**3GPP TSG RAN WG1 Meeting #117 R1-2405362**

**Fukuoka, Japan, May 20th – 24th, 2024**

**Source: Moderator (Intel Corporation)**

**Title: Summary #2 of discussions for Rel-19 7-24 GHz Channel Modeling Validation**

**Agenda item: 9.8.1**

**Document for: Discussion**

# Introduction

In this contribution, moderator summarizes issues identified by the submitted maintanence contributions for RAN1 #117 agenda 9.8.1 regarding validation of channel models for 7 – 24 GHz. Based on the workplan presented in RAN1 #116-bis, R1-2402128, RAN1 should target the following for this meeting.

**RAN1 #117 - Objective #1:**

* Continuation of collection and identification of the potential issues for validation.
* Determination of potential criteria for channel modeling updates.
* Initial collection of measurement/simulated results and proposals for methodology updates.

# Suggested proposals for agreement/conclusion

This section will be completed by the moderator after offline discussions.

# Status summary of Proposal/TPs

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| **Proposal/TP** | **Status** | **Moderator Notes** |
| Proposal #1-1B | Discuss |  |
| Proposal #1-2A | Not agreeable in current form. |  |
| Proposal #1-3 | Modified version agreed in Tuesday session |  |
| Proposal #2-1 | Do not pursue this meeting |  |
| Proposal #2-2 | Do not pursue this meeting |  |
| Proposal #3-1 | Discuss |  |
| Proposal #3.7-1A | Discuss |  |
| Proposal #3.7-2 | Merged with #3.7-1A |  |
| Proposal #3.7-3A | Discuss |  |
| Proposal #4-1A | Discuss |  |
| Proposal #4-2A | Discuss |  |
| Proposal #4-3 | Proposal update needed |  |
| Proposal #4-4A | Discuss |  |

# Summary of issues

## 4.1 General Proposals

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| **Company** | **Proposals & Observations** |
| Interdigital [1] | **Observation 1:** Based on companies’ views, there are several aspects related to FR3 channel model that may need additional validation through further analysis or measurement campaign.  **Observation 2:** Following ITU-R WP 5D, RAN4 is to study various RF parameters related to UE and BS transmission and reception capabilities on some bands of interest, including 7.125-8.4 GHz, and 14.8-15.35 GHz. |
| vivo [9] | **Proposal 3:** RAN1 studies how to judge whether to update the channel modeling based on the experiment results from different components.    **Proposal 4:** RAN1 studies how to update the channel modeling to meet the continuity at the frequency boundary of 7GHz and 24GHz. |
| ZTE [10] | **Proposal 1:** The following methodology can be considered to evaluate the deviation between measurement results and existing results:   |  | | --- | | *Principle for deviation justification:*   * To ensure the consistency over frequency and considering the impact of previous sources over certain frequency, the new inputs should be utilized jointly with the existing results in TR 38.901 below 7 GHz and above 24 GHz to fit an updated curve from 0.5 to 100 GHz   *Procedure for model comparison for certain parameter:*   * Option-1: Direct comparison between the existing model and new results   In this way, the direct comparison between the new samples with the value range, e.g., generated by the existing model is conducted. If the new value is within the existing model, no update is needed.   * Option-2: Comparison between the existing model and new fitted model   In this way, the comparison between two models are conducted with following steps:   * + Step-1: For parameter X, generate the 1st set of samples according to the existing model in TR 38.901;   + Step-2: For parameter X, collect the 2nd set of samples according to the new measurement/simulation;   + Step-3: For parameter X, provide the new model based on both set-1 and set-2 jointly;   + Step-4: For parameter X, if the value range generated by existing model and new model obtained in Step-3 is overlapped, no update is needed. |   **Proposal 9:** RAN1 to clarify the characteristics of SMa scenario, e.g. building height, building density, BS antenna height, scenario area. |
| BUPT, Spark NZ, vivo [12] | **Proposal 1**: A criterion needs to be defined to determine if the parameters of the large-scale parameter table (Table 7.5-6) in TR38.901 need to be modified. The criteria include the effect of parameter changes on SINR, channel capacity, spectral efficiency, etc. |
| CATT [13] | **Proposal 5:** The SID can be interpreted as follows:   * “Adapt/extend as necessary” in the SID objective should be interpreted as limiting such adaptation/extensions to those that only addressing identified problems.   + Adaptation/extension includes updates that stem from validation efforts.   **Proposal 4:** SMa deployment scenario is not considered in the validation. |
| Sony [14] | Proposal 3: Channel measurement campaigns based on different kinds of sounder systems in the 7-24 GHz are welcomed, and sounding systems with fine spatial/angular and temporal resolutions are preferred.    Proposal 4: Channel measurements are encouraged to include both LOS and NLOS propagations in various scenarios, and a wide range of TX-RX separation distances are preferred (e.g., 1-100 m for indoor and 1-500 m for outdoor). |
| Nvidia [16] | **Observation 1:** Wireless channel modelling needs to provide consistency and, above all, a correct representation of the frequency, spatial, and temporal correlation across base stations, devices, and objects in the environment.  **Observation 2:** Deterministic, physics-based modelling for wireless propagation, especially ray tracing, are essential for studying, evaluating, and developing key technologies in 5G-Advanced toward 6G, including ISAC, RIS, larger antenna arrays in new spectrum such as 7-24 GHz and sub-THz bands, AI/ML, etc.  **Observation 3:** Task Group IEEE 802.11bf has embraced ray tracing based channel model for WiFi sensing.  **Observation 4:** Ray tracing simulations offer a valuable complement by providing cost-effective, controlled, and flexible tools for studying signal propagation characteristics in diverse scenarios.  **Proposal 1:** Complement field measurements with ray tracing simulations to validate the channel model of TR38.901 at least for 7-24 GHz.  A diagram of a work flow  Description automatically generated  Figure 1: Methodology of using ray tracing simulation to validate 3GPP TR 38.901 stochastic channel model.  **Proposal 2:** Consider the methodology illustrated in Figure 2 to use ray tracing simulations to validate the 3GPP TR 38.901 stochastic channel model.  **Proposal 3:** Consider the statistical modelling method with ray tracing in Recommendation ITU-R P.1411-12 as a starting point to produce simulation results for validating/updating the channel model. |
| AT&T [17] | **Observation 1:** Deployment scenarios identified to develop the channel models in 3GPP TR38901 do not include typical urban scenarios in North America.  Proposal 1: For the SI on channel models for 7-24GHz, for the validation of the channel models in TR38.901, measurements conducted by companies should be representative of the urban and sub-urban environments to which these models are applied.  **Proposal 2:** For the SI on channel models for 7-24GHz, RAN1 studies the addition of a deployment scenario that captures typical deployment scenarios outside of UMa and UMi |
| Qualcomm [18] | **Proposal 1:** RAN1 to consider introducing SMa model for 7-24 GHz, with potential extension to sub-7 GHz frequencies and using one of the following two options:   * Option 1: Use WINNER II as a starting point. * Option 2: Use UMa model in 38.901 as a starting point. |

