**3GPP TSG RAN WG1 #109-e R1-220xxxx**

**e-Meeting, May 9th – 20th, 2022**

**Agenda item: 9.5.1.2**

**Source: Moderator (ZTE)**

**Title: Summary #1 of [109-e-R18-Pos-03] Email discussion on evaluation of SL positioning**

**Document for: Discussion and Decision**

# Introduction

In RAN#94e meeting, the study item on Rel-18 NR positioning was approved, where one of the potential enhancements is for sidelink positioning. As shown in the SID, some bullets for sidelink positioning are to define evaluation methodology and evaluate performance.

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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. |

## References

The following papers are provided for the evaluation of SL positioning in RAN1#109-e meeting.

1. R1-2203128 Evaluation of SL positioning Nokia, Nokia Shanghai Bell
2. R1-2203163 Evaluation of SL positioning Huawei, HiSilicon
3. R1-2203466 Evaluation methodology and performance evaluation for SL positioning CATT, GOHIGH
4. R1-2203565 Evaluation of sideilnk positioning performance vivo
5. R1-2203623 Discussion on evaluation for SL positioning ZTE
6. R1-2203719 Discussion on evaluation of SL positioning LG Electronics
7. R1-2203822 Discussion on sidelink positioning evaluation methodology xiaomi
8. R1-2203910 Discussion on Evaluation for SL Positioning Samsung
9. R1-2203942 Evaluation of SL positioning NEC
10. R1-2203979 Discussion on evaluation methodoloty of SL positioning OPPO
11. R1-2204061 Discussion on sidelink postioning design CENC
12. R1-2204131 Evaluation methodology for SL positioning InterDigital, Inc.
13. R1-2204252 On Evaluation of SL positioning Apple
14. R1-2204558 SL Positioning Evaluation Methodology Lenovo
15. R1-2204754 Discussion on evaluation methods and results of sidelink based positioning CEWiT
16. R1-2204834 SL positioning evaluation methodology Fraunhofer IIS, Fraunhofer HHI
17. R1-2204939 Views on Evaluation Methodology for NR Sidelink Positioning Intel Corporation
18. R1-2204949 Evaluation of SL positioning Ericsson
19. R1-2205037 Sidelink Positioning Evaluation Assumptions and Results Qualcomm Incorporated

## Check points

This contribution provides the moderator summary of SL positioning evaluation, subject to the following email discussion.

[109-e-R18-Pos-03] Email discussion on evaluation of SL positioning by May 20 - Chuangxin (ZTE)

* Check points: May 16, May 20

All companies, please provide your initial inputs before Wed May 11th 23:59 UTC, then we still have time to update the proposals accordingly before the next round GTW on May 13th.

## Contact person of each company

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# General proposals for evaluation

## Performance metrics

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| **Company** | **Proposals** |
| Nokia [1] | Proposal 5: Use performance metrics of horizontal and vertical position accuracy for absolute positioning and of distance accuracy and direction accuracy for ranging. |
| Huawei [2] | The positioning error of 50%, 67%, 80%, 90%, and 95% for all cases are summarized in Table 5 |
| vivo [4] | Proposal 9: The following performance metric for sidelink evaluation should be defined:   * For relative and absolute positioning   + horizontal accuracy   + vertical accuracy * Ranging for distance   + accuracy of distance * Ranging for angle   + accuracy of angle |
| ZTE [5] | Percentiles of positioning error: 50%, 67%, 80%, 90% and 95% |
| LG [6] | Proposal 2: Evaluation metric for relative SL positioning accuracy needs to include the following factors.   * The distance between Ues * The speed of Ues * The SL positioning latency requirement   Proposal 3: Evaluation metric for SL positioning availability needs to include the following factors.   * Transmission/reception failure of SL PRS. * The SL positioning latency requirement |
| Xiaomi [7] | Proposal 3: Define horizontal distance accuracy and direction accuracy as performance metrics for sidelink ranging. |
| Samsung [8] | Proposal 2: At least CDFs of horizontal and vertical (vertical error not necessarily applicable to all solutions and/or scenarios) positioning errors are used as performance metrics in NR SL positioning evaluations |
| OPPO [10] | Proposal 5: In sidelink positioning evaluation, horizontal accuracy, vertical accuracy and other metrics defined in TR 38.855 can be used, and adding 95% and 99% as the percentile of positioning error to be analyzed. |
| IDC [12] | Proposal 11: Evaluate positioning accuracy based on the absolute position for both relative and absolute positioning methods  Proposal 12: For latency, evaluate both UE-to-UE and UE-to-Network latency, if applicable |
| Apple [13] | Proposal 1:   * Evaluation Metrics: Horizontal accuracy, vertical accuracy and PHY/end-to-end latency * Coverage Scenarios: Evaluation model for in-coverage, partial coverage and out-of-coverage scenarios is needed * UE deployment and positioning set selection: SL-UE deployment and candidate SL-Ues/gNBs and target SL-UE selection for the positioning evaluation are needed. |
| CEWiT [15] | Similar simulation is carried out for urban grid V2X layout with layout specified in 37.885 Annex A. Figure 3 and Figure 4 show the achieved accuracy in meters and Table 7 summarizes the achieved accuracies for 50 %, 80 % 90%, and 95% of the Ues for both methods |
| QC[19] | Proposal 6: The CDF of horizontal position, vertical position, and range error is used as a performance metric depending on the evaluated scenario. |

**FL comments:**

Both relative positioning and ranging are mentioned in companies’ contributions, so it is better to define the performance metrics to differentiate them as vivo [vivo, 4] suggested. Absolute positioning has been defined in Rel-16/17. Straightforwardly, relative positioning error is calculated by Relative positioning error = where ( and represents the location estimation and real location for vehicle 1, respectively [CATT, 3]. For ranging, the performance metric includes either accuracy of distance based on RTT or accuracy of angle based on AOA [Nokia, 1][vivo, 4][Xiaomi, 7].

95% and even 99% of the Ues on top of Rel-16/17 (i.e. 50%, 67%, 80%, 90%) are suggested by companies [Huawei, 2][ZTE, 5][OPPO, 10][CEWiT, 15] to align the requirement identified in TR38.845 and TS22.261 and TS22.104. CDF of positioning error is also proposed by many companies.

In addition, a few of companies propose to evaluate positioning latency, UE speed, etc. [LG, 6][IDC, 12][Apple, 13].

### Round 1

**Proposal 2.1.1-1:**

* The following performance metrics for SL positioning accuracy evaluation is defined:
  + For relative and absolute positioning
    - horizontal accuracy
    - vertical accuracy
  + For ranging
    - Ranging for distance, i.e. accuracy of distance
    - Ranging for angle, i.e. accuracy of angle
* Companies are required to output
  + The percentiles of positioning accuracy error including 50%, 67%, 80%, 90% and 95% of Ues,
    - FFS 99% of Ues
  + And the CDF of positioning accuracy error
* Performance metrics other than positioning accuracy, such as PHY/end-to-end latency, UE speed error, etc. are up to companies

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| **Company** | **Comments** |
| vivo | We suggest putting 95% into FFS |
| CATT | Support in principle.  95% and 99% can be removed in the proposal. |
| Huawei, HiSilicon | Having 95% or not depends on the requirement. |
| Samsung | For raging, there is no reference (in TR38.845 and TS22.261 and TS22.104) for requirements of angle. So, we suggest to consider distance only.  Also, we think that 95% as FFS. |
| Lenovo | FL’s proposal is a good starting point. We also agree that to limit the percentile of positioning accuracy until 90% with 95% and 99% for FFS. |
| NEC | Suggest removing 95% |
| OPPO | Support the proposal, in our view 95% should be included to evaluate whether Set 2 or Set 3 requirements in 38.845 can be supported or not. |
| NTT DOCOMO | OK with the proposal. Same view with HW. |
| LGE | We agree to the proposed performance metrics in general with the following comments.  **Comment 1.** For ranging and relative positioning, we need to consider a distance in defining a performance metric. For example, a very high accuracy is not needed in ranging or relative positioning between UEs, which are apart by a long distance. In most cases, such a high accuracy is needed e.g. in lane change or avoiding collision, which happens in a very short distance.  A metric similar to PRR used in V2X evaluation can be used for this purpose. For example, the positioning error of average or target percentile in CDF vs. distance between UEs can be used as a metric. If CDF needs to be analyzed, then the CDF per distance can also be considered as a metric. We’re open to the method to include a distance into a metric. The point is that this issue should be included in defining a metric.  We propose to add the following sub-bullet.   * Companies are required to output   + The percentiles of positioning accuracy error including 50%, 67%, 80%, 90% and 95% of UEs,     - FFS 99% of UEs   + And the CDF of positioning accuracy error   + The positioning error of average or target percentile in CDF vs. distance between UEs   **Comment 2.** Different from the conventional Uu link based positioning, SL PRS is transmitted and received through the PC-5 interface. Considering the out-of-coverage use cases, the SL PRS resources selected by UE based on sensing can conflict with other UE’s SL PRS resources. As a result, there will be the cases where the SL PRS is not properly transmitted or received by UEs due to e.g. resource collision, half-duplex or prioritization. It needs to be considered in assessing a solution. Therefore we should include the SL positioning availability as a critical performance metric.   * + SL positioning availability is analyzed as a performance metric   **Comment 3.** With the same reason above, the SL PRS transmission or reception cannot be always successful due to e.g. resource collision, half-duplex or prioritization. Once this happens, it is necessary to retransmit the SL PRS, which causes the SL positioning latency increase. It also needs to be considered in assessing a solution. Therefore we should include the SL positioning latency as a critical performance metric. Or, at least other metrics should have a limit on the required latency.   * + SL positioning latency is analyzed as a performance metric |
| Xiaomi | We also think 95% can be FFS. |

