**3GPP TSG RAN WG1 Meeting #109-E R1-22xxxxx**

**e-Meeting, May 9th – May 20th, 2022**

**Source: Moderator (Intel Corporation)**

**Title: FL summary #1 on SL positioning scenarios and requirements**

**Agenda item: 9.5.1.1**

**Document for:** **Discussion and Decision**

# Introduction

This document presents a summary of submitted contributions to AI 9.5.1.1 (“SL positioning scenarios and requirements”).

[109-e-R18-Pos-02] Email discussion on SL positioning scenarios and requirements by May 20 – Debdeep (Intel)

* Check points: May 16, May 20

The Rel-18 SI on expanded and improved NR positioning, the following objective is provided in regarding studies on support of SL positioning, of which the first two objectives, highlighted below, are discussed under this agenda item.

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| * Study solutions for sidelink positioning considering the following: [RAN1, RAN2] * Scenario/requirements   + 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 based on existing 3GPP work and inputs from industry forums [RAN1] * Define evaluation methodology with which to evaluate SL positioning for the 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 relative positioning, ranging and absolute positioning: [RAN1, RAN2]   + Evaluate bandwidth requirement needed to meet the identified accuracy requirements [RAN1]   + 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 from physical layer perspective, including signal design, resource allocation, measurements, associated procedures, etc, reusing existing reference signals, procedures, etc from sidelink communication and from positioning as much as possible [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 and alignment with RAN3 and SA2 as required]   Note: When the bandwidth requirements have been determined and the study of sidelink communication in unlicensed spectrum has progressed, it can be reviewed whether unlicensed spectrum can be considered in further work. Checkpoint at RAN#97 to see if sufficient information is available for this review. |

Based on the submitted contributions to RAN1 #109-E meeting, the discussion points are categorized into the following topics:

* Network coverage scenarios for SL positioning
* Target use-cases and bands for SL positioning
* Operation scenarios involving SL positioning
* Technical requirements for the target use-cases for SL positioning

**For the first round of discussions, please provide your inputs latest by Wednesday, May 11th, 11:59 UTC.**

Please follow the naming convention in this example:

* *SLPosScenReq\_FLS-v000.docx*
* *SLPosScenReq\_FLS-v001-CompanyA.docx*
* *SLPosScenReq\_FLS-v002-CompanyA-CompanyB.docx*
* *SLPosScenReq\_FLS-v003-CompanyB-CompanyC.docx*

If needed, you may “lock” a spreadsheet file for 30 minutes by creating a checkout file, as in this example:

* Assume CompanyC wants to update *SLPosScenReq\_FLS-v002-CompanyA-CompanyB.docx*.
* CompanyC uploads an empty file named *SLPosScenReq\_FLS-v003-CompanyB-CompanyC.checkout*
* CompanyC checks that no one else has created a checkout file simultaneously, and if there is a collision, CompanyC tries to coordinate with the company who made the other checkout (see, e.g., contact list below).
* CompanyC then has 30 minutes to upload *SLPosScenReq\_FLS-v003-CompanyB-CompanyC.docx*
* If no update is uploaded in 30 minutes, other companies can ignore the checkout file.
* Note that the file timestamps on the server are in UTC time.

To avoid excessive email load on the RAN1 email reflector, please note that there is NO need to send an info email to the reflector just to inform that you have uploaded a new version of this document. Companies are invited to enter the contact info in the table below.

## FL1 Question 1-1

* *Please consider entering contact info below for the points of contact for this email discussion:*

|  |  |  |
| --- | --- | --- |
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# Network coverage scenarios

Most submitted contributions to this agenda item indicate that all three NR network coverage scenarios are included in the scope of the study:

* In coverage (IC)
* Partial coverage (PC)
* Out of coverage (OOC).

As can be observed from the SID objectives, this is consistent with the SI objective for SL positioning.

However, there are some further views regarding potential (de-)prioritization of the different coverage scenarios.

In particular, reference [7] proposes to prioritize only out of coverage scenarios over the other two. Reference [11] proposes to prioritize in-coverage scenarios. [26] proposes “Evaluations of positioning performance in partial coverage scenarios should not be performed”, while [20] suggests that partial coverage scenarios be studied and evaluated with a second priority.

On the other hand, multiple contributions propose to study and evaluate all three network coverage scenarios for SL positioning.

In relation to different use-cases, it is expected that not all network coverage scenarios may apply for all use-cases. For example, it would be reasonable to expect that commercial use-cases may be limited to in-coverage scenarios only. This is discussed further in Section 3.

## FL1 Question 2-1

* *Please share your views on the following options for handling of different network coverage scenarios for studies on SL positioning:*
  + ***Option 1:*** *All network coverage scenarios (in-coverage, partial coverage, and out-of-coverage) are studied/evaluated at same priority level.*
  + ***Option 2:*** *Studies of in-coverage and out-of-coverage scenarios are prioritized during the SI.*
  + ***Option 3:*** *Studies of in-coverage scenarios are prioritized during the SI.*
  + ***Option 4:*** *Studies of out-of-coverage scenarios are prioritized during the SI.*
  + ***Option 5:*** *Other option(s)*

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| **Company** | **Preferred option** | **Comments** |
| ZTE | Option 2 | We are also open to study all network coverage scenarios from specification perspective, but only evaluate in-coverage and out-of-coverage. Hence, we suggest removing ‘/evaluated’ in Option 1. |
| CATT | Option 4  Or  Option 2 | In our point of view, the main task of Rel-18 sidelink positioning should be finding the positioning solution for UEs in out-of-coverage and evaluating its positioning performance. |
| CMCC | Option 2 | To limit the heavy workload, we prefer to first focus on in-coverage and out-of-coverage, as the evaluation and physical layer design may be more complicated than the other two scenarios. In addition, considering V2X and IIoT use cases that we are interested in, in-coverage and out-of-coverage scenarios are more common and typical. |
| vivo | Option 4 |  |
| Huawei, HiSilicon | option 5 | By Option 5 we mean from evaluation perspective, we don’t specifically need to consider the coverage situation because accuracy target is independent of coverage situation. However, from solution perspective, we will further look into what positioning methods will be applied to which coverage scenario which will be studied in AI9.5.1.3 |
| Lenovo | Option 1 | We would like to study/support all network coverage scenario with considering various use cases and positioning calculation entity. From sidelink point of view, there is no need to additionally exclude partial coverage scenario. It doesn't cause too much workload. |
| Spreadtrum | Option 2 |  |

