator's view, this is the simplest arrangement.
2. Single SI for 9 months to study all the items that require it. At the end of 9 months a WI will be created that includes objectives for these items and also objectives for those items that did not need study. A consequence is that no work would start on PRS/SRS aggregation, RedCap positioning, etc for the first 9 months. In the moderator's view this will put significant workload on the 9 months WI and it not preferred.
3. Both SI and WI are approved. An SI for 9 months to study all the items that require it, and a WI to enable normative work on PRS/SRS aggregation, RedCap positioning to begin immediately. At the end of the SI, the WI can be updated to include extra objectives coming from conclusions of the study. Time Unit planning would probably treat these as one item.
4. Other options may also be possible.

Companies are requested to provide their views these options.

Feedback Form 12: Views on overall structure of the work - final round

1 – Apple France

We are fine with either 1) a single WI in which all objectives that are identified to start as SI (if included) will go through a 9 month study while objectives identified as WI can start as normative work, or 2) a single SI without any normative work within a 9 month (or whole release) studying only objectives that are identified to start as SI (if included in the package). Please note that in our view, PRS/SRS aggregation, and positioning for RedCap, if any one is included in the final package, cannot start as a normative work.

2 – Nokia Denmark

Options: Option 1 is the cleanest, as indicated by the moderator.

As several companies pointing out that there are timing alignment issues with bandwidth aggregation, so if any aspect of accuracy enhancement needs to start with a study, it is bandwidth aggregation. Thus, we cannot agree that PRS/SRS aggregation can begin immediately, while carrier phase have been studied in Rel-16 and is captured in TR38.855 and can start in the normative work if options 1 or 3 are selected.

3 – ZTE Corporation

We prefer option1, i.e. single WI in which the items requiring study start with a study phase of, e.g., 9 months. In our view, both carrier aggregation and carrier phase based positioning can directly go to normative work as we have studied before.

4 – InterDigital France R&D

We have questions for clarification for Option 1 and Option 3. Will the outcome of the study under Option 1 be captured in TR 38.857? If we choose Option 3, will the outcome of the study be captured in TR 38.857 or in a new TR?

5 – Qualcomm Incorporated

Option 1

6 – Beijing Xiaomi Mobile Software

Consider the high workload of SL positioning and Ranging, it may not be practical to handle it together with the other two. We suggest splitting the current positioning item into two separate SI/WIs:

SI/WI #1: include "SL positioning and Ranging" related objectives with a 9 month SI followed by WI

SI/WI#2: include "Redcap positioning" and "Improved accuracy, integrity and power efficiency" related objectives with a WI including 9 month study phase

7 – Samsung R&D Institute UK

Before we start the discussion how should the work be structured in terms of study item, work item, or a study phase within a work time, we need a discussion about work scope. As we commented in Redcap positioning section, current work scope is huge and thus some of discussion for prioritization for currently listed work scope and down-scoping is necessary.

We think that depending on the final scope, overall structure of the work can be decided. If we make a reasonable work scope, Option 1 can be considered. On the other hand, down-scoping is not agreed, Option 3 can be considered with reasonable TU allocation both for SI and WI.

8 – CATT

Regarding to the overall structure of the work:

[CATT] We share the similar view with the Moderator's that Option 1 seems to be the simplest arrangement. We also see Option 1 and Option 3 is basically the same from the work load distribution of the WGs in the time duration of 18 months.

In comparison with Option 1/Option 3, one advantage of Option 2 may be the smaller potential impact on RAN3/RAN4 work, especially for RAN4. From the previous experience of positioning WIs, RAN1 may seek some timely help from RAN4 during WI. If we consider that RAN4 are still heavily involved in R17 work when RAN1 starts its R18 work, it is desirable that RAN1 to minimize the impact on RAN4 before RAN4 completes its R17 work. Another benefits of Option 2 may be that RAN1/RAN2 can focus on the issues to be studied in the first 9 months w/o diverging the attention to the issues specifically for normative work, e.g., UE capabilities, RRC parameters etc. during the first 9 months.

Thus, with the consideration of the potential impact on RAN4's work, we slightly prefer Option 2.

9 – Huawei Tech.(UK) Co.. Ltd

Our preference is option 1 (WI with study phase)

10 – NTT DOCOMO INC.

We prefer either Option 1 or Option 3. Given that the scope of Rel-18 positioning seems to be large, the objectives not requiring study should be discussed early.

11 – Sony Europe B.V.

Our preference is option 3.

The study item outcomes should be properly captured in a TR report, at least on sidelink-positioning and positioning integrity.

We can start the normative work for redcap positioning.