## Positioning methods

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| **Company** | **Proposals** |
| Huawei [2] | For urban grid, roads are usually congested. Considering traffic safety, normally we need to pay attention to the distance and direction between two vehicles. The RTT positioning method is suitable for distance estimation and the AOA method is sufficient for direction estimation. RTT+AOA method is used for the relative positioning between two UEs. For each UE, any other vehicle in the same street is selected for positioning pairing as in Figure 1.  For highway, vehicles are sparse with high velocity. TDOA method is used for the absolute positioning with multiple fixed Ues (e.g. RSU). The RSUs are interlaced on both sides of the road with distance of 200m with the deployment shown in Figure 2 |
| vivo [4] | For one UE in the simulation, there are multiple Ues to select for constituting a pair of Ues for positioning evaluation. How to select suitable UE pair(s) for a UE for accuracy evaluation also needs to be considered. Two options are provided that option 1 is selecting the nearest UE and option 2 is selecting the UE in a certain range. Both of the two options are reasonable for evaluation and at least, the method of UE pair selection used for evaluation should be provided with evaluation results  Proposal 10: Companies should provide the method of UE pair selection in the simulation assumption. |
| ZTE [5] | Proposal 2: For absolute positioning, TDOA or RTT are supported. For relative positioning, RTT and AOA are supported. |
| IDC [12] | Proposal 8: Study assumptions to realize TDOA or AoD based SL positioning methods  Proposal 9: Prioritize evaluation of RTT-based SL positioning methods  Proposal 10: Study evaluation assumptions for Uu-assisted SL positioning once SL positioning evaluation is complete |
| QC [19] | Proposal 12: For public safety scenarios, evaluate out-of-coverage cases as well as in-coverage.  Proposal 16: Evaluate both sidelink-only and joint Uu/SL positioning for commercial scenarios.  Proposal 19: Evaluate both sidelink-only and joint Uu/SL positioning for commercial scenarios. |

**FL comments:**

Many companies suggest joint Uu/SL positioning. In the simulation, both BS and RSU (anchor Ues) are used to locate the target Ues where all Ues including UE type RSUs are assumed in in-coverage. TDOA can be used to align companies’ results.

It is common understanding that relative positioning or ranging should be performed between a UE pair both of which locations are unknown. It seems only RTT and/or AOA positioning methods are applicable. Specifically, RTT+AOA should be used for relative positioning, one of RTT and AOA is used for ranging.

In addition, in the simulation, it is suggested to clarify what UE pair selection is assumed. [vivo, 4][ZTE, 5] suggest that relative positioning or ranging is performed between a UE pair within X m. That is, if the distance between two Ues is larger than X m, the relative positioning or ranging will not be performed in the simulation.

### Round 1

**Proposal 2.2.1-1**

* For absolute positioning evaluation, joint Uu/SL positioning is supported if BS is deployed
  + All Ues including anchor Ues are assumed in in-coverage, where anchor Ues’ locations are known, e.g. RSUs, and both BS and anchor Ues are used to locate target Ues
  + TDOA positioning method is used
* For relative positioning or ranging evaluation, RTT and/or AOA positioning methods are used
* In the evaluation, relative positioning or ranging is performed between two Ues within X m
  + Both Ues are assumed in out-of-coverage
  + FFS X which can be different for different scenarios

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| **Company** | **Comments** |
| vivo | For absolute positioning evaluation, at least, SL only positioning also needs to be studied and evaluated |
| CATT | For the positioning methods used in the evaluation, we prefer to be up to companies to select proper solutions for sidelink positioning, especially in the study phase. |
| Huawei, HiSilicon | For the 1st bullet, we prefer to prioritize pure SL positioning for reducing the evaluation effort for both absolute and relative positioning/ranging.  We also agree with CATT that positioning method could be up to each company to report.  For the last bullet, the evaluton is not relevant to coverage scenarios. |
| Samsung | We think that the reliability of anchor UEs’ locations should be considered for the evaluation. We cannot assume that this information is known perfectly in sidelink and considering realistic sidelink environment is very important for study.  We think that positioning methods (TDOA, RTT, etc.) can be discussed separately. We do not need to tie positioning methods and absolute/relative positioning for the evaluation. |
| **FL** | It seems companies also prefer SL only postioning, and prefer to be up to companies to select positioning metods.  @Samsung reliability of anchor UEs’ locations will be discussed in section 2.4.  Here is the suggested update:  **Proposal 2.2.1-1**   * For absolute positioning evaluation, all UEs including anchor UEs are assumed in in-coverage, where anchor UEs’ locations are known, e.g. RSUs.   + SL only positioning evaluation is supported     - Anchor UEs are used to locate target UEs   + Joint Uu/SL positioning evaluation is supported if BS is deployed     - Both BS and anchor UEs are used to locate target UEs * In the evaluation, relative positioning or ranging is performed between two UEs within X m   + ~~Both UEs are assumed in out-of-coverage~~   + FFS X which can be different for different scenarios * Positioning method should be reported by companies, e.g. for relative positioning or ranging evaluation, RTT and/or AOA positioning methods are used, for absolute positioning evaluation, DL-TDOA or UL-TDOA is used. |
| Lenovo | A UE-type RSU (fixed anchor) may be deployed for absolute positioning. In the case joint Uu/SL positioning further details need to be clarified, e.g., how to fuse the information from both interfaces, etc. For simplicity, the standalone SL only positioning evaluation should also be supported. The type of positioning methods should be kept flexible and up to company’s discretion at this stage of the study. Support FL’s revision. |
| NEC | Thanks moderator for updating the proposal, we prefer not to limit positioning schemes at this stage, and our suggestion as following   * For absolute positioning evaluation, joint Uu/SL positioning is supported if ~~BS is deployed~~ UE is in coverage   + All UEs including anchor UEs are assumed in in-coverage, where anchor UEs’ locations are known~~, e.g. RSUs~~, and both BS and anchor UEs are used to locate target UEs   + ~~TDOA positioning method is used~~ |
| OPPO | Support the update from FL basically, however seems “all UEs including anchor UEs are assumed in in-coverage” in the main bullet should be moved to to the 2nd sub-bullet:   * For absolute positioning evaluation~~, all UEs including anchor UEs are assumed in in-coverage, where~~ anchor UEs’ locations are known, e.g. RSUs.   + SL only positioning evaluation is supported     - Anchor UEs are used to locate target UEs   + Joint Uu/SL positioning evaluation is supported if BS is deployed and all UEs including anchor UEs are assumed in in-coverage     - Both BS and anchor UEs are used to locate target UEs |
| NTT DOCOMO | We are supportive of OPPO’s update. |
| LGE | For the 1st bullet, the stand-alone SL positioning should be prioritized than joint Uu/SL positioning. In this sense, if e.g. UE-type RSU locations are assumed to be known, there is no reason not to simulate SL TDOA in out-of-coverage areas based on multiple RSUs. Therefore we propose to modify the proposal as follows.   * For absolute SL positioning evaluation, all the anchor UEs’ locations are assumed to be known (e.g. RSUs) regardless of the network coverage.   + TDOA positioning method is used   + In in-coverage area, joint Uu/SL positioning using both BS and anchor UEs can be used   For the 2nd bullet, we need to define the antenna configuration for AoA measurement. For example, a single panel with multiple antenna elements or multiple panels distant from each other can be considered.   * For relative positioning or ranging evaluation, RTT and/or AOA positioning methods are used   + FFS antenna configuration for AoA measurement   For the third bullet, the relative positioning or ranging can be used regardless of the network coverage. For example, in in-coverage area, the relative positioning is enough and more efficient than the absolute positioning for collision avoidance. The first sub-bullet is not needed.   * In the evaluation, relative positioning or ranging is performed between two UEs within X m   + ~~Both UEs are assumed in out-of-coverage~~   + FFS X which can be different for different scenarios |
| xiaomi | We prefer to OPPO’s revision. |