# Target use-cases and bands for SL positioning

Following from the SID and TR 38.845 , TS 22.261 , and TS 22.104 , the target use-cases for SL positioning can be broadly classified into four categories:

* V2X use-cases (primary ref: TR 38.845)
* Public safety use-cases (primary ref: TR 38.845)
* Commercial use-cases (primary ref: TS 22.261)
* IIoT use-cases (primary ref: TS 22.104).

In general, views expressed in most contributions are aligned with the above set of target use-cases, with some specific views on potential prioritization of some of the use-case over others. Towards this,

* reference [6] suggests prioritizing V2X and public safety use-cases;
* reference [7] proposes to prioritize V2X and IioT use-cases;
* reference [20] proposes to study V2X use-case as first priority and IioT use-case as second priority;
* reference [25] proposes: “*Define a subset of the potential use cases for the evaluation of the potential solutions. The subset(s) may be grouped according the specification impact”.*

## FL1 Question 3-1

* *Please share your views on the following options for target use-cases for studies on SL positioning:*
  + ***Option 1:*** *All four identified use-cases (V2X, public safety, commercial, and IioT) are studied/evaluated at same priority level.*
  + ***Option 2:*** *Studies on V2X and public safety use-cases are prioritized during the SI.*
  + ***Option 3:*** *Studies on V2X and IioT use-cases are prioritized during the SI.*
  + ***Option 4:*** *Studies on V2X use-cases are prioritized during the SI.*
  + ***Option 5:*** *Other option(s).*

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| **Company** | **Preferred option** | **Comments** |
| ZTE | Option 3 or Option 4 | Considering the high workload, we more prefer option 4 or option 3. The corresponding simulation work will be easier. |
| CATT | Option 3 | Since the positioning requirements of V2X use cases from 5GAA and IioT use cases from verticals are more urgent, V2X use cases and IioT use cases should have higher priority than the other two kinds of use cases. |
| CMCC | Option 3 | In general, we are open for all use cases, however, due to the limited workload, we prefer to consider two evaluation cases at most. We prefer V2X and IioT use cases, which are more promising in applications. |
| Vivo | Option 4 | Considering the high workload and limited time for the new SL channel model calibration, we prefer option 4 |
| Huawei, HiSilicon | Option4 or option 5 | Similar issue. If the study is for the solution, we assume the SLP solution should be in general applicable to all cases.  If we are talking about the evaluations only, we prefer to have V2X (first priority) and commercial (second priority) use cases. |
| Lenovo | Option 1 | We prefer to study all use cases. I.e., V2X, public safety, commercial, and IioT.  To consider the potential workload, RAN1 is encouraged to select 1 or 2 representative commercial ranging use cases (stated in [TS 22.261, 6]) based on the stringent requirement:   * Smart TV Remote * Picture and video sharing based on ranging results and * Distance based smart device control * Smart Vehicle Key * Touchless Self-checkout Machine Control * Hands Free Access * Smart Transportation Metro/Bus Validation * Ranging of UE’s in front of vending machine * Finding Items in a supermarket * Distance based intelligent perception for public safety * Long Distance Search * Long range approximate location |
| Spreadtrum | Option 2 |  |

It is observed in multiple contributions that, for V2X use-cases, NR bands n47 (primarily) and n38 (in some regions) are the available bands for dedicated V2X-related operations, and both are subject to a maximum bandwidth (BW) of 40 MHz with smaller bandwidths in various regions.

Further, reference proposes to deprioritize consideration of FR2 bands.

On the other hand, several contributions suggest consideration of both FR1 and FR2 bands (across different use-cases and scenarios) with maximum possible BWs supported for SL operations, at least from the perspective of RAN1 specifications.

*Note that exact assumptions on bandwidth for SL positioning evaluations are expected to be discussed as part of AI 9.5.1.2 (Evaluation methodology for SL positioning).*

## FL1 Question 3-2

* *Please share your views on the following options for considered frequency ranges and bands for studies on SL positioning:*
  + ***Option 1:*** *Both FR1 and FR2 bands (with BWs up to 100 MHz and 400 MHz respectively) are considered in the study. For V2X use-cases, maximum BW of 40 MHz is considered.*
  + ***Option 2:*** *Deprioritize FR2 bands during the SI. For V2X use-cases, maximum BW of 40 MHz is considered.*
  + ***Option 3:*** *Other option(s).*

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| **Company** | **Preferred option** | **Comments** |
| ZTE | Option 2 with revision | We more prefer option 2 as the basic V2X functionality in FR2 is not complete yet. However, we think it is worth to study 100MHz from specification perspective as it is feasible in licensed bands. |
| CATT | Option 2 | Considering the sidelink beam management mechanism has not been introduced in NR V2X, and it may be discussed in Rel-18 sidelink evolution work item, we prefer the potential solutions investigation and performance evaluation should focus on FR1 bands and ITS bands(for V2X use caes) in Rel-18. |
| CMCC | Option 2 | As no baseline for sidelink operation in FR2 has been defined yet in sidelink, we prefer deprioritize FR2 band in this release, and focus on FR1. |
| Vivo | Option 2 | Same view as CATT and CMCC |
| Huawei, HiSilicon | Option 2 | Given the available bandwidth for V2X is up to 40MHz, we should focus on 40MHz bandwidth for SLP evaluation. |
| Lenovo | Option 2 | We prefer to firstly study on licensed band SL Positioning for FR1. For FR2, it can be further evaluated based on ongoing FR2 SL enhancements in separate SI. |
| Spreadtrum | Option 2 |  |

Regarding potential limitations/combinations of target use-cases and network coverage scenarios, TR 38.845 and TS 22.104 indicate that V2X, public safety, and IIoT use-cases are relevant to both in-coverage and out-of-coverage scenarios, and consequently, also relevant to partial coverage scenarios. However, for commercial use-cases, it may be reasonable to limit to in-coverage scenarios only.