#### Summary of Issues

Among the inputs from companies, several companies commented RAN1 needs to determine the necessity of the channel model updates. Moderator has tried to formulate some methods (in Proposal #1-1) based on proposal from ZTE and BUPT. Moderator acknowledges that further discussions may be needed, and Proposal #1-1 should be considered starting point for further discussion in this meeting.

Nvidia has provided inputs to consider ray tracing methods for validating the channel model updates. From moderator’s understanding companies are free to provide inputs that may help with validation efforts, which includes field measurements, obtaining data from synthetic ray tracing models, or even published literature. In fact, many of the channel model parameters in the existing TR38.901 were obtained from ray tracing models. Moderator assumes no explicit proposal is needed to consider ray tracing data that each company may bring to RAN1..

##### Proposal #1-1

The following methodologies are considered for evaluating necessity of channel model changes:

* Option 1: Direct channel coefficient comparison between the existing model and updated model
  + Conduct direct comparison of channel coefficient samples and/or channel coefficient statistics with legacy and updated model/parameters.
  + If the channel coefficient statistics is within value statistical ranges and of the existing model, do not consider channel model update.
* Option 2: Generated random parameter comparison between the existing model and updated model
  + Generate random large scale and fast fading parameters that will be used as input for channel coefficient generation with legacy and updated model/parameters.
  + If the output random variable statistics within value statistical ranges of the existing model, do not consider channel model update.
* Option 3: SINR (geometry) distribution comparison between existing model and updated model
  + Compute DL SINR geometry distribution with legacy and updated model/parameters.
  + DL SINR geometry can be computed based on RSRP of links (based on TR37.873), where interference is averaged over all interfering cells.
  + If the DL SINR geometry distribution is similar to existing model, do not consider channel model update.
* Other options are not precluded.
* FFS: how to assess and consider continuity at the frequency boundaries of 7 and 24 GHz.

Second issue is inclusion of new deployment scenario that cannot be addressed using existing deployment scenarios. It is noted that some companies have provided measurements for sub-urban deployment settings which seems to be quite different from UMa or RMa scenarios. Instead of updating UMa or RMa model parameters, it might be easier to simply define a new scenario. From the modeling perspective, whether new set of modeling parameters are agreed as new Uma or new RMa, or agreed as new deployment scenario called SMa may not be a big difference. With this said, defining a new SMa deployment scenario may require measurement inputs from companies to verify and complete modeling of the scenario. Moderator expects further discussion will be needed for SMa inclusion. Therefore, Proposal #1-2 should be considered as an input for initial discussion. The proposal could be revised based on further discussions.

##### Proposal #1-2

* RAN1 recognizes sub-urban deployments cannot be represented by existing deployments in TR38.901 (such as UMi, UMa, RMa).
* Consider new deployment targeting sub-urban deployments (SMa).
  + Addition of the SMa deployment scenario to the TR38.901 will be subject to availability of the measurements and completion of the deployment scenario modeling.
  + FFS: BS heights and building height distributions of SMa deployment scenario.
  + FFS: whether SMa can be applicable for frequencies beyond 7 to 24 GHz

#### 1st Round Discussion

Moderator asks companies to provide comments on proposal #1-1 and #1-2. If companies feel there are better alternatives/options to consider, please provide them and moderator will try to add them for discussion.