## Frequency

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| **Company** | **Proposals** |
| Nokia [1] | Proposal 2: For the V2X use cases, consider simulation bandwidths of 10, 20 and 40 MHz in FR1 ITS spectrum (band n47). |
| CATT [3] | Proposal 3: For SL positioning, simulation bandwidth is assumed to be 20MHz or 40MHz for the case below 6GHz. |
| Vivo [4] | Proposal 5: Evaluation scenarios below 6 GHz can be seen as baseline for SL positioning evaluation.  Proposal 6: Simulation bandwidth can be 5,10 and 20 M for SL positioning evaluation. |
| ZTE [5] | Bandwidth: 20MHz, 40MHz and 100MHz are used for evaluation of SL positioning, where 20MHz and 40MHz are typically used for ITS band, and 100MHz are typically used for licensed band in FR1  Proposal 3: SL positioning evaluation work should focus on FR1. |
| Xiaomi [7] | Proposal 1: For V2X, the deployment scenario of urban grid and highway scenario in TR 37.885 can be reused  - 20MHz bandwidth in ITS band, 100MHz bandwidth in FR1 and 400MHz in FR2 licensed band can be considered  Proposal 2: For commercial, the indoor hotspot deployment can be reused  - 100MHz bandwidth in FR1 and 400MHz bandwidth in FR2 can be assumed. |
| IDC [12] | Proposal 6: Prioritize evaluation in FR1 over FR2 for SL positioning |
| Apple [13] | Proposal 2: Commercial Use Case:   * Methodology: Re-use methodology in 38.855 (Study on NR positioning support Rel-16) and 38.857 (Study on NR Positioning Enhancements Rel-17)[2] * Scenarios: Indoor Office, UMi street canyon, UMa (ISD 500m) with focus on FR1 * Maximum BW: 5MHz, 50MHz for 2GHz, 100MHz for 4GHz   Proposal 3: IIoT Use Case:   * Methodology: Re-use methodology in 38.855 (Study on NR positioning support Rel-16) [3] and 38.857 (Study on NR Positioning Enhancements Rel-17) [2]. * Scenarios:, IIoT (InF-SH and InF-DH) with focus on FR1 * Maximum BW: 5MHz, 50MHz for 2GHz, 100MHz for 4GHz   Proposal 4: V2X Use Case:   * Methodology: Re-use methodology in 38.885 (Study on NR Vehicle-to-Everything (V2X) Rel-16) [4] * Scenarios: Highway and Urban * Maximum BW: 20 MHz for 6 GHz and 100 MHz for 30 GHz |
| QC [19] | Proposal 10: The maximum bandwidth to use for an ITS band is 40 MHz.  Observation 1: No licensed bands are available for V2X applications. |

**FL comments:**

Rel-16/17 sidelink mainly focused on FR1, and it may not work well in FR2 due to lack of basic FR2 functionalities, e.g. beam management. Because the evaluation assumption for FR2 in sidelink has not been updated and it will be discussed at Q4 in this year. Many companies suggested deprioritizing FR2.

Simulation bandwidths of 20, 40 and 100 MHz in FR1 are mainly suggested by companies where 100MHz is for licensed band. One company [QC, 19] proposes that maximum bandwidth to use for an ITS band is 40 MHz. For the simulation purpose, FL suggests including 100MHz for comparison where it doesn’t mean 100MHz has been deployed.

### Round 1

**Proposal 2.3.1-1**

* For SL positioning evaluation, simulation bandwidths of 20, 40 and 100 MHz in FR1 are used.

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| **Company** | **Comments** |
| vivo | We prefer to FFS 100 MHZ in FR1 |
| CATT | We prefer the following revision of the proposal:  **Updated Proposal 2.3.1-1**  For SL positioning evaluation, the following simulation bandwidths are used.   * 20, 40 and 100 MHz in FR1 * 20 and 40 MHz in ITS |
| Huawei, HiSilicon | 100MHz in FR1 should be FFS, because it does not exist in the PC5 interface. |
| Samsung | OK |
| Lenovo | The licensed (20, 40, 100 MHz) and ITS (20, 40, 100 MHz) bands for the BW evaluations can be split accordingly. As the FL mentioned, 100 MHz may be useful for comparative purposes even though in reality it is understood that it may not be practically feasible. |
| NEC | Support |
| OPPO | OK |
| NTT DOCOMO | OK |
| LGE | Support. Currently n79 band supports up to 100MHz for V2X in licensed spectrum, so we can simulate SL positioning with 100MHz in FR1. |
| Xiaomi | Since study on bandwidth requirement is included in the SID, FR2 spectrum shall also be included. RAN decision at Q4 also relies on the evaluation results of both FR1 and FR2 spectrum in RAN1. |

## Other common configuration

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| **Company** | **Proposals** |
| Huawei [2] | Table 7 Common parameters   |  |  | | --- | --- | | Parameter | Value | | Reference Signal Physical Structure and Resource Allocation (RE pattern) (reference to figure in contribution) | Comb-4 | | Reference signal | PRS: Gold, 1-port | | Number of symbols | 4 | | Description of positioning technique / applied positioning algorithm | MUSIC | |
| LG [6] | Proposal 4: The existing DL PRS can be reused for SL PRS to meet the three sets of the positioning requirements defined in RAN positioning SI. |
| NEC [9] | Proposal 3 Existing PRS and SRS should be used as baseline for evaluation. |
| CEWiT [15] | |  |  | | --- | --- | | Network/sidelink synchronization | Ideal | |
| Ericsson [18] | Proposal 1 Do not define any baseline reference signals in the evaluation methodology  Proposal 2 UE and gNB parameters are common for all use cases, with FR1/FR2 parameter differentiations  Proposal 3 Reuse Table 6.1 from 38.857 for common parameters for evaluations in Rel-18 |
| QC [19] | Proposal 1: Sidelink PRS and other sidelink communications cannot be FDMed with each other, i.e. they can only be TDMed.  Proposal 2: As baseline for absolute positioning, there is no uncertainty in the sidelink anchors location coordinates.  Proposal 3: Optionally for absolute positioning, consider that the SL anchors have a location coordinate uncertainty.  Proposal 4: Explicit simulation of all links, individual parameters estimation is applied. Companies should provide description of applied algorithms for estimation of signal location parameters. FFS whether a common algorithm is to be agreed upon.  Proposal 5: Network synchronization error. Network sync error, per UE dropping, is defined as a truncated Gaussian distribution of (T1 ns) rms values between an gNB and a timing reference source which is assumed to have perfect timing, subject to a largest timing difference of T2 ns, the range of timing errors is [-T2, T2], T2 = 2\*T1. FFS whether the same is applied to UE-to-UE synchronization error, e.g. for TDoA evaluations. |

**FL comments:**

Some assumptions defined in Rel-16/17 positioning can still be used, such as PRS or SRS pattern and sequence.

[QC, 19] suggests no uncertainty in the sidelink anchors location coordinates as baseline for absolute positioning.

[CEWiT, 15] suggests perfect network/sidelink synchronization. However, [QC, 19] suggests to reuse Network synchronization error defined in TR 38.857.

### Round 1

**Proposal 2.4.1-1**

For SL positioning evaluation,

* The existing PRS or positioning SRS is reused
* Explicit simulation of all links, individual parameters estimation is applied. Companies should provide description of applied algorithms for estimation of signal location parameters.
* As baseline for absolute positioning, there is no uncertainty in the sidelink anchors location coordinates.
* Perfect network and sidelink synchronization is the baseline.
  + Network synchronization error defined in TR 38.857 Table 6-1 can be optionally used by companies for Synchronization between BS and BS, and between BS and anchor UEs.

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| **Company** | **Comments** |
| CATT | We prefer the following revision of the proposal:  **Updated Proposal 2.4.1-1**  For SL positioning evaluation,   * The existing pattern and sequence of DL-PRS or positioning SRS ~~is~~ can be reused for evaluation purpose. * Explicit simulation of all links, individual parameters estimation is applied. Companies should provide description of applied algorithms for estimation of signal location parameters. * As baseline for absolute positioning, ~~there is no uncertainty in the~~ sidelink anchors location coordinates are known. * Perfect network and sidelink synchronization is the baseline.   + Network synchronization error defined in TR 38.857 Table 6-1 can be optionally used by companies for Synchronization between BS and BS, and between BS and anchor UEs. |
| Huawei, HiSilicon | In general OK with CATT”s version.  We suggest to note that this proposal does not imply that hybrid Uu+PC5 should be evaluated. |
| Samsung | For the third bullet, we need to consider the uncertainty in the sidelink anchors location coordinates as baseline. We should consider realistic sidelink environments.  For the fourth bullet, synchronization error should be considered as baseline in order to study positioning methods (TDOA, RTT, etc.) and its’ validity over sidelink. |
| **FL** | @Huawei, whether joint Uu+PC5 positioning is evaluated will be discussed in each scearios as described in section 3, 4 and 5.  **Updated Proposal 2.4.1-1 from FL**  For SL positioning evaluation,   * The existing pattern and sequence of DL-PRS or positioning SRS ~~is~~ can be reused for evaluation purpose. * Explicit simulation of all links, individual parameters estimation is applied. Companies should provide description of applied algorithms for estimation of signal location parameters. * As baseline for absolute positioning, ~~there is no uncertainty in the~~ sidelink anchors location coordinates are perfectly known.   + Uncertainty in the sidelink anchors location coordinates can be considered by companies * Perfect network and sidelink synchronization in the evaluation is supported.   + Network synchronization error defined in TR 38.857 Table 6-1 can also be used by companies for Synchronization between BS and BS, and between BS and anchor UEs. |
| Lenovo | Support FL’s revision. We also think that the sync. error can be optionally modelled. Suggest the following edit:   * Perfect network and sidelink synchronization in the evaluation is supported.   + Network synchronization error defined in TR 38.857 Table 6-1 can also be optionally used by companies for Synchronization between BS and BS, and between BS and anchor UEs. |
| NEC | Agree with the updated proposal. |
| OPPO | SL-PRS design is being discussed in another agenda, existing pattern and sequence of DL-PRS/SRS can be evaluated as baseline, other new patterns/sequences can also be evaluated for comparison.   * The existing pattern and sequence of DL-PRS or positioning SRS ~~is~~ can be reused as baseline for evaluation purpose.   + Companies should provide the description if other pattern and sequence are evaluated. |
| NTT DOCOMO | OK with the updated proposal by FL |
| LGE | Support. It’s recommended to reuse the existing positioning RS as much as possible, rather than introducing a new RS for SL positioning. |
| xiaomi | We suggest to set perfect synchronization as only one option, and FFS other more realistic assumptions, especiall for synchronization error models between ranging UEs. |