## FL1 Proposal 3-3

* *For V2X, public safety, and IioT use-cases, all three network coverage scenarios are in-scope.*
* *Commercial use-cases for SL positioning are limited to in-coverage scenarios only.*

*Please share your views on the above proposal.*

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| **Company** | **Comments** |
| CATT | We prefer to de-prioritize the partial coverage scenario for all use cases, in order to reduce the work load of the group.  The updated proposal as follows, Updated FL1 Proposal 3-3  * *For V2X, public safety, and IioT use-cases, only in-coverage and out-of-coverage ~~all three network coverage~~ scenarios are in-scope.* * *Commercial use-cases for SL positioning are limited to in-coverage scenarios only.* |
| CMCC | As I mentioned in the questions above, to limit the workload, we prefer to consider up to two use cases. |
| Vivo | We prefer to de-prioritize Commercial use-cases  The updated proposal as follows, Updated FL1 Proposal 3-3  * *For V2X, public safety, and IioT use-cases, all three network coverage scenarios are in-scope.* * *~~Commercial use-cases for SL positioning are limited to in-coverage scenarios only.~~* |
| Huawei, HiSilicon | SID has already demonstrated they are in-scope, the discussion for this agenda we assume should indicate which scenarios and requirements we should look at for evaluations. Note also that Table 7.9-1 from TS 22.261 (Table 1 in 5.1 below) specifies that the ranging requirements are not limited only to IC. In addition, the suggested proposal is covered by the discussions in Question 2-1 and 3-1 |
| Lenovo | As mentioned in Question 3-1, we can firstly select 1 or 2 representative commercial ranging use cases (stated in [TS 22.261, 6]), and then we can further determine whether to limit the coverage scenario to in-coverage scenarios for commercial use cases. Furthermore, coverage scenarios are also a separate KPI for commercial ranging and all scenarios are considered according to Table 7.9-1 of TS22.261. |

# Operation scenarios involving SL positioning

On operation scenarios, the following have been mentioned in company contributions:

* Scenario 1: PC5-based positioning
* Scenario 2: Combination of Uu- and PC5-based positioning solutions
* Scenario 3: Combination of NR RAT-dependent and RAT-independent solutions.

While consideration of Scenario 1 (PC5 only) may be somewhat obvious, hybrid options like either of or both Scenarios 2 and 3 are proposed in several contributions (e.g., [4], [10], [20], [24], [26], [27]). For Ues in coverage, it can be seen rather beneficial to consider availability of positioning mechanisms including assistance information from the NR network in addition to positioning or ranging methods operating exclusively over SL.

## FL1 Proposal 4-1

* *Following three operation scenarios are considered for studies on SL positioning:*
  + *Scenario 1: PC5-based positioning*
  + *Scenario 2: Combination of Uu- and PC5-based positioning solutions*
  + *Scenario 3: Combination of NR RAT-dependent and RAT-independent solutions.*

*Please share your views on the above proposal.*

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| **Company** | **Comments** |
| ZTE | We suggest focusing on scenario 1 and 2 only as it is hard to evaluate the scenario 3 in RAN1. |
| CATT | We prefer to prioritize Scenario 1. |
| CMCC | Scenario 1 and scenario 2 should be included for studies, where scenario 1 is applicable for out-of-coverage scenarios, and scenario 2 is applicable for in-coverage scenarios. |
| Vivo | We prefer to prioritize Scenario 1. |
| Huawei, HiSilicon | From SID, we only see Scenario 1 and scenario 2 are in the scope. |
| Lenovo | We prefer to study on scenario 1 and scenario 2. Scenario 3 can be decided by other WGs, e.g., RAN2. |
| Spreadtrum | We prefer Scenario 1 and Scenario 2. |

# Requirements for SL positioning

Considering various use-cases, the requirements for SL positioning can be defined using one of:

* Ranging (defined by distance and/or direction accuracy)
* Relative positioning (defined by accuracy of horizontal and vertical positions determined, relative to a reference node’s position)
* Absolute positioning (defined by accuracy of absolute horizontal and vertical positions determined).

For out-of-coverage and partial coverage scenarios, ranging and relative positioning may be more practical than absolute positioning, that would require assumption on knowledge on coordinates of reference nodes. At the same time, if SL positioning solutions are devised and studied, e.g., based on basic positioning methods like RTT, TDOA, or AoD/AoA, it would be natural to also study them towards enabling absolute positioning in different scenarios, as applicable.

From the perspective of requirements, it is also necessary to consider absolute positioning requirements as already identified in the RAN TR and SA2 TSs for the target use-cases for SL positioning. For consideration on absolute positioning in out of coverage and partial coverage scenarios, presence of anchoring nodes with known coordinates may be assumed in RAN1 studies. These may be modeled via assumptions on dedicated RSUs (for V2X use-cases) for out of coverage cases, while knowledge and propagation of coordinate information from NR network nodes, e.g., gNBs, are considerable for partial coverage scenarios.