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| Company | Comments |
| Ericsson | Regarding proposal #1-1, there was a rather long discussion on how to evaluate the necessity of model changes in RAN1#116b. While most companies seemed to have similar ideas in principle, there was no conclusion. Therefore, we fell that it may not be very helpful to reopen this discussion again with different detailed options.  We support proposal #1-2, however we believe that the last FFS sub-bullet should be covered by the same considerations as the first sub-bullet, i.e. the availability of measurements (or previous modeling efforts such as e.g. WINNER II as pointed out by Qualcomm [18] ). |
| Sharp | We overall agree with proposal #1-1, specific details and options can be discussed further in the meeting. It is important to initiate this discussion in this meeting as companies have started providing their views on whether to update certain channel parameters based on measurements. Currently, there is no agreed upon option/method to update parameters and hence, companies have different perspective. A discussion on proposal #1-1 would be helpful for companies to provide a common perspective.  We do not completely agree with the first bulletin Proposal #1-2 right now. As a first step we should define the SMa scenario and details of deployment clearly. Companies can then in the subsequent meeting present measurements/ray tracing simulations to understand the difference between SMa and other scenarios and decide if we really want to introduce a SMa scenario. The second bullet should be discussed first, before drawing a conclusion (as presented in the first bullet). |
| QC | Support Proposal 1-1. We think this should be equally applicable to 9.8.1 and 9.8.2.  For Proposal 1-2. Generally supportive. Can we revise first sentence to read “RAN1 recognizes that a dedicated sub-urban macro scenario in 38.901 can more accurately represent existing suburban deployments in the field.” Its just a slight change in tone, and avoids showing prior efforts in 38.901 in a negative light. |
| ATT | We are ok with the direction of Proposal 1-1.  For proposal 1.2, we are supportive. We can add more parameters like ISD to the first FFS bullet. We do not think the second FFS bullet is necessary, we agree with Ericsson that this is again subject to measurements availability, as was the case for all other deployment scenarios in 38.901. |
| vivo | For Proposal #1-1, we are fine with Option 1 and 3, but not exactly sure how to choose the random parameters.  For Proposal #1-2, introducing a new deployment scenario seems to be not necessary. Current existing UMi, UMa, and RMa are enough to validate the channel model. |
| CATT | Proposal #1-1: Support.  Proposal #1-2: Not support. The SID already dictates that the validation may consider all existing scenarios: UMi, UMa, indoor-office, RMa and indoor-Factory. Therefore, SMa scenario is out of scope. BTW, this topic should be address in plenary . |
| Apple | For Proposal #1-1, we are fine with Option 1.  For Proposal #1-2, we are generally open on this scenario. Before any measurements, we need to agree on a clear definition of SMa (e.g., BS height, ISD, etc) |
| Huawei, HiSilicon | Proposal #1-1: generally fine.  Regarding the listed options, given that option 2 is essentially the same as option 1 and option 3 is rather complicated (may need extra simulation), we prefer option 1.  Proposal #1-2: not support.  We tend to abide by the SID, ‘*The validation may consider all existing scenarios*’, unless the necessity is solidly proved and recognized by the group. |
| Samsung | We are okay with proposal #1-1 in principle. However, Option 3 seems definition of metrics in calibration stage. So, we would like to ask which factor is related for evaluating necessity of channel model changes.  For proposal #1-2, we are open to discuss introducing new scenarios such as SMa. But, the description for specific difference with existing scenarios should be clarified. |
| ZTE | **Proposal #1-1:**  We are fine with defining the principle on whether to update an existing parameter or not for validation.  For Option 1, it’s not very meaningful to directly compare the final channel coefficient since it includes the impact of many parameters of phase, angle, delay and so on, even there is difference between the channel coefficient of existing and new model, it’s not clear which parameter needs updates. This option is better to directly compare the new sample results of a parameter (i.e. before fitted into a curve) with the curve (i.e. including mean and standard deviation) of the parameter of existing model.  For Option 2, we understand the intention is to compare the fitted curve based on new sample results with the curve of existing model, but it seems a bit confusing for the wording ‘Generated’, since only existing model can generate a curve of a parameter. Maybe it can be revised as “Comparison of a parameter between the curve of existing model and new fitted curve”.  For Option 3, it’s not clear what technique or simulation assumption is referred to, different antenna assumption may have different observation, what is supposed to be done if some techniques or assumptions can match but some others cannot? We think channel model discussion should be decoupled from the specific technique or antenna settings.  **Proposal #1-2:**  Although some difference regrading the channel feature, e.g., LoS probability is identified , before we conclude whether SMa scenario can be represented by existing scenarios, we still need to firstly clarify what is SMa scenario, i.e. the BS and UE antenna height, building height, building density and so on, we observe that different companies still have different understanding on the definition of SMa scenario, and it will lead to different observation on the parameters. Then, it’s valuable to have an aligned assumption on that, then we can conduct measurement/simulation to draw conclusion on how to achieve the target. |
| LGE | For Proposal #1-1: Supportive  For Proposal #1-2: Open to discuss further on SMa deployment. But as mentioned by some companies, it would be good to firstly make consensus on definition of SMa deployment. |
| Nokia | Regarding Proposal 1-1, while we don’t have any particular issue with what is provided, it is not clear how this conclusion is intended to help clarify company views on the need for channel modeling updates. Supporters of a channel modeling update will need to provide evidence that motivates the update and companies will still need to assess whether the benefit of the update justifies the additional effort in study and modeling. From that point of view, it seems that this proposal may not be necessary.  Regarding Proposal 1-2, we are generally fine with the proposal, and also with company recommendations to remove the final bullet. |

#### Summary of 1st Round Discussion & Monday Session

Moderator has updated Proposal #1-1A based on discussion from Monday session and inputs provided to the summary by companies. Moderator thinks the proposal as it stand might not be acceptable. However, moderator would like to use the proposal as material for discussion. The yellow highlights likely require some refinement.

##### Proposal #1-1A

The following are considered for evaluating necessity of channel model changes:

* Approach 1) define a methodology for systematic evaluation of whether changes are needed
  + Option 1: Direct channel coefficient comparison between the existing model and updated model
    - Conduct direct comparison of channel coefficient samples and/or channel coefficient statistics with legacy and updated model/parameters.
    - If the channel coefficient statistics is [within value statistical ranges and of the existing model], do not consider channel model update.
  + Option 2: Generated random parameter comparison between the existing model and updated model
    - Generate random large scale and fast fading parameters that will be used as input for channel coefficient generation with legacy and updated model/parameters.
    - If the output random variable statistics is [within value statistical ranges of the existing model], do not consider channel model update.
  + Option 3: SINR (geometry) distribution comparison between existing model and updated model
    - Compute DL SINR geometry distribution with legacy and updated model/parameters.
    - DL SINR geometry can be computed based on RSRP of links (based on TR37.873), where interference is averaged over all interfering cells.
    - If the DL SINR geometry distribution is similar to existing model, do not consider channel model update.
* Approach 2) ask companies to provide additional information when presenting (measurement) data
  + Option 4: proponent companies to provide information about motivation and reasons why changes to the channel model is essential. Some examples of the information are:
    - How the changes are expected to impact system operation or feature evaluation
* Other options/approaches are not precluded.
* FFS: how to assess and consider continuity at the frequency boundaries of 7 and 24 GHz.

Companies have split opinions on whether new deployment scenarios should be defined. Moderator suggests continue discussion on the following.

##### Proposal #1-2A

* Some companies provided information that ~~RAN1 recognizes~~ sub-urban deployments cannot be represented by existing deployments in TR38.901 (such as UMi, UMa, RMa).
* Consider new deployment targeting sub-urban deployments (SMa).
  + Addition of the SMa deployment scenario to the TR38.901 will be subject to availability of the measurements and completion of the deployment scenario modeling.
  + FFS: BS heights and building height distributions of SMa deployment scenario.
  + ~~FFS: whether SMa can be applicable for frequencies beyond 7 to 24 GHz~~

Proposal #1-2 not supported by: vivo, CATT, Huawei, HiSilicon, ZTE

##### Proposal #1-3

The following parameters are used as a starting point for aligning companies understanding of a potential Suburban Macro (SMa) scenario

* BS height: [22.5] m
* Layout: Hexagonal grid, 19 Macro sites, 3 sectors per site, ISD = [1732] m
* Typical building heights: [Up to two floors for residential buildings, up to five floors for commercial buildings]
* UT height: [1.5 or 4.5 m for residential buildings], [1.5/4.5/7.5/10.5/13.5 m for commercial buildings]
* UT distribution: [Uniform horizontally, 70% indoor residential users are on ground floor, 30% are on upper floor]
* FFS: ratio between residential and commercial buildings
* Indoor/Outdoor: [80% indoor and 20% outdoor, FFS on in-car users]
* LOS/NLOS: LOS and NLOS
* Min BS - UT distance(2D): [25] m

#### 2nd Round Discussion

Companies are asked to provide further comments on Proposal #1-1A and #1-2A.