We need to study first (it can be a study within a work item) on bandwidth aggregation.

12 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility :

We would be supportive of the Rapporteur's Option 1 or Option 3 (also agree that Option 1 may be the simplest from a project management point of view), given that it offers the chance of avoiding a burdened workload during the normative phase. In this case, both options enable the concurrent start of a SI and WI phases. We also think that the study items should be limited to at most 3 items highlighted by the Rapporteur including: SL positioning, Integrity for RAT dependent positioning and LPHAP.

13 – VODAFONE Group Plc

We support either option 1 or option 3

14 – Philips International B.V.

We prefer option 1

15 – Intel Finland Oy

Our preference is

- Preferred: SI + WI from the beginning and continued WI from the 2nd half of release
- OK: Study phases within WI (assuming overall work scope is to be reduced next time)

Less preferred: Study followed by WI

16 – Ericsson LM

Our preference is for option 3. Option 1 is also acceptable as long as the WI doesn't contain any objectives for the specification phase for the items that have a study phase, and thus that it's clear that such objective will have to be defined by the RAN plenary after the study phase.

17 – Ericsson LM

Adding that we think Option 2 will give a too high workload towards the end of Rel. 18.

5.5.2 Suggestion for SI/WI justification text

At the end of this discussion a draft SID/WID will be provided using the objective text that has been discussed extensively this week. Companies are requested to provide their suggestions for appropriate justification text for any of all of the topics included in the objectives. The moderator will merge into final text for the draft WID/SID.

Feedback Form 13: Suggested WID/SID justification text - Final Round

1 – CATT

Regarding to the WID/SID justification text:

[CATT] our suggested text as follows,

3GPP has completed the Study Item on “Scenarios and requirements of in-coverage, partial coverage, and out-of-coverage positioning use cases” in RAN#93e. As a result of the SI, the use cases, the scenarios and the corresponding positioning requirements for sidelink positioning are defined in TR38.845 based on TS 22.261 and TS 22.186. In addition, SA1 has recently completed the Work Item “Ranging based services” with the positioning requirements for ranging service being captured in TS 22.261. The ranging and relative/absolute positioning for V2X, public safety, and other commercials are required to be provided when a UE is inside the network coverage as well as outside the network coverage. Thus, there is a need for 3GPP to study and develop sidelink positioning solutions for supporting these use cases and corresponding requirements with the consideration of the ITS and other spectrums, including ranging, relative and absolute sidelink positioning.

For supporting 5G stringent performance requirements in TS 22.261 and to make NR positioning to be competitive with other positioning techniques (e.g., GNSS positioning), 3GPP needs to develop more advanced positioning solutions for further enhancements of the positioning accuracy. Two promising techniques will be considered in Rel-18: one is to take the advantage of the rich 5G spectrum to increase the bandwidth for the transmission and reception of the positioning reference signals through the carrier aggregation, and the other is to use the NR carrier phase measurements. Intra-band carrier aggregation of PRS/SRS was discussed with limited evaluation in Rel-17 SI on NR positioning enhancements. The work was not completed

mainly due to the time limitation of the SI. Thus, 3GPP should continue the work in Rel-18.

GNSS carrier phase positioning has been used very successfully for centimeter-level positioning but is limited to outdoor applications. GNSS carrier phase positioning also has longer positioning latency and larger power consumption than GNSS code phase positioning due to the need to implement track the carrier phase tracking loop to lock the very weak carrier signals. NR carrier phase positioning has significant advantages over GNSS carrier phase positioning for both indoor and outdoor applications. NR carrier-phase positioning will potentially have much shorter positioning latency and much smaller UE power consumptions than GNSS carrier-phase positioning due to the fact that NR reference signals are not limited to outdoor, and NR reference signals are much stronger than GNSS signals.

Power efficiency while maintaining high accuracy should also be a focus for positioning enhancements in Rel-18. Use cases and requirements of LPHAP (low power high accuracy positioning) are captured in TS 22.104. There is a clear commercial demand for devices reaching these requirements, which cannot be achieved by NR UEs based on Rel-15/16/17 specifications. A study would be needed to determine the power consumption model allowing to evaluate achievable battery life with positioning and to study the technical solutions for supporting LPHAP.

3GPP has introduced RedCap UE in Rel-17, but there is no discussion of the corresponding positioning requirements. The positioning solutions developed in Rel-16 and Rel-17 for eMBB UEs should also be applicable to RedCap UEs. However, the impacts of the reduced UE capability on NR positioning, including the coverage and the accuracy needs to be evaluated, and based on the evaluation, there may need to have further consideration on whether further enhancement is needed to support RedCap positioning, including the configuration of the DL PRS and UL SRS for positioning, the physical layer procedures, the UE capability, etc.