## FL1 Proposal 5-1

* *Positioning accuracy requirements for SL positioning to consider the following metrics:*
  + *Ranging, expressed as accuracy at a particular percentile in the CDF of the error in estimated distance and/or direction from a reference node*
  + *Relative positioning accuracy, expressed as accuracy at a particular percentile in the CDF of the error in estimated horizontal and vertical positions relative to a reference node*
  + *Absolute positioning accuracy, expressed as accuracy at a particular percentile in the CDF of the error in estimated absolute horizontal and vertical positions*
  + *Note: the exact applicability of particular requirements may vary across use-cases*

*Please share your views on the above proposal.*

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| --- | --- |
| **Company** | **Comments** |
| ZTE | Agree |
| CATT | We prefer the following revision: Updated FL1 Proposal 5-1  * *Positioning accuracy requirements for SL positioning to consider the following metrics:*   + *Ranging, expressed as accuracy requirement for ~~at~~ a particular percentile of UEs ~~in the CDF of the error~~ in estimated distance and/or direction from a reference node*   + *Relative positioning accuracy, expressed as accuracy requirement for ~~at~~ a particular percentile of UEs ~~in the CDF of the error~~ in estimated horizontal and vertical positions relative to a reference node*   + *Absolute positioning accuracy, expressed as accuracy requirement for ~~at~~ a particular percentile of UEs ~~in the CDF of the error~~ in estimated absolute horizontal and vertical positions*   + *Note: the exact applicability of particular requirements may vary across use-cases* |
| CMCC | We are fine with the proposal in general with one clarification.  Regarding the terminology “reference node” in the first and second bullet, does it related to the reference device that we have investigated in Rel-17, of which the coordinate is known in priori? In our understanding, ranging is to acquire distance between two UEs and/or direction of a UE from another UE, in typical use cases of ranging, e.g., vehicle collision avoidance, what matters is a target UE knowing its distance and/or direction ranging from another UE, whose coordinate is not necessarily required. |
| Huawei, HiSilicon | As ranging and relative positioning inherently involves two UEs, we propose the following modification: Updated FL1 Proposal 5-1  * *Positioning accuracy requirements for SL positioning to consider the following metrics:*   + *Ranging, expressed as accuracy at a particular percentile in the CDF of the error in estimated distance between the target UE and the reference UE and/or direction of the target UE from the reference UE ~~from a reference node~~*   + *Relative positioning accuracy, expressed as accuracy at a particular percentile in the CDF of the error in estimated horizontal and vertical positions of the target UE in a reference coordinate system ~~relative to a reference node~~*   + *Absolute positioning accuracy, expressed as accuracy at a particular percentile in the CDF of the error in estimated absolute horizontal and vertical positions*   + *Note: the exact applicability of particular requirements may vary across use-cases* |
| Lenovo | Agree, on bullet one reference node terminology may cause some confusion with respect to positioning reference unit (with known location) discussed in Rel-17. Since ranging involves distance/direction determination between a pair of UEs, we would prefer more clear terminology, e.g., ranging between an initiator entity and responder entity. |
| Spreadtrum | Support. |

In addition, requirements on positioning latency are also available from the SA2 TSs and RAN TRs and have been proposed for consideration by multiple companies.

In the next sub-sections, the requirements identified for each of the potential target use-cases are discussed, including consideration of potential harmonization of requirements across use-cases to manage the evaluation efforts.

# Requirements for ranging requirements for SL positioning

Requirements on ranging and relative positioning are some of the most important considerations for SL positioning. Ranging in LOS conditions is one of the minimal functionalities expected for V2X use-cases to estimate distance between two vehicles or direction of one vehicle from another vehicle or RSU, etc.

The requirements on ranging are defined in TS 22.261 and TR 22.855, and are reproduced below in Table 1.

**Table 1: Requirements on ranging services from TS 22.261 (Table 7.9-1)**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ranging scenario** | **Ranging Accuracy**  **(95 % confidence level)** | | **Availability** | **Latency**  10ms  50ms  50ms | **Effective ranging distance** | **Coverage** | **NLOS/LOS** | **Relative UE velocity** | **Ranging interval** | **Number of concurrent ranging operation for a UE** | **Number of concurrent ranging operation in an area** |
| **Distance Accuracy** | **Direction Accuracy** |
| Smart TV Remoter | 10cm up to 3 meter separation | ±2° horizontal direction accuracy at 0.1 to 3 meter separation and AoA coverage of (-60°) to (+60°);  ±2° Elevation direction accuracy at 0.1 to 3 meter separation and AoA coverage of (-45°) to (+45°) | 99 % | 50ms | 10m | IC/PC/OOC | LOS | Static/ Moving  (<1m/s) | 50ms | - | - |
| Picture and video sharing based on Ranging results | 10cm | 2° | 99 % | 50ms | 10m | IC/PC/OOC | LOS | Static/ Moving  (<1m/s) | 50ms | - | - |
| Distance based smart device control | 10cm | - | 99 % | 100ms | 20m | IC/PC/OOC | LOS | Static/ Moving  (<1m/s) | 50ms | 20 | - |
| Smart Vehicle Key | 10 cm | - | 99 % | 50ms | 30m | IC/PC/OOC | LOS | Static/ Moving  (<2m/s) | 25ms | - | 50UEs/  (104m2) |
| Touchless Self-checkout Machine Control | 10cm | - | 99% | 150ms | 1m | IC/PC/OOC | LOS | Static/ Moving  (<1m/s) | 100ms | - | = |
| Hands Free Access | 10cm | - | 99 % | 500ms | 10 m | IC/PC/OOC | LOS | Static/ Moving  (1 m/s) | 50ms | - | 20 UEs/3.14\*100m2 |
| Smart Transportation Metro/Bus Validation | 10cm | - | 99 % | - | 2m | IC/PC/OOC | LOS | Static/ Moving  (3km/h) | 50ms | 20 | 100 in the area of 8 m2 |
| Ranging of UE’s in front of vending machine | 20cm | 10° | - | 1s | 5m | IC/PC/OOC | LOS | Static/ Moving  (<1m/s) | 50ms | - | 10 |
| Finding Items in a supermarket | 50 cm | 5 degree | 95 % | - | 100m | IC/PC/OOC | LOS | Static/ Moving  (<1m/s) | 250ms | - | 100 UEs/  (3.14\*104m2) |
| distance based intelligent perception for public safety | 50cm | - | 99 % | - | 20m | IC/PC/OOC | LOS | Static/ Moving  (<20km/h) | - | 100 | - |
| Long Distance Search | 20m | 5° | 99 % | - | 100m-1km | IC/PC/OOC | LOS | Static/ Moving  (up to 10m/s) | 5s | - | - |
| Long range approximate location | [10m] | ±[12.5°] | 99 % | - | 500m | IC/PC/OOC | LOS | Static/ Moving  (<10m/s) | - | 1 | [50]UEs/  (104m2) |