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| Company | Comments |
| Ericsson | We support Approach 2 in proposal #1-1A  Regarding proposal #1-2A, we note that several companies rightly point out that the scope of validation is only the existing scenarios in 38.901. However, the scope of “adapt/extend as necessary” in the SID is obviously not limited to only existing scenarios and functionality. In RAN1#116b, the potential addition of a SMa scenario was discussed in both agenda items 9.8.1 and 9.8.2 which lead to some confusion. It would be good if it could be clarified whether discussion on potential new scenarios such as SMa as part of “adapt/extend as necessary” should be treated under 9.8.1 or 9.8.2. We have been under the assumption that such additions should be discussed in 9.8.1 but we are happy to conduct further discussions under 9.8.2 instead if this makes companies more comfortable. In any case we support proposal #1-2A.  Additionally, based on comments from many companies regarding the potential SMa scenario, we believe it would be very useful to try to agree on the general description of the SMa scenario, so that companies can prepare potential new measurements or studies. Note that this would be useful to the progress of the discussions even if in the end there is no consensus on adding a SMa scenario. We suggest the following as a starting point for these discussions, though we are very open to proposals for adjustments as long as progress towards a consensus view can be made:  **Proposal**: **The following parameters are used as a starting point for aligning companies understanding of a potential Suburban Macro (SMa) scenario**   * **BS height: [22.5] m** * **Layout: Hexagonal grid, 19 Macro sites, 3 sectors per site, ISD = [1732] m** * **Typical building heights: [Up to two floors for residential buildings, up to five floors for commercial buildings]** * **UT height: [1.5 or 4.5 m for residential buildings], [1.5/4.5/7.5/10.5/13.5 m for commercial buildings]** * **UT distribution: [Uniform horizontally, 70% indoor residential users are on ground floor, 30% are on upper floor]** * **FFS ratio between residential and commercial buildings** * **Indoor/Outdoor: [80% indoor and 20% outdoor, FFS on in-car users]** * **LOS/NLOS: LOS and NLOS** * **Min BS - UT distance(2D): [25] m** |
| ATT | For proposal#1-1A: We think approach 2 can be merged with approach 1, i.e. for approach 1, option 2, if the output random variable statistics is not within a certain statistical range of the existing model, companies are asked to provide additional information on why the model needs to be modified, and additional information on how the conclusion was reached (experiment design, modelling, etc.)  For proposal#1-2A: we strongly support introduction of a new channel model. As a north American operator, we see first-hand how the lack of representation of typical sub-urban deployments in north America in the deployment scenarios in 38.901 affect the performance evaluations of the various 5G and 5G-A features. For typical parameters for the evaluations, we are ok to start with the typical values that Ericsson provided, and these can be updated by contributions from companies. |

#### Summary of Tuesday Session

Moderator to add conclusion/agreements from Tuesday session here.

#### 3rd Round Disussion

Continue discussion for Proposal #1-1B.

##### Proposal #1-1B

The following are considered for evaluating necessity of channel model changes:

* Approach 1) define a methodology for systematic evaluation of whether changes are needed
  + Option 1: Direct channel coefficient or large/small scale parameter comparison between the existing model and updated model
    - Conduct direct comparison of channel coefficient samples and/or generated random large scale and fast fading parameters~~, and/or channel coefficient statistics~~ with legacy and updated model/parameters.
    - If the ~~channel coefficient~~ statistics is [within value statistical ranges and of the existing model], do not consider channel model update.
    - Companies to provide information on statistics and metrics used to determine whether values are within statistical ranges
  + ~~Option 2: Generated random parameter comparison between the existing model and updated model~~
    - ~~Generate random large scale and fast fading parameters that will be used as input for channel coefficient generation with legacy and updated model/parameters.~~
    - ~~If the output random variable statistics is [within value statistical ranges of the existing model], do not consider channel model update.~~
  + Option 2~~3~~: SINR (geometry) distribution comparison between existing model and updated model
    - Compute DL SINR geometry distribution with legacy and updated model/parameters.
    - DL SINR geometry can be computed based on RSRP of links (based on TR37.873), where interference is averaged over all interfering cells.
    - If the DL SINR geometry distribution is similar to existing model, do not consider channel model update.
    - Companies to provide information on measurement metrics used to determine whether values are similar to existing models
* Approach 2) ask companies to provide additional information when presenting (measurement) data
  + Option 3~~4~~: proponent companies to provide information about motivation and reasons why changes to the channel model is essential. Some examples of the information are:
    - How the changes are expected to impact system operation or feature evaluation
* Notes:
  + Other options/approaches are not precluded.
  + Multiple options may be presented by companies.
  + FFS: how to assess and consider continuity at the frequency boundaries of 7 and 24 GHz.