GNSS positioning integrity is scheduled to be completed in Rel-17. RAT-dependent positioning integrity was dropped off from Rel-17 due to the time limitation. It is important and necessary to further work on the RAT-dependent positioning integrity in Rel-18. Most of the accomplishments made in Rel-17 for GNSS integrity can be used for supporting RAT-dependent positioning integrity, including the signalling and procedures, the KPI definitions, etc. The main work for RAT-dependent integrity in Rel-18 may be the identification of the error sources, threat models, occurrence rates and failure modes requiring RAT-dependent positioning solutions.

2 – Huawei Tech.(UK) Co.. Ltd

Proposed justification part for LPHAP: 3GPP has identified positioning use cases to be supported by 5GS [TR 22.872] and defined positioning service requirements for general 5G system and for vertical in TS 22.261 and TS 22.104, respectively, which were recently updated by the SA1 Rel-18 WI on LPHAP (Low Power High Accuracy Positioning for industrial IoT scenarios, Unique identifier: 910036). For cases of massive asset tracking, AGV tracking in industrial factory and person localization in danger zones with requirement of high accuracy, extreme low power consumption with battery life sustainable up to one or more years is necessary. From the RAN side, NR positioning in Rel-16 or Rel-17 had no study to evaluate whether a device can support low power consumption with battery life up to one or more years. Rel-17 NR positioning has evaluated the power consumption of *RRCIDLE/INACTIVE state positioning and the results showed that the device can save up to 40% power for positioning in RRCIDLE/INACTIVE state* [TR 38.857] compared to that in RRC_CONNECTED state. However, the results do not provide insight into the UE battery life. Therefore, there is a need for RAN to evaluate whether and how LPHAP requirements can be met.

Proposed justification part for improved accuracy: The Rel-17 SI on NR positioning enhancements identified the benefit of PRS/SRS intra-band CA for accuracy enhancement [TR 38.857], where simulations results showed that UL-TDOA in InF-DH scenario can improve the accuracy from 0.5m@90% with 100MHz bandwidth to <0.2m@90% by aggregating two contiguous bandwidths of 100MHz. Aggregating a spectrum for coherent transmission and reception of PRS/SRS with larger than 100MHz in FR1, e.g., 160MHz in 2.515GHz – 2.675GHz, and 200MHz in 3.4GHz – 3.6GHz, can effectively improve positioning accuracy. For practical IIoT deployment, enabling PRS/SRS frequency aggregation for NR positioning enhancement in Rel-18 is crucial to reach the 0.2m accuracy target in order to be competitive in the under-7GHz indoor positioning market. Investigations on ensuring phase coherency across multiple CCs were not conducted by RAN4. So there is a need to complete the RAN4 part of the study, and specify techniques for PRS/SRS intra-band CA for positioning accuracy enhancement.

3 – Ericsson LM

Proposed justification text for integrity:

Positioning integrity is a measure of the trust in the accuracy of the position-related data and the ability to provide timely warnings based on assistance data provided by the network. The focus in Rel 17 work has been on GNSS integrity, while the fundamental integrity framework is being introduced as part of the common procedures and information and it therefore natural to be extended to RAT-dependent positioning as well as there are relevant integrity aspects of mission critical use cases that rely on positioning estimates and the corresponding uncertainty estimate. Integrity enables applications to make the correct decisions based on the reported position, e.g., when monitoring a robotic arm to decide whether its arm movement are within allowed limit to ensure safety distances to humans and other objects.

The GNSS integrity work in Rel 17 progressed well, but not all key aspects from the Rel 17 study item will have been addressed when Rel 17 is completed. Aspects such as GNSS integrity for OSR are being studied by RTCM SC 134 will be published early 2022 and are important to consider. Also, local environment GNSS feared events due to multipath, jamming and spoofing are also important. Furthermore, additional SSR error characteristics needs to be considered.

5.5.3 Other comments

Any other comments to make?

Feedback Form 14: Other comments - Final Round

1 – Huawei Tech.(UK) Co.. Ltd

While the moderator suggested that improved accuracy and power efficiency may be candidates for down-scoping should such a need arise, we don't agree that improved power efficiency and accuracy are the first targets for down-scoping.

5.6 Summary from Final Round

Regarding the overall structure of the work, there is a clear majority of companies that either prefer option 1 or at least find option 1 acceptable. Based on this, the moderator has created a single draft WID with objectives for study work and objectives for normative work. For the topic areas for which study is required, RAN plenary will need to discuss and approve appropriate objectives for the normative phase of the work after the study has been completed. For these topics there is also an open question question as to how the results of the

study phase will be captured (e.g. new TR, existing TR, etc).