Different views on defining requirements on ranging have been expressed in submitted contributions as summarized below:

* References [7] and [20] propose that ranging requirements are not separately considered and instead they are assumed to be fulfilled by the requirements on relative positioning.
* Reference [10] proposes the following for ranging:
  + *Distance accuracy (< 3 m) for 90% of UEs.*
* Reference [15] proposes:
  + “*The scenario of direct ranging between two UEs shall be prioritized compared with ranging with assistance of third UE.*”
* Reference [16] indicates that the same requirements should be considered for ranging, relative positioning, and absolute positioning.
* Reference [23] proposes:
  + “*RAN1 to select 1 or 2 representative commercial ranging use cases to derive commercial SL positioning requirements, preferably based on the KPIs, e.g., accuracy, latency aligned with that of V2X or Public Safety*”
* Reference [24] proposes:
  + “*For commercial with ranging scenario, the more concrete applications for the positioning should be firstly clarified.”*
* Reference [27] proposes:
  + “*The number of concurrent ranging operations in an area and the number of concurrent operations for a UE shall be added to the evaluation criteria.”*
* Reference [28] proposes the following requirements down selected from Table 1:
* **Table 2. Ranging use-cases and requirements proposed in [28]**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ranging scenario** | **Ranging Accuracy**  **(95 % confidence level)** | | **Availability** | **Latency**  10ms  50ms  50ms | **Effective ranging distance** | **Coverage** | **NLOS/LOS** | **Relative UE velocity** | **Ranging interval** | **Number of concurrent ranging operation for a UE** | **Number of concurrent ranging operation in an area** |
| **Distance Accuracy** | **Direction Accuracy** |
| Hands Free Access | 10cm | - | 99 % | 500ms | 10 m | IC/PC/OOC | LOS | Static/ Moving  (1 m/s) | 50ms | - | 20 UEs/3.14\*100m2 |
| distance based intelligent perception for public safety | 50cm | - | 99 % | - | 20m | IC/PC/OOC | LOS | Static/ Moving  (<20km/h) | - | 100 | - |
| Long Distance Search | 20m | 5° | 99 % | - | 100m-1km | IC/PC/OOC | LOS | Static/ Moving  (up to 10m/s) | 5s | - | - |

As a first step, it would be necessary to align views on the handling of requirements on ranging. Towards this, the following question is raised.

## FL1 Question 5.1-1

* *Please share your views on the handling of ranging requirements for SL positioning:*
  + ***Option 1:*** *Based on requirements defined in Table 7.9-1 in TS 22.261.*
    - *Please also indicate preferred use-cases and requirements from this table.*
  + ***Option 2:*** *For ranging, the requirements on distance accuracy are same as those identified for relative and absolute positioning.*
  + ***Option 3:*** *For ranging, the requirements are a subset of selected requirements from those identified for relative and absolute positioning.* 
    - *Please indicate preferred requirements.*
  + ***Option 4:*** *For ranging, the requirement on distance accuracy is < 3m for 90% of the UEs.*
  + ***Option 5:*** *Ranging requirements are not separately considered but assumed to be covered by relative positioning requirements.*
  + ***Option 6:*** *Other option(s).*

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| **Company** | **Preferred option** | **Comments** |
| ZTE | Option 5 | We prefer to make things simpler, so the requirements of ranging can be considered with relative poisoning together. |
| CATT | Option 4 | In addition, for ranging, the direction accuracy also needs to be considered. |
| CMCC | Option 5 | Based on the definition in TS22.261, ranging is to acquire distance between two UEs and/or direction of one UE from another UE. In our views, the typical use cases should be first justified before we discussing specific direction accuracy. Regarding the distance accuracy, we prefer Option 5. |
| vivo | Option 4 | Same view as CATT, the direction accuracy also needs to be considered. |
| Lenovo | Option 3 | We prefer to select 1 or 2 commercial ranging use cases to derive commercial SL positioning requirements. The accuracy and latency of the selected commercial ranging use case should align with that of V2X or Public Safety”. For example, Long Distance Search and Hands Free Access. |

# Requirements for SL positioning for V2X use-cases

For V2X use-cases, TR 38.845 provides the following sets of use-cases based on the identified requirements from TS 22.261.

**Table 3. Requirements for SL positioning for V2X use-cases**

|  |  |
| --- | --- |
| Set # | SL positioning accuracy requirements (for absolute and relative positioning) |
| 1 | 10 – 50 m horizontal accuracy, 3 m vertical accuracy, with 68 – 95 % confidence level |
| 2 | 1 – 3 m horizontal accuracy, 2 – 3 m vertical accuracy, with 95 – 99 % confidence level |
| 3 | 0.1 – 0.5 m, 2 m absolute vertical accuracy (/0.2 m relative vertical accuracy) with 95 – 99 % confidence level |

Considering the large number of use-cases and requirements, multiple contributions indicated prferences to limit the requirements to focus on for V2X use-cases. While some contributions indicating picking the most demanding requirements to focus on, some others have opined that, in view of Rel-18 being the first release for SL positioning, some of the most challenging requirements (e.g., sub-1m horizontal accuracy) may be deferred to a future release. The views are summarized below for V2X use-cases:

* References [8], [9], and [11] propose selecting the requirements based on “Set 2” in Table 3:
  + *Horizontal accuracy of 1 – 3 m; Vertical accuracy of 2 – 3 m (absolute and relative)*
* References [13], [18], and [21] propose selecting the requirements based on “Set 3” in Table 3:
  + *Horizontal accuracy of 0.1 – 0.5 m; Vertical accuracy of 2 m (absolute)/ 0.2 m (relative)*
* References [23], [28], and [29] propose selecting the requirements based on the following:
  + *Horizontal accuracy of 1 m; Vertical accuracy of 1 ~ 2 m (absolute)/ 0.2 m (relative)*

For the last case, the proponents have argued their preference from the perspective of aligning the requirements between V2X and public safety use-cases.