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| Company | Comments |
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## 4.2 Suggestions on Prioritization/De-prioritization

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| **Company** | **Proposals & Observations** |
| Interdigital [1] | **Observation 3:** The study of the Intra-cluster K factor requires more time than what is available in the SI, and further the potential required changes may have some overlap with the ongoing investigation for near-field channel model.  **Observation 4:** In the conducted measurement [10], the receive antennas were installed on a moving van having a fixed polarization. However, there is no fixed positioning of a UE in practice.  **Proposal 1:** For validation of FR3 channel modelling, prioritize the effort on RMa pathloss and UMa delay spread parameters.  **Proposal 2:** For validation of FR3 channel modelling, prioritize the effort on 7.125-8.4 GHz, and 14.8-15.35 GHz.  **Proposal 3:** RAN1 deprioritize study of Intra-cluster K factor.  **Proposal 4:** RAN1 deprioritize study of random power variability in each polarization. |
| LGE [3] | **Proposal 2:** Deprioritize following parameters for studies for channel model validation   * LOS probability * Blockage region parameters/blocker parameters * Spatial correlation for blockages * Oxygen absorption |
| ZTE [10] | **Proposal 10:** The updates of existing cluster structure is deprioritized. |
| CATT [13] | Table 1 Frequency sub-ranges and examples frequencies selection in 7 – 24 GHz range   | **Frequency sub-range** | **Frequency**  **(GHz)** | **Example frequency**  **(GHz)** | | --- | --- | --- | | 1 | 7.125 - fboundary, low | 10 | | 2 | fboundary, low - fboundary, high | 15 | | 3 | fboundary, high - 24.250 | 20 | | Note 1: fboundary, low is within the frequency range 10 - 13 GHz.  Note 2: fboundary, high is within the frequency range 16 - 18 GHz. | | |   **Proposal 1:** Prioritize for measurement of 7GHz, 10GHz and 15GHz related frequency ranges (or frequency sub-ranges) in the validation. |

#### Summary of Issues

Companies have provided several aspects for prioritization and de-prioritization. While the work on channel modeling should be driven by individual company contributions, having some prioritization or guidance can help companies focus their attention and energy to narrower set of scope.

From progressing the study item, having an explicit agreement on prioritization or de-prioritization may not be necessary at this early stage of the SI. SI progression so far seems to be generally aligned with work plans. With this said, given that companies have provided inputs, moderator has drafted set of proposals for discussions.

##### Proposal #2-1

RAN1 prioritizes discussions of the following aspects:

* RMa pathloss
* UMa delay spread
* measurement of 7.125-8.4 GHz frequencies
* measurement of 14.8-15.35 GHz frequencies
* measurement of 10GHz frequencies

##### Proposal #2-2

RAN1 de-prioritizes discussions of the following aspects:

* Intra-cluster K factor
* random power variability in each polarization
* LOS probability
* Blockage region parameters/blocker parameters
* Spatial correlation for blockages
* Oxygen absorption
* Cluster structure

#### 1st Round Discussion

Moderator asks companies to provide comments on proposal #2-1 and #2-2.

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| Company | Comments |
| Ericsson | We don’t see the need for either of these proposals. The discussion in RAN1 is driven by contributions from companies and we see no reason to prematurely limit the scope of the work beyond that of the SID. If some companies need external guidance on where to focus their future efforts, then just reading the existing contributions to RAN1#116b and RAN1#117 should give a good indication of hot topics. |
| Sharp | Do not agree with proposal #2-1. The SID clearly states that validation is for the range of 7-24 GHz and all scenarios in TR 38.901 (UMi, UMa, InH, InF, RMa). Companies have different measurement capabilities and can measurement different scenarios.  Similarly, for Proposal #2-2, we think that there is no need to restrict the parameters explicitly for now. If companies are really interested in prioritization we believe that all frequency dependent channel parameters can be validated first (but this is again contribution driven and no hard restrictions should be imposed as such). |
| QC | Can we try to work further on Proposal 2-1 without saying what is getting deprioritized? It gives companies/proponents a chance to bring more data to prove their points after the summer. Angular spread for UMa might have to be looked at closely as well. |
| ATT | While we agree based on measurements that some parameters might require closer look than others, we do not see a need for prioritization at this stage. This item is driven by the contributions and measurements of companies. |
| vivo | Support |
| CATT | Proposal #2-1: Support to prioritize discussion of the listed aspects except for RMa pathloss. RMa scenario focuses on larger and continuous coverage with lower frequency, whether RMa scenario should be focused in the validation needs further discussion.  Proposal #2-2: Support in principle. Random power variability in each polarization can be further validated, considering that variability was observed in some publications. The other parameters can be deprioritized, since they are independent of the frequencies |
| Apple | We do not agree with Proposal #2-1. For example, we do not understand why any measurement on frequency of 13 GHz or on UMa pathloss at different gNB height is deprioritized.  We are fine with Proposal #2-2 in general. |
| Huawei, HiSilicon | Proposal #2-1: we prefer to prioritize aspects that have been proved inappropriate through measurement campaigns as below:  RAN1 prioritizes discussions of the following aspects:   * Delay spread at 6-13GHz * AoD spread at 6.5/10GHz * AoA spread at 6.5/10GHz * Number of clusters at 10GHz * …   Proposal #2-1: fine. |
| Samsung | We don’t think both proposals is needed at this time. The measurement results were not submitted sufficiently yet to discuss the prioritization of channel parameters. So, we would like to suggest open to all of parameters before next RAN1 meetings (when the measurement results sharing is started). |
| ZTE | Proposal #2-1  We don’t think prioritization on specific parameter or frequency is needed, since the discuss should be contribution driven, once sufficient measurement/simulation results from companies prove that one parameter needs to revisit, we can prioritize the discussion on such parameter naturally, but at this early stage, we can keep the door open.  Proposal #2-2  Similarly, if sufficient measurement/simulation results prove that some parameters don’t need to revisit, we can directly draw a conclusion that these parameters don’t need to revisit, just like Proposal #3.7-1. |
| BUPT | Proposal #2-2  Not Support. We should not limit the diversity of study parameters upfront. We will also enumerate the impact of parameter updates on parameters such as capacity, SINR, spectral efficiency, etc. in subsequent meetings. |
| LGE | For Proposal #2-1: Different companies have different interests and capabilities for measurement and validation. Hence it seems we need more discussion to prioritize/deprioritize the specific scenario.  For Proposal #2-2: We understand that the de-prioritization should be based on measurement and studies. However, we believe some parameters, such as Oxygen absorption, Blockage region parameters/blocker parameters, and Spatial correlation for blockages, are outside the company's interest in validation. Also, if a clear consensus can be reached, it would be better to conclude directly with "Not to revisit" as suggested in #3.7-1.. |
| Spark NZ | We don’t agree with the moderator proposal to prioritise some tasks. The issue cluster structure was discussed in the scope of the SI and in this meeting R12404331 has provided measurements for Uma environment to show that inter cluster K factor models are needed to improve the ability of the 3GPP model to predict sparsity . BUPT and Spark NZ will provide further measurements and AoA and AoD distributions to provide further evidence that inter cluster K factor models are valid for other environments. |
| Nokia | We don’t feel a prioritization is necessary at this point. In our view, channel modeling updates should be proposed by contributing companies and motivated by available data. We don’t see the benefit of telling companies which aspects of focus on and what aspects they should not study, particularly at this early stage. |

#### Summary of 1st Round Discussion

Good number of companies do not feel prioritization or de-prioritization is not needed at least in this meeting.