Although the work is currently proposed to be a WI, only RedCap is proposed to start with normative work. Even for RedCap there were proposals for a study phase to the work. In the next phase of discussion it may be worth to reconsider whether to start with an SI.

The moderator thanks companies that provided inputs to towards the justification text. This material has been merged with material already being drafted by the moderator form the justification text in proposed WID in RP-212706.

6 Conclusions

The revised objective text as a result of the final round (collected from sections 2.6, 3.6 and 4.6) is shown below. The 'revision marks' show changes relative to the proposed objective text going into the final round. This same text is also provided with the proposed WID in RP-212706.

Objective Text

- Study (for study phase of 9 months) solutions for sidelink positioning considering the following: [RAN1, RAN2]
 - Scenario/requirements [Moderator comment: These could be moved to the justification section in the final WID]:
 - 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 and feasibility of potential solutions for SL positioning, considering: [RAN1, RAN2]
 - Relative positioning, ranging and absolute positioning
 - Study of positioning methods (e.g. TDOA, RTT, AOA/D, etc) including combination of SL positioning measurements with other RAT dependent positioning measurements (e.g. Uu based measurements) [RAN1]
 - Study of sidelink reference signals for positioning purposes, including signal design, phy layer control signalling, 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 covering both UE based and network based positioning [RAN2, including coordination with alignment with SA2 as required]
 - Recommend solutions, if any, to be specified in the normative phase [RAN1, RAN2]
- 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, [RAN1, RAN2].
 - Study methodologies, procedures, signalling, etc for determination of positioning integrity for both UE-based and UE-assisted positioning [RAN2, RAN1]
 - Study (for study phase of 9 months) and, if found beneficial, specify solutions for accuracy improvement based on PRS/SRS bandwidth aggregation for intra-band carriers[RAN1, RAN4, RAN2, RAN3]:
 - RAN4 to consider implications of PRS/SRS bandwidth aggregation (e.g. timing errors, phase coherency, frequency errors, power imbalance, etc).
 - Study (for study phase of 9 months and, if found beneficial, specify solutions for accuracy improvement based on NR carrier phase measurements [RAN1, RAN4, RAN2, RAN3]
 - Reference signals, physical layer measurements, physical layer procedures to enable positioning based on NR carrier phase measurements for both UE-based and UE-assisted positioning [RAN1]
 - Focus on reuse of existing PRS and SRS, with new reference signals only considered if found necessary
 - Signalling for configuration and measurement reporting [RAN2, RAN3]
 - Study (for study phase of 9 months) 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 [RAN2, RAN1]
- Positioning support for RedCap UEs, considering the following:
- Evaluate positioning performance of existing positioning procedures and measurements with RedCap UEs[RAN1, RAN4]
 - Based on the evaluation assess the necessity of enhancements and, if needed, identify enhancements to help address limitations associated with for RedCap UEs [RAN1, RAN2]
 - Define core and performance requirements for positioning measurements performed by RedCap UEs [RAN4]

Moderator comments for next phase of discussion at RAN#94e:

1. There is a view from many companies that further downscoping is required prior to approval of this item
2. Objectives on PRS/SRS aggregation, Carrier phase positioning, LPHAP, and Redcap are still contentious to some degree and all continue to receive comments that they should be removed as apart of a downscoping exercise. More specifically:
 - a) PRS/SRS aggregation had 4 companies (in the Final Round) proposing the area to be downscoped
 - b) Carrier Phase had 3 companies (in the Final Round) proposing the area to be downscoped
 - c) LPHAP had 1 company (in the Final Round) proposing the area to be downscoped
 - d) RedCap has 3 companies (in the Final Round) proposing the area to be downscoped and 4 companies suggesting that it should start with a study phase.
3. For objectives that have a study phase:

- a) RAN plenary will need to discuss and approve appropriate objectives for the normative phase of the work after the study phase has been completed.
 - b) There is an open question as to how the results of the study phase will be captured (e.g. new TR, existing TR, etc).
4. The work is currently proposed to be a WI with some objectives starting by a study phase, and only RedCap proposed to start with normative work. Even for RedCap there were proposals for a study phase to the work. In the next phase of discussion it may be worth to reconsider whether to start with an SI.
5. For the SL positioning objective it remains contentious whether unlicensed spectrum should be considered in the scope. The current objective text does not include unlicensed but it can be expected that there will be further discussion of this aspect before final approval.