## FL1 Question 5.2-1

* *Please share your views on the requirements for V2X use-cases for SL positioning:*
  + ***Option 1:*** *Based on “Set 2” in TR 38.845:*
    - *Horizontal accuracy of 1 – 3 m; Vertical accuracy of 2 – 3 m (absolute and relative)*
  + ***Option 2:*** *Based on “Set 3” in TR 38.845:*
    - *Horizontal accuracy of 0.1 – 0.5 m; Vertical accuracy of 2 m (absolute)/ 0.2 m (relative)*
  + ***Option 3:*** *As below:* 
    - *Horizontal accuracy of 1 m; Vertical accuracy of 1 ~ 2 m (absolute)/ 0.2 m (relative)*
  + ***Option 4:*** *Other option(s).*

|  |  |  |
| --- | --- | --- |
| **Company** | **Preferred option** | **Comments** |
| ZTE | Option 1 | We prefer set 2 for 95% UE or 90% UE |
| CATT | Option 1 | We prefer Option 1 with the revision as follows,   * + ***Option 1:*** *Based on “Set 2” in TR 38.845:*     - *Horizontal accuracy of 1 – 3 m; Vertical accuracy of 2 – 3 m (absolute and relative) for 90% of UEs* |
| CMCC | Option 1 | Considering the BW limitation in ITS band (up to 40MHz), Set 2 is a more reasonable choice in this release. We are fine with the horizontal and vertical accuracy, and additionally, we think that similar as Rel-16/17, the number of UEs for which the accuracy holds can also be considered, and we think @90% UEs can be the starting point. |
| vivo | Option 1 | In addition, we prefer Option 1 with modification since 1-3 m is a range other than bound   * + ***Option 1:*** *Based on “Set 2” in TR 38.845:*     - *Horizontal accuracy of ~~1 –~~ 3 m; Vertical accuracy of ~~2 –~~ 3 m (absolute and relative) for 90% of UEs*   And suggest it can be the common requirement for all use-cases. Then, only select one or two use cases as a baseline for evaluation. |
| Huawei, HiSilicon | Option 1 | for option 1 the “(absolute and relative)” should be meant for both Horizontal and vertical requirement. As set 2 provides a range of values for the accuracies, we prefer to take 3 m only for both the horizontal and vertical accuracy, also given the limitation of 40MHz bandwidth. |
| Lenovo | Option 3 |  |
| Spreadtrum | Option 1 |  |

In terms of associated latency requirements, as can be noted from the related set of requirements defined in TS 22.261 for high-accuracy positioning (Table 7.3.2.2-1), different use-cases require a range of positioning latency requirements, ranging from 10ms to 1s. For V2X use-cases, some sources (e.g., [13], [18], [21]) indicated targeting a common set of values for end-to-end and PHY latency.

## FL1 Question 5.2-2

* *Please share your views on the requirements on positioning latency for V2X use-cases for SL positioning:*
  + ***Option 1:*** *End-to-end latency of 10 ms to 1s, depending on use-cases selected as in* *Table 7.3.2.2-1.*
  + ***Option 2:*** *End-to-end latency < 100 ms and PHY latency < 10 ~ 15 ms.*
  + ***Option 3:*** *Other option(s).*

|  |  |  |
| --- | --- | --- |
| **Company** | **Preferred option** | **Comments** |
| ZTE | Option 3 | We prefer only focusing accuracy requirement in this release. |
| CATT | Option 3 | The latency requirements should be de-prioritize in Rel-18. |
| CMCC | Option 1 | We share similar views with ZTE and CATT that, as this is the first release to enable sidelink positioning function, we prefer to focus on the evaluation and discussion on accuracy. But back in Rel-16, though only accuracy was evaluated, end-to-end latency/TTFF was also defined in the target requirement. In this sense, we are basically fine with the direction of Option 1, and we are also open for the exact values of end-to-end latency. |
| Vivo | Option 3 | Same view as ZTE and CATT |
| Huawei, HiSilicon | Option3 | Share the view that only accuracy should be focused on in this release. If we don’t plan or don’t have efforts to evaluate the latency then it is better to not set the latency target for now because otherwise it may cause confusion as no evaluation may mean no efforts to do it or that the latency can be met so no need to evaluate |
| Lenovo | Option 1 | V2X positioning requirements lack any latency requirements for absolute and relative positioning, So we can set a broad target requirement of positioning latency for V2X use cases in this first release. |
| Spreadtrum | Option3 |  |

Based on information in TR 38.845, relative speeds of up to 250 kmph have been proposed for consideration for V2X use-cases. In addition, reference [5] proposes consideration of **“***three category of velocity levels: low velocity (less than 20km/h), medium velocity (20-100km/h) and high velocity (100-250km/h)*”**.**

## FL1 Proposal 5.2-3

* *SL positioning solutions for V2X should target use-cases involving relative speeds up to 250 km/hr.*
  + *Note: Not all solutions need to satisfy the highest relative speeds.*

*Please share your views on the above.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | The discussion may not be needed if we focusing on accuracy requirement only. Then, UE speed may only impact simulation in which we can follow TR 37.885. |
| CATT | Support |
| vivo | For us, it is more like a conclusion, may not need to stress it here. |
| Huawei, HiSilicon | ok |
| Lenovo | Mobility parameters include absolute velocity and relative velocity. We prefer to have a common design for them. i.e., we can determine whether a high relative velocity is required based on workload for special design. |

# Requirements for SL positioning for public safety use-cases

The requirements for SL positioning for public safety use-cases can be obtained based on those in TR 38.845:

* 1 m horizontal accuracy for 90% of UEs
* 2 m (absolute) or 0.3 m (relative) vertical accuracy
* 95 – 98 % positioning service availability
* Latency < 5s
* Relative speed: up to 30 km/hr.