Based on the comments received, moderator suggests not further discuss the (de)-prioritization in this meeting.

#### [DISCUSSION CLOSED]

## 4.3 Discussion on Modeling Parameters

### 4.3.1 Penetration Loss

|  |  |
| --- | --- |
| **Company** | **Proposals & Observations** |
| Sharp, NYU Wireless [2] | **Observation 1:**Our results show a close adherence of measured penetration loss to the TR 38.901 material penetration loss model for wood (RMSE =1.7 dB) [4].  **Observation 2:** Our results show a close adherence of measured penetration loss to the TR 38.901 material penetration loss model for clear glass (RMSE = 1.0 dB) [4].  **Observation 3:** Ourresults shows that IRR glass exhibit significantly higher RMSE value of 8.9 dB at both frequencies. The TR 38.901 material penetration loss model consistently underpredicts the loss for IRR glass [4].  **Observation 4:** Our results shows that concrete walls exhibit significantly higher RMSE value of 42.9 dB at both frequencies. The observed discrepancy may be attributed to the measurements characterizing penetration through an indoor cinderblock wall, which differs substantially from the thicker building exterior walls considered by the TR 38.901 model [4]***.***  **Proposal 1:** The material penetration loss model in TR 38.901 for wood and clear glass are valid in the 7-24 GHz band and no further changes are required.  **Proposal 2:** RAN1 toassess thevalidity of TR 38.901 material penetration loss model for IRR glass and concrete using additional measurements in the 7-24 GHz band. |
| vivo [9] | Table : The final measurement results of three different materials.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Material** | **Penetration loss [dB]** | **Empirical result** | **Experiment result** | **Gap** | | Standard multi-pane glass |  | 3.6dB | 1.5dB | 2.1dB | | Concrete |  | 37dB | 8.6dB | 28.4dB | | Wood |  | 5.81dB | 5dB | 0.81dB |   **Observation 3:** The gap of penetration loss between the measurement and the empirical value for wood is within an acceptable range.  **Observation 4:** The penetration loss from measurement for concrete wall and glass are smaller than the empirical value with a large gap.  **Proposal 1:** RAN1 further validates the O-to-I penetration loss, with different materials in consideration of the thickness and the density. |
| ZTE [10] | Proposal 4: No need to update the material penetration losses for the frequency range 7~24 GHz. |
| Apple [11] | **Observation 7:** At 13 GHz carrier frequency, the penetration loss of glass in TR 38.901 is aligned with our measurement results, while the penetration loss of wood and concrete in TR 38.901 is not aligned with our measurement results.   |  |  |  | | --- | --- | --- | | Material | Penetration loss by measurements (dB) | Penetration loss by TR 38.901 (dB) | | ½ inch plywood | 1 |  | | 1/8 inch glass | 4 |  | | Cinder blocks | 21 |  | |
| CATT [13] | **Observation 2:** The gap between the O-2-I penetration loss related measurement results for 7-24GHz and the model in TR38.901 is not evident. |
| Sony [14] | **Fig. 1. The measured penetration of wooden and brick materials.**    **Fig. 2. Transmission loss of window glass in Nordic countries.**  **Observation 1:**  Regarding material penetration losses:  1. The TR 38901 model on material penetration loss is valid for the 7-24 GHz range.  2. The TR 38901 model on window glass penetration loss depends on the window glass layer design. If the thickness of the glass is in order of multiple half wavelengths, it has resonant behaviours in the frequency range of 7-24 GHz. This effect needs to be considered [4, 8, 10].  Observation 2:  Regarding shadowing and body loss:   1. The UE antenna has a broad directive pattern, but not the same as an omnidirectional antenna pattern in the GHz range. To have wide coverage angles, the UE may need multiple antennas. 2. Body shadowing is obvious, and human body reflection results in more directive patterns. In free space, the body blockage loss is higher compared with the 0.3x1.7 sqm rectangular screen of TR38.901. However, as stated in [5], it shows less blockage in the multi-path environment. The blockage loss may change depending on the environment. 3. Body loss is much less compared with the Gigahertz cellular bands (below 6 GHz). At higher frequencies, the body acts more as a scatter or blockage to the EM wave. 15 and 28 GHz have similar behaviour [6,7].   Proposal 1:  The TR 38901 model on window glass penetration loss depends on the window glass layer design and detail implementations. If the thickness of the glass is in the order of multiple ½ wavelengths, it has resonant behaviors in the frequency range of 7-24 GHz. This effect needs to be considered; more measurement data are welcomed. Blockage loss depends on the distance and environment. Further study on different scenarios, including near-field effects, is recommended. |
| Qualcomm [18] | Figure Glass penetration loss measurements at 13 GHz with comparative measurements at 3.4 GHz.  **Observation 4:** Standard Glass penetration losses at 13 GHz are in line with the expected losses from the penetration loss model in TR 38.901. For IRR glass, the measurements at multiple locations with IRR glass showed smaller losses at 13 GHz than that predicted by the model. At 3.4 GHz, IRR glass loss measurements align with that of the model.  **Proposal 5:** Further study penetration losses incurred due to IRR glass in FR3.    Figure Drywall penetration loss measurements at 13 GHz with comparative measurements at 3.4 GHz.  **Observation 5:** Average drywall/wood penetration losses at 13 GHz are in line with the expected losses from the penetration loss model in TR 38.901. |

#### Summary of Issues

Companies have provided measurements for penetration loss for various materials.