# Evaluation for V2X

## Support of highway and urban grid

**FL comments:**

For V2X evaluations, the typical simulation scenarios contain highway and urban grid scenarios as described in TR 37.885 Annex A. After reviewing contributions from companies, it seems no controversial to reuse the configuration defined in TR 37.885 Annex A for highway and urban scenarios.

------------------------------ Annex A in TR 37.885: Road configuration for urban grid and highway -----------------------

Parameters regarding the road configuration for urban grid and highway are given in the following table:

Table A-1: Road configuration for urban grid and highway

|  |  |  |
| --- | --- | --- |
| Parameter | Urban case | Highway case |
| Number of lanes | 2 in each direction (4 lanes in total in each street) | 3 in each direction (6 lanes in total in the highway) |
| Lane width | 3.5 m | 4 m |
| Road grid size by the distance between intersections | 433 m \* 250 m. NOTE1 | N/A |
| Simulation area size | Minimum 1299 m \* 750 m NOTE2 | Highway length >= 2000 m. Wrap around should be applied to the simulation area. |
| NOTE1: 3 m is reserved for sidewalk per direction (i.e., no vehicle or building in this reserved space).  NOTE2: This value is tentative and could be modified after SA1’further input. | | |

Figure A-1 and A-2 show illustrative diagrams of urban grid and highway, respectively.



Figure A-1: Road configuration for urban grid



Figure A-2: Road configuration for highway scenario

### Round 1

**Proposal 3.1.1-1**

* For SL positioning evaluation, V2X use case with highway and urban grid scenarios defined in TR 37.885 is supported.
  + The road configuration for urban grid and highway provided in TR 37.885 Annex A is reused

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Generally Okay, and suggest selecting V2X use case with highway and urban grid scenarios as a baseline for evaluation |
| CATT | Support |
| Huawei, HiSilicon | Support. |
| Samsung | OK at least for in-coverage case. One clarification question. How to handle scenarios of out-of-coverage case where there is no base station? For example, in a long tunnel. |
| **FL** | @Samsung there is no tunnel in highway and urban grid. Relative positioning only can be used to reflect the secnriaos of out-of-coverage case. |
| Lenovo | Agree with FL’s proposal |
| NEC | OK |
| OPPO | OK |
| NTT DOCOMO | OK |
| LGE | Support |
| Xiaomi | support |

## UE drops

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Nokia [1] | Proposal 1: For the V2X use cases, reuse the evaluation methodology of TR 37.885. Both urban and highway scenarios shall be considered. Vehicular UEs, UE-type RSUs and pedestrian UEs/VRUs shall be considered |
| Huawei [2] | Proposal 4: Take the following two scenarios for V2X use cases for evaluations:   * Urban grid:   + The relative positioning based on sidelink between two UEs is evaluated.   + The relative horizontal accuracy is evaluated. * Highway:   + The absolute positioning based on sidelink between the target UE and multiple fixed UEs is evaluated.   + The absolute horizontal accuracy is evaluated. * For both urban grid and highway scenarios, 100% Vehicle type 2 is a starting point for the UE drop model. |
| CATT [3] | UE dropping defined in TR 37.885[4] is reused, where only type 2 UE is assumed as shown in the following:   * Vehicle UE type: length 5 meters, width 2.0 meters, height 1.6 meters, antenna height 1.6 meters |
| Vivo [4] | Proposal 7: Positioning for vehicle UE based on V2V/V2P/V2R link and positioning for pedestrian UE based on P2V/P2P/P2R link should be contained in the evaluation. |
| ZTE[5] | |  |  | | --- | --- | | UE drop | According to TR 37.885, Type 2 UEs and Option A dropping are used. | |
| IDC [12] | Proposal 1: Use the vehicle types (i.e., Type 1, 2 and 3) defined in TR 37.855 as the starting point in the sidelink (SL) positioning study |
| CEWiT [15] | |  |  | | --- | --- | | Option A for Highway  Option A for urban grid | Option A for Highway  Option A for urban grid | |
| QC[19] | Proposal 8: Use the highway and urban grid UE drop models defined in TS 37.885 for V2X scenarios. |

**FL comments:**

Most companies suggest to reuse UE dropping models defined in TR 37.885. UE dropping Option A is suggested by several companies [Huawei, 2][CATT, 3][ZTE, 5][CEWiT, 15].

### Round 1

**Proposal 3.2.1-1**

* For SL positioning evaluation in highway and urban grid scenarios, UE dropping option A defined in section 6.1.2 of TR 37.885 is used, i.e.
  + The following UE dropping option is used for the highway scenario:
    - Option A
      * Vehicle type distribution: 100% vehicle type 2.
      * - Clustered dropping is not used.
      * - Vehicle speed is 140 km/h in all the lanes as baseline and 70 km/h in all the lanes optionally.
  + The following UE dropping option is used for the urban grid scenario:
    - Option A
      * Vehicle type distribution: 100% vehicle type 2.
      * Clustered dropping is not used.
      * Vehicle speed is 60 km/h in all the lanes.
      * In the intersection, a UE goes straight, turns left, turns right with the probability of 0.5, 0.25, 0.25, respectively.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Okay |
| CATT | Support |
| Huawei, HiSilicon | Support |
| Samsung | OK in principle |
| Lenovo | Support |
| NEC | OK |
| OPPO | OK |
| NTT DOCOMO | OK |
| LGE | We support the proposal with one comment. For the urban grid, we may add a low speed 15km/h as an option, which was the baseline speed in LTE-V2X evaluation.   * + The following UE dropping option is used for the urban grid scenario:     - * Vehicle speed is 60 km/h in all the lanes as baseline and 15 km/h in all the lanes optionally. |
| Xiaomi | Support |

## BS and RSU deployment

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei [2] | 100m  200m  200m  200m  Lane width:  4m  ≥2km  Figure 2 RSU deployment in Highway scenario |
| CATT [3] | BS deployment is the same as that defined in TR 36.885[3]. To support absolute positioning in the case of out of coverage, the location of RSU is assumed to be fixed and known. Considering the requirement of SL positioning, RSU deployment is revised to be uniformly located in the two sides of highway. Otherwise, if RSU is located in the middle of the highway, positioning accuracy would be significantly degraded due to DOP (Dilution of Precision).  Table 2: BS and UE-type RSU deployment   |  |  | | --- | --- | | Parameters | Highway for eV2X below 6GHz | | Layout | Baseline: Macro only, located along the highway 35m away with 1732m ISD  Note #1: Out of coverage can be evaluated assuming BS to be disabled. | | Inter-BS distance | Inter Macro: 1732m | | UE-type RSU | Uniform allocation with 200m spacing in the two sides of the highway |   Proposal 4: To support absolute positioning, RSU is uniformly allocated with 200m spacing in the two sides of the highway. |
| ZTE[5] | |  |  | | --- | --- | | RSU location | According to TR 37.885, uniformly allocated with 100m spacing in the middle of highway | | BS location | Allocated on both side of the road, inter-site distance is 500m | |
| Lenovo [14] | Proposal 2: RAN1 to consider the following additional deployment scenarios for the SL positioning evaluations for V2X use case evaluations 1) Highway (FFS RSU deployments only on one side or both sides (better GDOP) of the highway 2) Urban grid scenarios. |
| NEC [9] | For scenario 3 UMa, the specific parameters defined in Table 6.1.1-6 in [3] should be used as a starting point. Additional parameters, e.g., antenna pattern for UE-type RSU, deployment of UE-type RSU, dropping of cellular/Pedestrian UE, etc., should be defined from Urban grid and Highway following assumptions in Clause 6.1 [4]; |

**FL comments:**

The BS and RSU deployment for highway and urban grid is elaborated in TR 37.885 section 6.1.3 and TR 36.885 section A.1.3.