As such, the above is well-aligned with views expressed in most contributions.

## FL1 Proposal 5.3-1

* *SL positioning solutions for public safety use-cases should target the following requirements:*
  + *1 m horizontal accuracy and 2 m (absolute) or 0.3 m (relative) vertical accuracy for 90% of UEs*
  + *95 – 98 % positioning service availability*
  + *Latency < 5s*
  + *Relative speed: up to 30 km/hr.*

*Please share your views on the above.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | We prefer focusing on V2X and IIOT use cases only. Also, considering the workload, we prefer not to define latency requirement in this release. |
| CATT | Low priority.  Studies on V2X and IIoT use-cases are prioritized during the SI. |
| vivo | Low priority, and suggest no common requirement needs to be defined for public safety use-cases only. We can define a common requirement first in the release and only select one or two use cases as a baseline to evaluate, |
| Huawei, HiSilicon | We prefer to focus only on evaluations for V2X and as second priority commercial use cases and consider only the accuracy requirements. The evaluations for V2X and commercial use cases can also serve as a baseline for how accuracy can be achieved for public safety. |
| Lenovo | Agree with FL’s proposal. |

# Requirements for SL positioning for commercial use-cases

Requirements for SL positioning for commercial use-cases can be determined again based on the requirements in Table 7.3.2.2-1 in TS 22.261 (same as Table 1 in this document).

Most contributions expressing views on this issue indicate a choice that aims to align with the positioning accuracy requirements for public safety, that is:

* 1 m horizontal accuracy and [2 – 3] m (absolute) or 0.3 m (relative) vertical accuracy for 90% of UEs.
* End-to-end latency for position estimation < 100 ms
* Physical layer latency for position estimation < 10 ms

Aligning the requirements on positioning accuracy for these cases can help manage the amount of evaluation efforts more efficiently while not losing any insights.

Accordingly, the following is proposed.

## FL1 Proposal 5.4-1

* *SL positioning solutions for commercial use-cases should target the following requirements:*
  + *1 m horizontal accuracy and [2 – 3] m (absolute) or 0.3 m (relative) vertical accuracy for 90% of UEs*
  + *95 – 98 % positioning service availability*
  + *Latency: End-to-end latency < 100 ms; PHY latency < 10 s*
  + *Relative speed: up to 30 km/hr.*

*Please share your views on the above.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Low priority.  Studies on V2X and IIoT use-cases are prioritized during the SI. |
| vivo | Low priority, and suggest no common requirement needs to be defined for commercial use-cases only. We can define a common requirement first in the release and only select one or two use cases as a baseline to evaluate, |
| Lenovo | Agree with FL’s proposal.  There seems to be a typo for PHY latency, it should read < 10 ms. We are also fine to use an end-to-end target latency of < 1 s. |

# Requirements for SL positioning for IIoT use-cases

Requirements for SL positioning for IIoT use-cases can be determined based on information in TS 22.104, and reproduced in Table 4 below.

**Table 4. Requirements for SL positioning for IIoT use-cases from TS 22.104**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Scenario | Horizontal accuracy | **Vertical accuracy** | Availability | Heading | Latency for position estimation of UE | UE speed | Corresponding Positioning Service Level in TS 22.261 |
| Mobile control panels with safety functions (non-danger zones) | < 5 m | < 3 m | 90 % | n/a | < 5 s | n/a | Service Level 2 |
| Process automation – plant asset management | < 1 m | < 3 m | 90 % | n/a | < 2 s | < 30 km/h | Service Level 3 |
| Flexible, modular assembly area in smart factories (for tracking of tools at the work-place location) | < 1 m (relative positioning) | n/a | 99 % | n/a | 1 s | < 30 km/h | Service Level 3 |
| Augmented reality in smart factories | < 1 m | < 3 m | 99 % | < 0.17 rad | < 15 ms | < 10 km/h | Service Level 4 |
| Mobile control panels with safety functions in smart factories (within factory danger zones) | < 1 m | < 3 m | 99.9 % | < 0.54 rad | < 1 s | n/a | Service Level 4 |
| Flexible, modular assembly area in smart factories (for autonomous vehicles, only for monitoring purposes) | < 50 cm | < 3 m | 99 % | n/a | 1 s | < 30 km/h | Service Level 5 |
| Inbound logistics for manufacturing (for driving trajectories (if supported by further sensors like camera, GNSS, IMU) of indoor autonomous driving systems)) | < 30 cm (if supported by further sensors like camera, GNSS, IMU) | < 3 m | 99.9 % | n/a | 10 ms | < 30 km/h | Service Level 6 |
| Inbound logistics for manufacturing (for storage of goods) | < 20 cm | < 20 cm | 99 % | n/a | < 1 s | < 30 km/h | Service Level 7 |

As can be seen from the above, for positioning service levels 2 through 4, the (absolute and relative) horizontal positioning accuracy requirements are at 1 m, while for service levels 5, 6, 7, the horizontal positioning accuracy may be as low as 0.2 m.

While references [17], [21], [25], and [29] propose consideration of the most strict (absolute and relative) horizontal positioning accuracy requirements of ~0.2 m for IIoT use-cases, references [9] and [28] propose to consider up to service levels 3 or 4 to determine horizontal positioning accuracy of 1 m.

Further, references [9], [17], and [21] propose (absolute and relative) vertical positioning accuracy requirement of 1 m, while reference [29] proposes (absolute and relative) vertical positioning accuracy of 0.2 m.

While Table 4 indicates varied latency requirements, considering many of the use-cases demand very low latency, for simplicity, it is recommended to align the latency requirements to that for commercial use-cases.