Penetration loss for Drywall/Wood

* Similar to current model: Sharp/NYU Wireless, vivo, Qualcomm
* different to current model: Apple

Penetration loss for Clear glass

* Similar to current model: Sharp/NYU Wireless, Apple, Qualcomm
* different to current model: vivo (smaller), Sony (depends on thickness)

Penetration loss for IRR glass

* Similar to current model:
* Different to current model: Sharp/NYU Wireless, Qualcomm

Penetration loss for Concrete

* Similar to current model:
* Different to current model: vivo (smaller), Apple

Moderator suggests further discussions on the measurements and try to build consensus among companies on the O-to-I penetration loss modeling.

#### 1st Round Discussion

Moderator asks companies to provide comments on penetration loss aspects. Please note moderator does not have plans to conclude on the penetration loss aspects in this meeting. The original plan for the SI was to give companies time to perform survey and measurements until Q3. However, it would be good to get comments from companies to collect and summarize the potential aspects for consideration.

Based on the comments, moderator will try to formulate some summary of the current state of the discussions.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | It should be noted that the ambition with the existing penetration loss model in 38.901 was to capture some average behaviors. It should be expected that such a model can not capture resonant behavior or the range of penetration loss characteristics that occur across the vast range of building materials and building practices in the real world.  We don’t want to preclude such additions to the model, but would like to start the discussion with establishing the necessity of such changes. |
| Sharp | Discussion on proposal #1-1 should cover this as well. Companies can use proposal #1-1 as a starting point to report their observations. Thus, it’s important to have discussion on proposal #1-1 as it covers different aspects and helps in building a general understanding of when a parameter should be update/not updated. |
| CATT | Penetration loss modeling in TR 38.901 is a simplified model where the thickness of the material is not modelled. Actually, there are no typical values of the thickness in the real deployment. Some principles or metrics can be discussed to determine the necessity of the channel model updates (e.g., Proposal #1-1) |
| Apple | We need to unify the thickness of the material for the penetration loss, since we think that may impact the measurement results. |
| Moderator | Given that there are more measurement results to be provided by companies in Q3 of this year, it does not seem appropriate to try to conclude on measurements from this meeting.  However, it might good to have a summary of measurement results provided so that the available results could be reviewed and discussed further in future meetings.  Moderator has provided Proposal #3-1 to capture and list measurements information available in RAN1 #117 for further discussion. (available in section 4.3.7) |