**For BS and RSU deployment in highway**, basically there are three choices:

* Alt 1: Completely follows TR 37.885 section 6.1.3 and TR 36.885 section A.1.3.
  + For BS deployment in highway, two options are provided in TR 36.885 section 6.1.3
    - Option 1 (baseline): eNBs are located along the freeway 35m away with 1732m ISD in Figure A.1.3-2.
    - Option 2 (optional): Wrap around method of 19\*3 hexagonal cells with 500m ISD in Figure A.1.3-3.
  + For RSU deployment in highway, uniform allocation with 100m spacing in the middle of the freeway
* Alt 2: [Huawei, 2] [CATT, 3] suggest to modify RSU deployment to locate RSUs in the both sides of highway, where BS deployment seems not considered.
* Alt 3: [ZTE, 5] reuses the RSU deployment as described in 36.885, and modify the BS deployment to locate BS in the both sides of highway where inter-BS distance is 500 m.

In Alt 1, option 1 for BS deployment seems not preferable as both BSs and RSUs are only located in single side of some UEs. Even considering joint Uu and SL positioning, the positioning accuracy may not be good.

In Alt 2, it seems no way to evaluate joint Uu and SL positioning.

**For BS and RSU deployment in urban**,

* If absolute positioning is agreeable, TR 36.885 section A.1.3 can be completely followed as no companies have special proposals. That is, macro BSs are deployed for Urban case, ISD of macro eNB is 500 m and the wrap around model in Figure A.1.3-1 of TR 36.885 is used, UE type RSU is at the center of intersection.
* If only relative positioning is agreed for evaluation, BS and RSU will be disabled.

### Round 1

**Proposal 3.3.1-1**

* For SL positioning evaluation in highway scenario, down-select one of the following for BS and RSU deployment
  + Alt 1: BS and UE-type RSU deployment follows 36.855, where wrap around method of 19\*3 hexagonal cells with 500m ISD in Figure A.1.3-3 of TR 36.885 section A.1.3 is used.
  + Alt 2: BSs are disabled, RSUs are uniformly located with 200m spacing in the two sides of highway
  + Alt 3: UE type RSUs are uniformly allocated with 100m spacing in the middle of highway according to TR 36.885, and BS are uniformly allocated at both sides of the road where inter-BS distance is 500m
* For SL positioning evaluation in urban grid scenario, BS and RSU deployment if needed follows the description in TR 36.885 section A.1.3.

Companies provide the preferred option and comments.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Alt2. |
| Huawei, HiSilicon | Alt.2 to reduce the effort of discussion and evaluation. |
| Samsung | We think that all alternatives need to be considered rather than down-select one alternative. Also, there would be a scenario where both BS and UE-type RSU are not available such as a long tunnel in highway. |
| Lenovo | Support Alt. 2, however according to TR 36.885, the inter UE-type RSU distance can be 100 m. It is not clear in alt-2 if this is applicable to all RSU-types. Suggest a clarification to this aspect in Alt-2. |
| OPPO | Both Alt 1 and Alt 2 should be supported to evaluate the joint BS/SL positioning and the SL only positioning |
| NTT DOCOMO | Same view with OPPO. |
| LGE | We propose the following deployment.  For highway scenario,   * + - * BSs are deployed as in Figure A.1.3-3 of TR 36.855       * RSUs are deployed with 200m spacing in the two sides of highway, which is effectively equivalent to 100m spacing in the middle as specified in TR 36.885   For urban grid scenario,   * + - * BSs are deployed as in Figure A.1.3-1 of TR 36.855       * Following modification is added to RSU deployment in TR 36.885 |
| xiaomi | For highway scenario, alt 2 is preferred. It may need to clarify whether RSU in alt 2 is UE-type RSU. |

## Antenna model

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| --- | --- |
| **Company** | **Proposals** |
| CATT [3] | Antenna element patterns of macro BS, RSU and vehicle UE could reuse the definitions in TR 37.885[4].  Proposal 5: As a baseline, single panel (option 1 configuration defined in TR 37.885) is assumed for vehicle UE below 6GHz. |
| Vivo [4] | The current antenna configuration in TR37.885[5] for V2X contains two configuration for the location of antenna as following:  Option 1: Each antenna panel is deployed on the rooftop of the vehicle  Option 2: The antenna panel is deployed on the different location in the vehicle, .  Proposal 8: Support distributed antenna configuration for V2X positioning evaluation. |
| ZTE[5] | According to TR 37.885, Option 1 (single panel) as the baseline and Option 2 (two panels) as optional |
| IDC [12] | Proposal 3: Use panel and antenna placement in TR 37.855 (e.g., front and rear antenna array, panels on front and rear bumper) as the starting point for SL positioning study |
| QC [19] | Proposal 9: Use the antenna configurations, channel models, fading parameters from TS 37.885 for V2X scenarios. |

**FL comments:**

Above companies mention that the antenna configurations elaborated in TR 37.885 section 6.1.4 can be reused, where [CATT, 3][ZTE, 5] propose to use single panel as baseline for simplicity but [vivo, 4] proposes to use two panels for the sake of higher positioning accuracy.

### Round 1

**Proposal 3.4.1-1**

For SL positioning evaluation in highway and urban grid scenarios, antenna model follows the description in TR 37.885 section 6.1.4.

* + Vehicle UE option 1 is the baseline (Vehicle UE antenna is modelled in Table 6.1.4-8 and 6.1.4-9 in TR 37.885)
  + Vehicle UE option 2 (two panels) can be optionally selected by companies

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **vivo** | Sorry, we can not agree with option 2 as an optional case for evaluation since it is a more realistic deployment.  So, can we modify as follows for the progress  **Proposal 3.4.1-1**  For SL positioning evaluation in highway and urban grid scenarios, antenna model follows the description in TR 37.885 section 6.1.4, companies are encouraged to provide evaluation results using both options.   * + Option 1: Vehicle UE antenna is modelled in Table 6.1.4-8 and 6.1.4-9   + Option 2: Two panels(the antenna pattern for each location is given by Tables 6.1.4-10 and, 6.1.4-11. The antenna array configuration is given by Table 6.1.4-12) |
| CATT | Support |
| Huawei, HiSilicon | OK. One question regarding Option 2 is that for Option 2 (assuming UE type 2) with one panel at front rooftop and one panel at rear rooftop, they are basically non-located, which will have impact on positioning, or will create unnecessary complexity in the evaluation. |
| Samsung | OK |
| Lenovo | Support |
| NEC | Support |
| OPPO | OK |
| NTT DOCOMO | OK |
| LGE | Support. We think that option 2 is quite necessary and useful in angle estimation for relative positioning especially in FR1 band. |
| xiaomi | Support. |

## Channel models

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei [2] | Proposal 1: Support to use the channel model defined in TR 37.885 for V2X use case. |
| CATT [3] | The channel model between UE and RSU is basically established based on UMA scenario in TR38.901[5], including LOS probability, fast fading model. As an exception, according to TR37.885[4], the pathloss model is based on RMA scenario shown in Table 7. This channel model is suggested to be used for the evaluation.  The channel model between UE and UE has been defined in TR 37.885 [4], which should be reused for the evaluation |
| ZTE [5] | |  |  | | --- | --- | | SL channel model | UE2UE described in TR 37.885 | | Channel model between BS and UE | Described in TR 37.885 | |
| QC [19] | Proposal 9: Use the antenna configurations, channel models, fading parameters from TS 37.885 for V2X scenarios. |

### Round 1

**Proposal 3.5.1-1**

* For SL positioning evaluation in highway and urban grid scenarios, channel model follows description in TR 37.885 section 6.2.

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| --- | --- |
| **Company** | **Comments** |
| vivo | okay |
| CATT | We prefer the following revision:  **Updated Proposal 3.5.1-1**   * For SL positioning evaluation in highway and urban grid scenarios, channel model follows description in TR 37.885 section 6.2 and TR 38.901. |
| Huawei, HiSilicon | OK |
| Samsung | OK |
| Lenovo | Support |
| NEC | OK |
| OPPO | OK |
| NTT DOCOMO | OK |
| LGE | Support |
| Xiaomi | support |

## Absolute or relative Positioning

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| --- | --- |
| **Company** | **Proposals** |
| Huawei [2] | Proposal 4: Take the following two scenarios for V2X use cases for evaluations:   * Urban grid:   + The relative positioning based on sidelink between two UEs is evaluated.   + The relative horizontal accuracy is evaluated. * Highway:   + The absolute positioning based on sidelink between the target UE and multiple fixed UEs is evaluated.   + The absolute horizontal accuracy is evaluated. |
| CATT [3] | Absolute positioning: RSU and vehicle UE  Relative positioning can be evaluated assuming RSU to be disabled |
| vivo [4] | For one UE in the simulation, there are multiple UEs to select for constituting a pair of UEs for positioning evaluation. How to select suitable UE pair(s) for a UE for accuracy evaluation also needs to be considered. Two options are provided that option 1 is selecting the nearest UE and option 2 is selecting the UE in a certain range. Both of the two options are reasonable for evaluation and at least, the method of UE pair selection used for evaluation should be provided with evaluation results  Proposal 10: Companies should provide the method of UE pair selection in the simulation assumption. |
| ZTE [5] | |  |  |  | | --- | --- | --- | | Anchors selection | For absolute positioning, all BSs and RSUs can be used | Relative positioning is performed for two Ues within 100m | |
| Xiaomi [7] | Proposal 4: For V2X and commercial use case, consider both options  - Option 1: ranging UEs have line of sight path between them;  - Option 2: ranging UEs are select from UEs within a given distance. |
| CENC [11] | Proposal 3: Consider relative positioning using Multi-RTT, which does not affect by the timing synchronization. |

**FL comments:**

For urban scenario, [Huawei, 2][vivo, 4] propose only relative positioning for simplicity where BS and RSU (anchor UEs) deployments are not needed. In addition, [vivo, 4][ZTE, 5] suggests UE pair selection in a certain range, i.e. within X m, where [ZTE, 5] suggests X = 100 m.