## FL1 Proposal 5.5-1

* *SL positioning solutions for IIoT use-cases should target the following requirements:*
  + *For horizontal accuracy, down select between:*
    - *1 m (absolute or relative) for 90% of UEs*
    - *0.2 m (absolute or relative) for 90% of UEs*
  + *For vertical accuracy, down select between:*
    - *1 m (absolute or relative) for 90% of UEs*
    - *0.2 m (absolute or relative) for 90% of UEs*
  + *90 – 99 % positioning service availability*
  + *Latency: End-to-end latency < 100 ms; PHY latency < 10 s*
  + *Relative speed: up to 30 km/hr.*

*Please share your views on the above.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | Here is our suggestion to mitigate the workload.   * *SL positioning solutions for IIoT use-cases should target the following requirements:*   + *For horizontal accuracy, down select between:*     - *1 m (absolute or relative) for 90% of UEs*     - *~~0.2 m (absolute or relative) for 90% of UEs~~*   + *For vertical accuracy, down select between:*     - *1 m (absolute or relative) for 90% of UEs*     - *~~0.2 m (absolute or relative) for 90% of UEs~~*   + *~~90 – 99 % positioning service availability~~*   + *~~Latency: End-to-end latency < 100 ms; PHY latency < 10 s~~*   + *~~Relative speed: up to 30 km/hr.~~* |
| CATT | We prefer the proposal with the revision as follows, Updated FL1 Proposal 5.5-1  * *SL positioning solutions for IIoT use-cases should target the following requirements:*   + *For horizontal accuracy~~, down select between~~:*     - *1 m (absolute or relative) for 90% of UEs*     - *~~0.2 m (absolute or relative) for 90% of UEs~~*   + *For vertical accuracy~~, down select between~~:*     - *1 m (absolute or relative) for 90% of UEs*     - *~~0.2 m (absolute or relative) for 90% of UEs~~*   + *~~90 – 99 % positioning service availability~~*   + *~~Latency: End-to-end latency < 100 ms; PHY latency < 10 s~~*   + *Relative speed: up to 30 km/hr.* |
| CMCC | We prefer both 1m for the horizontal and vertical accuracy. Though sub-meter requirement (<0.2m or <0.5m) was defined in Rel-17 for IIoT use cases, based on the evaluation back then, we should remember that the requirement can only be met in the ideal InF-SH scenario. However, considering the practical NLOS dominant indoor factory scenario, a more reasonable choice is to set meter-level requirement at the first place. |
| vivo | Low priority, and suggest no common requirement needs to be defined for IIoT use-cases only. We can define a common requirement first in the release and only select one or two use cases as a baseline to evaluate, |
| Huawei, HiSilicon | Rel-17 already supports 0.2/0.5 meter for IIoT use case. We do not see any reason to do it again with SL positioning only to have a less-demanding requirement. |
| Lenovo | We prefer an accuracy of “*1 m (absolute or relative) for 90% of UEs”*. Similar to P5.4-1, there seems to be a typo for PHY latency, it should read < 10 ms. However, we also prefer to consider a relaxed end-to-end latency requirement of < 1s as indicated in TS 22.104 |

# Other issues

In addition to the requirements discussed above, in contributions, some further requirements and metrics have been proposed. Some of these include:

* Direction/orientation accuracy
* Concurrent UEs performing relative location estimation
* Coverage range for V2X use-case > 300 m
* UE power consumption for SL positioning

## FL1 Proposal 6-1

* *Please share any other issues related to scenarios and requirements for SL positioning studies, including consideration of any further requirements or assumptions, in Rel-18 that should be addressed in this agenda.*

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | The angle accuracy requirement needs to be defined for ranging. |

# Outcome from RAN1 #109-e

…

# References

1. RP-213588, Revised SID on Study on expanded and improved NR positioning, Intel (Email discussion moderator), RAN #94-e.
2. 3GPP TR 38.845, Study on scenarios and requirements of in-coverage, partial coverage, and out-of-coverage NR positioning use cases.
3. 3GPP TS 22.261, Service requirements for the 5G system.
4. 3GPP TS 22.104, Service requirements for cyber-physical control applications in vertical domains.
5. R1-2203057, Considerations on scenarios and target requirements for sidelink positioning, FUTUREWEI
6. R1-2203127, SL positioning scenarios and requirements, Nokia, Nokia Shanghai Bell
7. R1-2203162, Discussion on scenarios and requirements, Huawei, HiSilicon
8. R1-2203334, Consideration on SL positioning scenarios and requirements, Spreadtrum Communications
9. R1-2203465, Discussion on SL positioning scenarios and requirements, CATT, GOHIGH
10. R1-2203564, Discussion on SL positioning scenarios and requirements, vivo
11. R1-2203622, Discussion on scenarios and requirements for SL positioning, ZTE
12. R1-2203718, Discussion on SL positioning scenarios and requirements, LG Electronics
13. R1-2203737, Considerations on SL positioning scenarios and requirements, Sony
14. R1-2203751, Scenarios and requirements for sidelink positioning, MediaTek Inc.
15. R1-2203821, Discussion on sidelink positioning scenarios and requirement, xiaomi
16. R1-2203909, On SL Positioning Scenarios and Requirements, Samsung
17. R1-2203941, SL positioning scenarios and requirements, NEC
18. R1-2203978, Discussion on SL positioning scenarios and requirements, OPPO
19. R1-2204094, Discussion on V2X use cases, scenarios, and requirements for sidelink positioning, TOYOTA Info Technology Center
20. R1-2204130, Potential scenarios and requirements for SL positioning, InterDigital, Inc.
21. R1-2204251, Discussion on SL positioning scenarios and requirements, Apple
22. R1-2204309, Discussion on SL positioning scenarios and requirements, CMCC
23. R1-2204557, Potential SL Positioning Scenarios and Requirements, Lenovo
24. R1-2204666, Views on SL positioning scenarios and requirements, Sharp
25. R1-2204753, Discussion on sidelink based positioning requirements & scenarios, CEWiT
26. R1-2204806, On SL positioning scenarios and requirements, Intel Corporation
27. R1-2204833, SL positioning scenarios and requirements, Fraunhofer IIS, Fraunhofer HHI
28. R1-2204948, SL positioning scenarios and requirements, Ericsson
29. R1-2205036, Sidelink Positioning Scenarios and Requirements, Qualcomm Incorporated