For highway scenario, it seems all of absolute positioning, relative positioning and ranging should be evaluated.

### Round 1

**Proposal 3.6.1-1**

* For SL positioning in highway scenario, the performance metrics include absolute horizontal accuracy, relative horizontal accuracy and ranging.
* For SL positioning evaluation in urban scenario, the performance metrics include relative horizontal accuracy and ranging.
  + Relative positioning or ranging is performed between two UEs within X = 100m

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | We are confused about the difference between the proposal and Proposal 2.1.1-1, do you mean the performance metrics for different scenarios are different? |
| CATT | We prefer to only using ranging as performance metrics in commercial use cases, and for urban scenario, the performance metrics can include absolute horizontal accuracy. We can live with the introduction of X, but the values of X had better to be FFS at this stage.  The updated proposal as follows,  **Updated Proposal 3.6.1-1**   * For SL positioning in highway scenario, the performance metrics include absolute horizontal accuracy and relative horizontal accuracy ~~and ranging~~. * For SL positioning evaluation in urban scenario, the performance metrics include absolute horizontal accuracy and relative horizontal accuracy ~~and ranging~~.   + Relative positioning ~~or ranging~~ is performed between two UEs within X ~~=100~~m     - FFS: The values of X |
| Huawei, HiSilicon | For highway scenario, we think both absolute accuracy and relative accuracy matter. For urban grid scenario, we slight prefer to only consider relative positioning due to the poor LoS condition. |
| Samsung | We do not see big motivation in this proposal that absolute positioning is precluded in urban scenario. |
| **FL** | @CATT, vivo, Samsung for Urban grid scenarios, the Los condition is quite pool if we follow the deployment of TR37.885, the absolute positioning accuracy is very low even we consider 100MHz. That’s why several companies suggest relative positioning only. |
| Lenovo | We also share the view that relative horizontal accuracy implies ranging as well, i.e. distance accuracy, so ranging can be removed. |
| NEC | We propose to remove the distance limit at this stage since it is too early to define such limit without adequate simulation results. |
| OPPO | We suggest add “at least” as below, companies can evaluate other metrics if they think necessary.   * For SL positioning in highway scenario, the performance metrics at least include absolute horizontal accuracy, relative horizontal accuracy and ranging. * For SL positioning evaluation in urban scenario, the performance metrics at least include relative horizontal accuracy and ranging.   + Relative positioning or ranging is performed between two UEs within X = 100m |
| NTT DOCOMO | We are not sure this proposal is really necessary in this stage. |
| LGE | Support with the following comment.  As explained in our response to Proposal 2.1.1-1, the positioning accuracy of relative positioning or ranging should be a function of a distance between UEs. For example, it’s not expected that the accuracy less than 10cm is needed when the target UE is distant from the peer UE by 100m. As suggested in our response to Proposal 2.1.1-1, we can use the positioning error vs. distance as a metric. Or we can use multiple CDFs depending on the distance. For example, if X=100m, we can divide the distance as e.g. <10m, <50m, <100m, and provide a metric (e.g. CDF) for each distance category. |
| xiaomi | It seems X=100m is arbitrarily selected. Multiple values of X can be provided to see the impact of ranging distance. |

## Others for V2X

Companies can provide any other suggestions for the evaluation in highway and urban scenarios if any.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Samsung | We suggest to consider a scenario where BS is not available (out-of-coverage) in addition to highway and urban scenario. |
|  |  |

# Evaluation for public safety and commercial

## Support of public safety and commercial

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| --- | --- |
| **Company** | **Proposals** |
| Nokia [1] | Proposal 3: For the public safety use cases, reuse the evaluation methodology of TR 36.843. |
| Huawei [2] | Proposal 2: The channel model between UEs for commercial use cases may reference indoor to indoor channel model defined in A2.1.2 in TR 36.843.  Proposal 3: Consider only V2X use case and commercial use case for the purpose of evaluation. |
| CATT [3] | Proposal 1: For SL positioning, evaluation is preferred to be only focused on V2X use cases and IioT use cases . |
| Vivo [4] | Proposal 1: Use case of public safety and commercial share the same evaluation assumption.  Proposal 2: Considering the timeline and overload of simulation for positioning, defining the sidelink channel model and evaluating positioning performance for public safety and commercial use cases can be set as low priority. |
| ZTE [5] | Proposal 4: For evaluation of SL positioning, three scenarios are suggested, including highway, urban and indoor factory. |
| Xiaomi [7] | Proposal 2: For commercial, the indoor hotspot deployment can be reused |
| OPPO [10] | Proposal 1: In sidelink positioning evaluation, evaluation methodologies defined in TR38.855 and TR38.857 should be the baseline for commercial and IioT use cases with following modifications:   * + Replacing channel model with sidelink channel model;   + Introducing anchor UE dropping and selection procedure.   Proposal 2: In sidelink positioning evaluation, the modified evaluation methodology for commercial use case could be reused for public safety use case. |
| Apple [13] | Proposal 2: Commercial Use Case:   * Methodology: Re-use methodology in 38.855 (Study on NR positioning support Rel-16) and 38.857 (Study on NR Positioning Enhancements Rel-17)[2] * Scenarios: Indoor Office, Umi street canyon, Uma (ISD 500m) with focus on FR1 * Maximum BW: 5MHz, 50MHz for 2GHz, 100MHz for 4GHz   Proposal 5: Public Safety: for both indoor and outdoor scenarios.   * Methodology: Use methodology in 38.855[3] * Scenarios: Re-use Indoor Office, Umi street canyon and Uma (ISD 500m) from 38.855[3] * NOTE: based on requirements [5], evaluation can be incorporated into Commercial use case. |
| CEWiT [15] | Proposal 2: For Rel 17 sidelink evaluation, reuse the simulation parameters form 38.855 and 38.857 for public safety and IioT use cases. |
| Ericsson [18] | Proposal 7 Reuse Table 6.1-1-3 from 38.855 for parameters for evaluations of commercial use cases in Rel-18. For UE to UE evaluations (relative positioning / ranging), the UE model can be used at both ends of the link.  Proposal 10 Reuse Table 6.1-1-4 from 38.855 for parameters for evaluations of TRP to UE links in outdoor use cases in Rel-18.   |  |  |  | | --- | --- | --- | | Scenario 2 | Indoor, commercial | Table 6.1-1-3 from 38.855 | | Scenario 3 | Indoor, public safety | FFS for device to device  Table 6.1-1-3 from 38.855 for TRP to UE. | | Scenario 5 | outdoor, commercial | Table 6.1-1-4 from 38.855 for outdoor TRP-UE links  v2v channel models for UE to UE links in LOS conditions | | Scenario 6 | outdoor, public safety | Table 6.1-1-4 from 38.855 for outdoor TRP-UE links  v2v channel models for UE to UE links  FFS: LOS condition | |
| QC [19] | Proposal 11: Use urban macro layout with 1732m ISD (Option 5 from TS 36.843) and/or urban macro layout with 500m ISD (Option 3 from TS 36.843) for public safety evaluations.  Proposal 13: For joint SL-Uu positioning in public safety scenarios, use the same UE-gNB channel models and the same UE-gNB band and bandwidth as the commercial scenarios.  Proposal 14: For general commercial use cases, for gNB-UE channels, Rel-16 scenarios and channel models in TR 38.855 are reused for Uu channels. These are included for reference in the Appendix.   * For the absolute time of arrival modelling in IOO, Uma, Umi, sources may provide the details of their model.   Proposal 15: Use TS 36.843 A.2.1.2 channel models for UE-UE Outdoor to Outdoor, Indoor to Indoor channels.   * For UMI/UMA scenarios, for both FR1, FR2, support the following UE drop assumption:   + Baseline Scenario: 10 Ues per sector, uniform drop of Ues wherein all Ues randomly and uniformly dropped throughout the macro geographical area. All Ues are dropped outdoors. No buildings are dropped * Optional: For InH scenarios, for both FR1, FR2   + Uniformly at random drop of [X] indoor Ues |

**FL comments:**

In contribution from [vivo, 4], the related scenario, parameters, and channel model defined in previous release are well summarized in Table 1 for the use cases in SID.

Table 1 channel model of four use cases

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Use case | Public Safety | Commercial | IIOT | V2X |
| scenario | Indoor/Umi/Uma | Indoor/Umi/Uma | InF-SH/InF-DH | Urban/Highway |
| Channel model | Uu only  channel model in TR38.901 is used | Uu only and  channel model in TR38.901 is used | Uu only and  channel model in TR38.901 is used | Uu and sidelink, and  channel model in TR37.885 is used |

Some issues for public safety and commercial use case have been discussed in Rel-17 sidelink evaluation methodology and the related conclusions have been agreed in RAN1#103e and 104e meeting as follows.

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| Agreements:  For **the public safety and commercial use cases**, reuse the parameters of “Reference system deployments” specified in Section A.2.1.1 of TR 36.843 with following modification:   * Carrier frequency:   + Include 3.5 GHz for commercial use case (optional) * System bandwidth:   + Include 40 MHz for commercial use case (optional) and 20 MHz dedicated spectrum for out-of-coverage scenarios (optional) * “eNB” is replaced by “gNB”   Agreements:   * + - * For the layout for **public safety and commercial use cases**, support “7 macro sites with 3 cells per site in the layout”   Agreements:   * + - * For **public safety use case**, at least following layout option is supported: * Option 5 of TR 36.843: Urban macro (1732m ISD)   + UE dropping as in Table A.2.1.1-1     - All Ues are outdoors Ues     - Mix of outdoor and indoor Ues   Agreements:   * For **commercial use case**, at least following layout options are supported:   + Option 3 of TR 36.843: Urban macro (500m ISD) (all Ues outdoor)     - UE dropping as in Table A.2.1.1-1       * All Ues are outdoors Ues   + Option 1: Urban macro (500m ISD) + 1 RRH/Indoor Hotzone per cell for optional     - UE dropping as in Table A.2.1.1-1       * Mix of outdoor and indoor Ues   + Option 5 of TR 36.843: Urban macro (1732m ISD) for optional     - UE dropping as in Table A.2.1.1-1       * All Ues are outdoors Ues       * Mix of outdoor and indoor Ues   Agreements:  For **the public safety and commercial use cases**, reuse the parameters of **“Channel models” specified in Section A.2.1.2 of TR 36.843 with following modification:**   * **Each component of channel model reuses what is specified in TR 38.901**.   Agreements:   * For public safety and commercial use cases, at least following option is supported for UE RF parameters: * Reuse the number of TX AP, the number of RX AP, antenna gain for P-UE specified in TR 37.885. |

Based on companies’ contributions, it is controversial to support public safety and commercial use case for SL positioning evolution. Supporting companies basically suggest one or more of Indoor/Umi/Uma scenarios defined in TR 38.855. Several companies also mention that public safety and commercial use case can share the same evaluation assumptions. The concern on support of evaluation of public safety and commercial use case mainly includes Rel-18 workload and incomprehensive simulation assumptions.

* Public safety use case for SL positioning evaluation in Rel-18
  + Support: Nokia, OPPO, Apple, CEWiT, Ericsson, QC
  + Not support or low priority: Huawei, CATT, ZTE, vivo, xiaomi,
* Commercial use case for SL positioning evaluation in Rel-18
  + Support: Huawei, xiaomi, OPPO, Apple, Ericsson, QC
  + Not support or low priority: Nokia, CATT, ZTE, vivo, CEWiT

As shown in the above agreements made for Rel-17 sidelink evaluation methodology, Option 5 of TR 36.843: Urban macro (1732m ISD) is selected for both public safety and commercial use case. Considering workload in Rel-18, this seems a good balance from FL perspective. Then, channel models for both BS-2-UE and UE-2-UE defined in TR 36.843 and the above agreements can be reused.

### Round 1

**Proposal 4.1.1-1**

* For SL positioning evaluation on public safety and commercial use cases, down-select the two options:
  + Alt 1: Public safety and commercial use cases share the same evaluation assumption.
    - Option 5 of TR 36.843: Urban macro (1732m ISD) is used for evaluation.
      * All Ues are outdoors
    - Reuse the parameters of “Channel models” specified in Section A.2.1.2 of TR 36.843 with following modification:
      * Each component of channel model reuses what is specified in TR 38.901
  + Alt 2: Public safety and commercial use cases for SL positioning evaluation in Rel-18 are not supported

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| **Company** | **Comments** |
| vivo | Alt 2, or public safety and commercial use cases can be as optional use cases and no common parameters are defined, the detailed parameter is left up to each company and details should be provided  In public safety and commercial use cases scenarios, there are no existing channel model and RSU deployment, and difficult to calibrate the platform and evaluate it in the limited meetings.  In addition, Rel-18, includes many simulations, including SL, Redcap, and carrier phase. So, we prefer to only choose one or two scenarios for evaluation to reduce load. In this case, V2X can be the baseline for evaluation. |
| CATT | Alt 2.  We prefer the public safety and commercial use cases to be low priority in Rel-18. |
| Huawei, HiSilicon | We prefer to evaluate commercial use cases. The reason is that the ranging use case is clear, and there is a need to provide the evaluation results to understand how accurate ranging can achieve with cellular solutions.  We may have existing evaluation methodology from LTE D2D. |
| Samsung | We do not need to evaluate positioning performance for all use cases.  However, we also think that we do not need to have an agreement to preclude some use cases for evaluation. |
| Lenovo | We share the view with vivo, that the public safety and commercial use cases can be optional, and it’s up to each company to provide details on their evaluations. |
| NEC | Alt 2 but rephrased as below   * + Alt 2: Public safety and commercial use cases for SL positioning evaluation in Rel-18 are ~~not supported~~ of low priority. |
| OPPO | We think the simulation should focus on the indoor scenario especially in commercial use cases and we can also accept the simulation of commercial use cases and public safety as optional considering the work load. |
| NTT DOCOMO | Basically we think all use cases should be considered based on SID. But in Option 1, all UEs are outdoors, which would be invalid for commercial use case. Set as optional would be fine. |
| xiaomi | We share the view as HW that commercial use case shall be evaluated. The necessity to support ranging service for commercial use cases has been clearly stated in the SID. Further depriorization of use cases in WG discussion is not desirable.  In addition, we do not think a pure ourdoor scenario is suitable for commercial use case. Note that commercial ranging services are much different from commercial communication services. It is not proper to directly cite R16 sidelink communication agreements. The service requirement of commercial ranging has been clearly capatured in TS 22.261. For commercial ranging use cases, many use cases happen in the building (e.g. in home or office), and thus the deployment scenario of indoor hotspot in TR 38.802 shall also be included to evaluate the ranging/sidelink positioning performance. |

## Absolute or relative Positioning

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| **Company** | **Proposals** |
| Huawei [2] | Proposal 6: For commercial use cases, the relative positioning based on sidelink between two UEs is evaluated.   * The distance accuracy and/or direction accuracy are considered. |
| Xiaomi [7] | Proposal 4: For V2X and commercial use case, consider both options  - Option 1: ranging UEs have line of sight path between them;  - Option 2: ranging UEs are select from UEs within a given distance. |
| QC [19] | Proposal 12: For public safety scenarios, evaluate out-of-coverage cases as well as in-coverage.  Proposal 16: Evaluate both sidelink-only and joint Uu/SL positioning for commercial scenarios. |

**FL comments:**

Because no RSU is deployed, how to select anchor UEs which coordinates are known should be discussed for absolute positioning. Also, how to select UE pairs for relative positioning or ranging should be discussed.

### Round 1

**Proposal 4.2.1-1**

* For SL positioning evaluation for public safety and commercial use case, the performance metrics include absolute horizontal accuracy, relative horizontal accuracy and ranging.
  + FFS how to select anchor UEs for absolute positioning, e.g. 1 or 2 of the nearest UEs as the anchor UEs of which coordinates are known
  + FFS how to select UE pairs, e.g. relative positioning or ranging is only performed between two UEs within X m

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| **Company** | **Comments** |
| Huawei, HiSilicon | For commercial use cases, we prefer to evaluate either relative positioning (relative horizontal accuracy) or ranging (distance/angle accuracy). |
| Samsung | In our understanding, it is not clear this proposal should be for use cases of public safety and commercial. FFSs can be discussed in general for all use cases. |
| Xiaomi | Relative horizontal accuracy and ranging accuracy can be prioritized for commercial use case. |

## Others for public safety and commercial

Companies can provide any other suggestions for evaluation on public safety and commercial use cases if any.

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| **Company** | **Comments** |
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# Evaluation for IIOT

## Support of IIOT use case for simulation

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| **Company** | **Proposals** |
| Nokia [1] | Proposal 4: For the IIoT indoor factory use cases, reuse the evaluation methodology for InF-SL and InF-DL of TR 38.901 and in clause 6.1 of TR 38.857. |
| Huawei [2] | Proposal 3: Consider only V2X use case and commercial use case for the purpose of evaluation. |
| CATT [3] | Proposal 1: For SL positioning, evaluation is preferred to be only focused on V2X use cases and IioT use cases . |
| Vivo [4] | Proposal 3: Considering the timeline and overload of simulation for positioning, IioT use cases can be set as low priority. |
| ZTE [5] | Proposal 4: For evaluation of SL positioning, three scenarios are suggested, including highway, urban and indoor factory. |
| NEC [9] | For scenario 4 and 5 inF, the specific parameters defined in Table 6.1.1 in [5] should be used as a starting point. |
| OPPO [10] | Proposal 2: In sidelink positioning evaluation, evaluation methodologies defined in TR38.855 and TR38.857 should be the baseline for commercial and IioT use cases with following modifications:   * + Replacing channel model with sidelink channel model;   + Introducing anchor UE dropping and selection procedure. |
| Apple [13] | Proposal 3: IioT Use Case:   * Methodology: Re-use methodology in 38.855 (Study on NR positioning support Rel-16) [3] and 38.857 (Study on NR Positioning Enhancements Rel-17) [2]. * Scenarios:, IioT (InF-SH and InF-DH) with focus on FR1 * Maximum BW: 5MHz, 50MHz for 2GHz, 100MHz for 4GHz |
| CEWiT [15] | Proposal 2: For Rel 17 sidelink evaluation, reuse the simulation parameters form 38.855 and 38.857 for public safety and IioT use cases. |
| Ericsson [18] | Proposal 6 Reuse Table 6.1-1 from 38.857 for parameters for evaluations of IIOT use indoor use cases in Rel-18. For UE to UE evaluations (relative positioning / ranging), the UE model can be used at both ends of the link.   |  |  |  | | --- | --- | --- | | Scenario 4 | outdoor, IIOT | Table 6.1-1-4 from 38.855 for outdoor TRP-UE links  v2v channel models for UE to UE links  FFS: LOS condition | | Scenario 1 | Indoor, IIOT | Table 6.1-1 from 38.857 | |
| QC [19] | Proposal 17: For IioT scenarios, the Rel-17 scenarios and channel models in TR 38.857 Section 6 are reused for the purpose of Uu gNB-UE channel models. These are included for reference in the Appendix.  Proposal 18: Use TS 36.843 A.2.1.2 channel models for UE-UE Indoor to Indoor channels, with uniformly at random drop of [X] indoor Ues. FFS X. |

**FL comments:**

* IIOT use case for SL positioning evaluation in Rel-18
  + Support: Nokia, ZTE, NEC, OPPO, Apple, CEWiT, Ericsson, QC
  + Not support or low priority: Huawei, CATT, vivo,

Most companies support SL positioning for IIOT use case where InF-SH and InF-DH defined in TR 38.857 are suggested. Because indoor factory scenarios were not discussed in LTE and NR sidelink, channel model for UE-2-UE should be newly introduced.

### Round 1

**Proposal 5.1.1-1**

* + For SL positioning evaluation on IIOT use case, In-SH and InF-DH defined in TR 38.857 are used

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| **Company** | **Comments** |
| vivo | Similar to public safety and commercial use cases scenarios, we suggest In-SH and InF-DH can be as optional use cases, and no common parameters for SL link are defined, the detailed parameter is left up to each company and details should be provided |
| CATT | Support |
| Huawei, HiSilicon | Given that IIoT can already achieve sufficient high accuracy in Rel-17, we wonder the necessity of doing it again with SL, which has limited bandwidth. |
| Samsung | OK |
| **FL** | @vivo, If we support IIOT use case even as optional, it is better to align simulation assumption expecially for channel models as UE-2UE channel model for InF is not defined yet in NR and LTE.  @Huawei The new thing here is SL positioning. Rel-17 just covers Uu positioning. |
| Lenovo | We are also fine to support either the In-SH or In-DH models. |
| NEC | Support. |
| OPPO | OK |

## Channel models

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| Company | Proposals |
| ZTE [5] | |  |  | | --- | --- | | SL channel model | Modify InF-SH described in TR 38.901, i.e. replace BS with the anchor UE in the channel model of BS-2-UE, where anchor UE height, transmit power are used to replace gNB’s. | |
| Ericsson [18] | Proposal 6 Reuse Table 6.1-1 from 38.857 for parameters for evaluations of IIOT use indoor use cases in Rel-18. For UE to UE evaluations (relative positioning / ranging), the UE model can be used at both ends of the link. |

**FL comments:**

For UE-2-UE channel model, [ZTE, 5][Ericsson, 18] suggest to revise BS-2-UE channel model defined in TR 38.901. That is, replace BS parameters with the UE parameters in the channel model of BS-2-UE, e.g. UE height, antenna model, transmit power are used to replace gNB’s.

### Round 1

**Proposal 5.2.1-1**

* For SL positioning evaluation on indoor factory scenarios, BS-2-UE channel model defined in TR 38.901 is revised for UE-2-UE channel model.
  + The UE parameters in the channel model defined in 38.901, e.g. UE height, antenna model, transmit power are used to replace gNB’s corresponding parameters.

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| **Company** | **Comments** |
| Huawei, HiSilicon | We consider evaluating IIoT accuracy again low priority. |
| Samsung | OK |
| Lenovo | Support |
| NEC | OK |
| OPPO | OK |
| NTT DOCOMO | OK |

## Absolute or relative Positioning

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| **Company** | **Proposals** |
| ZTE [6] | |  |  |  | | --- | --- | --- | | Anchors selection | **For absolute positioning, all BSs and 20 anchor UEs randomly selected are used to locate target UE** | **Relative positioning is performed for two UEs within 10m** | |
| QC [19] | Proposal 19: Evaluate both sidelink-only and joint Uu/SL positioning for commercial scenarios. |

**FL comments:**

Because no RSU is deployed, how to select/deploy anchor UEs which coordinates are known should be discussed for absolute positioning. Also, how to select UE pairs for relative positioning or ranging should be discussed.

### Round 1

**Proposal 5.3.1-1**

* For SL positioning evaluation on IIOT use case, the performance metrics include absolute accuracy, relative accuracy, and ranging.
  + FFS how to select anchor UEs for absolute positioning, e.g. 20 anchor UEs are randomly deployed in the simulation area
  + FFS how to select UE pairs, e.g. relative positioning or ranging is only performed between two UEs within X m

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| **Company** | **Comments** |
| CATT | We prefer to only using ranging as performance metrics in commercial use cases, and RSU can also be used in the IIoT use cases for absolute positioning.  The updated proposal as follows,  **Updated Proposal 5.3.1-1**   * For SL positioning evaluation on IIOT use case, the performance metrics include absolute accuracy and relative accuracy~~, and ranging~~.   + FFS how to select anchor UEs/RSU for absolute positioning, e.g. 20 anchor UEs/RSU are randomly deployed in the simulation area   + FFS how to select UE pairs, e.g. relative positioning ~~or ranging~~ is only performed between two UEs within X m |
| Samsung | As we commented in Proposal 4.2.1-1, FFSs can be discussed in general for all use cases. |
| Lenovo | Support and fine with CATT’s revisions. |
| NEC | Agree |
| OPPO | OK |
| NTT DOCOMO | Agree. Anchor UE includes RSU in our understanding, for CATT’s update. |

## Others for IIOT

Companies can provide any other suggestions for evaluation on IIOT use cases if any.

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| **Company** | **Comments** |
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# Other scenarios/assumptions

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| **Company** | **Proposals** |
| Samsung [8] | Proposal 1: The following evaluation scenarios are defined for NR SL positioning studies   * Scenario 1. Out-of-coverage,   + SL positioning should be able to work in stand-alone manner   + Square model can be used and various inter-TP distance used for evaluation.   + The movement from both reference UEs and measurement UE is considered in evaluation. * Scenario 2. In-coverage,   + SL positioning can be used to assist Uu positioning.   + SL positioning can be used in stand-alone manner   + UMi/Uma/Indoor models (TR38.885) and InF-SH/InF-DH models (TS38.857) can be reused. * FFS: Specific parameters for the evaluation scenarios |
| OPPO [10] | 1. In sidelink positioning evaluation, indoor evaluation scenario should be defined for V2X use case if the evaluation for this scenario is deemed necessary. |
| Fraunhofer [16] | Proposal 1: The channel model parameter shall be selected to better cover effects typical in real-world scenarios. At least for scenarios targeting a high accuracy the ground reflection model as defined by TR38.901 shall be enabled.  Proposal 3: Include the parameters in tables 1, 2 and 3 for the common evaluations for the high accuracy, NLOS and out-of-coverage scenarios respectively. |

**FL comments:**

No proposal is suggested

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| **Company** | **Comments** |
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# Proposals for GTW

# Proposals for email endorsement