### 4.3.2 Pathloss

|  |  |
| --- | --- |
| **Company** | **Proposals & Observations** |
| Sharp, NYU Wireless [2] | **Observation 5:** The measured pathloss values for InH-Office scenario in LOS at 6.75 GHz and 16.95 GHz generally fall below the predicted mean pathloss in TR 38.901. Furthermore, at 6.75 GHz and 16.95 GHz, 83% and 85% of the measured pathloss values fall outside the one standard deviation range around the mean pathloss predicted by TR 38.901. This indicates that TR 38.901 tends to overestimate the pathloss at 6.75 GHz and 16.95 GHz in the InH-Office scenario for LOS channel condition. The RMSE between the predicted and measured pathloss values was calculated to be approximately 6 dB and 7 dB at 6.75 GHz and 16.95 GHz, respectively.  ***Proposal 3:*** TR 38.901 overestimates the pathloss at 6.75 GHz and 16.95 GHz in the InH-Office scenario for LOS channel condition. Further investigation and potential adjustments may be required in the existing TR 38.901 InH-Office LOS pathloss model.  **Observation 6:** The measured pathloss values for InH-Office scenario in NLOS channel condition at 6.75 GHz and 16.95 GHz generally fall below the predicted mean pathloss in TR 38.901. Furthermore, at 6.75 GHz and 16.95 GHz, 50% and 30% of the measured pathloss values fall outside the one standard deviation range around the mean pathloss predicted by TR 38.901. This indicates that the TR 38.901 model tends to overestimate the pathloss at 6.75 GHz and 16.95 GHz in the InH-Office scenario for NLOS channel condition. To quantify this discrepancy, the RMSE between the predicted and measured pathloss values was calculated to be approximately 13 dB and 9.7 dB at 6.75 GHz and 16.95 GHz, respectively.  ***Proposal 4:*** TR 38.901 overestimates the pathloss at 6.75 GHz and 16.95 GHz in the InH-Office scenario for NLOS channel condition. Further investigation and potential adjustments may be required in the existing TR 38.901 InH-Office NLOS pathloss model.  **Observation 7:** The measured pathloss for InH-Office scenario in NLOS channel condition at 6.75 GHz and 16.95 GHz values generally fall below the predicted mean pathloss by TR 38.901 using the optional method. Furthermore, at 6.75 GHz and 16.95 GHz, 62% and 30% of the measured pathloss values fall outside the one standard deviation range around the mean pathloss predicted by TR 38.901. This indicates that the TR 38.901 model tends to overestimate the pathloss at 6.75 GHz and 16.95 GHz in the InH-Office scenario in NLOS channel condition using the optional method. To quantify this discrepancy, the RMSE between the predicted and measured pathloss values was calculated to be approximately 14 dB and 9.2 dB at 6.75 GHz and 16.95 GHz, respectively.  ***Proposal 5:*** TR 38.901 using the optional method overestimates the pathloss at 6.75 GHz and 16.95 GHz in the InH-Office NLOS scenario. Further investigation and potential adjustments may be required in the existing TR 38.901 InH-Office NLOS optional pathloss model. |
| Ericsson [6] | Observation 1: In a suburban residential scenario, the path loss has a 10⋅log\_10 (f) frequency dependence up to 10 GHz and a rather flat frequency dependence above 10 GHz.  Table Path loss model for a generic Suburban Macro (SMa) scenario.   | Scenario | LOS/NLOS | Pathloss [dB], *fc* is in GHz and *d* is in meters | Shadow  fading  std [dB] | Applicability range,  antenna height  default values | | --- | --- | --- | --- | --- | | SMa | LOS | TBD | TBD | TBD | | NLOS |  | TBD |   **Proposal 2:** The parameters in Table 2 may be considered as a starting point for specifying the path loss for a generic Suburban Macro (SMa) scenario, where and are FFS. |
| Nokia, Anritsu [7] | **Observation 1:** The path loss measured from an indoor factory environment exhibits very weak frequency dependency beyond the first meter of free space propagation, both in LOS and NLOS scenarios.  **Observation 2:** The current 3GPP indoor factory path loss model aligns well with the measured data (at 3.5, 11, 29 GHz) across sub-6GHz, 7-24 GHz, and mmWave frequencies.  **Observation 5:** Negligible impact of center frequency on measured path loss in an outdoor courtyard environment for both LOS and NLOS scenarios, when referenced to the first meter of free space propagation (frequency squared effect in path loss). |
| Samsung [8] | **Observation 1** The initial measurement campaign shows the general pathloss trends over frequency band when compared to frequency dependent value (20log10(fc)) of the UMa pathloss defined in 3GPP |
| vivo [9] | **Observation 1:** The pathloss gap between the measurement and the empirical formula is within the max range of 5dB under the LOS conditions in indoor scenario.  **Observation 2:** The pathloss gap between the measurement and the empirical formula is within the max range of 15dB under the NLOS conditions in indoor scenario, that can be considered under the agreeable level in between. |
| ZTE [10] | **Observation 5:** In case of LoS UEs, the pathloss of SMa scenario can well match the pathloss model of UMa in TR 38.901.  **Observation 6:** In case of NLoS UEs, the pathloss of SMa scenario is smaller than the pathloss model of UMa in TR 38.901, but the deviation range is still within the range of UMa pathloss considering the impact of shadow fading. |
| Apple [11] | **Observation 1:** The pathloss of UMa LOS scenario in TR 38.901 is aligned with our measurement results at frequency of 13 GHz.  **Observation 2:** The pathloss of UMa NLOS scenario in TR 38.901 is aligned with our measurement results without building clutter at frequency of 13 GHz.  **Observation 3:** The pathloss of UMa NLOS scenario in TR 38.901 is not well aligned with our measurement results with building clutter at frequency of 13 GHz, with the difference about 5 dB. |
| CATT [13] | **Observation 1:** In indoor-office scenario, the gap between the path loss related measurement results for 7-24GHz and the model in TR38.901 is not evident. |
| Sony [14] | **Table 4. The path loss from the Tx antenna to the Rx UE antennas at the points marked in Fig. 9.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Points | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **0** | | 3GPP TR-  38901 | 67.5dB | 76. | 90.8 | 99.3 | 105 | 108.9 | 109.7 | 105 | 96.4 | 94.1 | 88.3 | 75 | 67.3 | | Measurements | 66 | 75 | 84 | 94 | 101 | 106 | 107 | 98 | 93 | 87 | 81 | 72 | 67 |   Observation 3: The 3GPP TR38.901 path loss and power delay profile should still be valid for the frequency 7-24GHz, but more validation tests are welcomed.  Proposal 2: Further comparisons of both the large-scale and small-scale channel parameters in the 7-24 GHz band using measurements to the current channel model in TR 38.901, including but not limited to pathloss, penetration loss, delay spread, angular spread, channel sparsity, shadow fading, and correlation distances. |
| AT&T [17] | A graph of a path loss model  Description automatically generated  Omnidirectional path loss data at 15 GHz, collected by the omnidirectional receiver (as described in 3-1) over 96 LOS locations across four floors of an office building is displayed above. All collected path loss data was within the maximum measurable path loss of the channel sounding system with the omnidirectional receiver (165 dB).  The PLE of 1.5 dB/decade in LOS is consistent with the current InH LOS 3GPP SCM model PLE of 1.7 at 15 GHz [2].  A graph with blue and green dots  Description automatically generated  **Observation 2:** The indoor path loss measurements conducted at 15 GHz over 11 TX locations and 650 RX locations on floors of an office building agree well with the previously proposed 3GPP SCM path loss model in LOS and NLOS environments. Measurements at 8 GHz, 11 GHz, 15 GHz will be presented in future contributions to further validate the 3GPP SCM channel model for InH environments and outdoor environments. |
| Qualcomm [18] | A diagram of a pathlose measurement  Description automatically generated  Figure 11 Pathloss measurements from a transmitter mounted at a height of 26 meters. Measurements were made at 13 GHz.  **Observation 2:** Pathloss measurements at 13GHz in a Rural Macro setting are in line with existing pathloss models in TR 38.901. There does not appear to be a need to update the Rural Macro pathloss models currently available in TR 38.901.   |  |  | | --- | --- | | A diagram of a pathlose measurement  Description automatically generated | A diagram of a pathlose measurement  Description automatically generated |   Figure 12 Pathloss comparison between FR1 and FR3. A 12 dB difference in pathloss is observed between FR1 and FR3 --- in line with theoretical expectations.  **Observation 3:** Pathloss comparison between measurements at 13GHz and 3.4 GHz are in line with expectations. A 12 dB difference in pathloss is observed between these frequency bands.  **Proposal 3:** RAN1 to consider extending the RMa pathloss models to 7-24 GHz frequency range.  **Proposal 4:** Generalize the pathloss models for UMa in TR 38.901 to accommodate different base station heights. Pathloss model in TR 36.873 can be used as a starting point. |

#### Summary of Issues

Companies have provided measurements for pathloss for various deployment scenarios.

InH-Office LOS PL

* Similar to current model: vivo (tolerable within 5dB), CATT, AT&T
* Different to current model: Sharp/NYU Wireless (over-estimated)

InH-Office NLOS PL

* Similar to current model: vivo (tolerable within 15dB), CATT, AT&T
* Different to current model: Sharp/NYU Wireless (over-estimated)

InF LOS/NLOS PL

* Similar to current model: Nokia, Anritsu
* Different to current model:

UMa PL frequency depend factor

* Similar to current model: Samsung

UMa LOS PL

* Similar to current model: Apple (@13GHz)

UMa NLOS PL

* Similar to current model: Apple (without building clutter @13GHz)
* Different to current model: Apple (with building clutter @13GHz)

Outdoor Courtyard (?) PL

* Similar to current model: Nokia/Anritsu
* Different to current model:

RMa LOS/NLOS PL

* Similar to current model: AT&T

SMa NLOS PL

* Different to current model: Ericsson (different compared to UMa/RMa)

Moderator suggests further discussions on the measurements and try to build consensus among companies on the pathloss modeling.

#### 1st Round Discussion

Moderator asks companies to provide comments on path loss aspects. Please note moderator does not have plans to conclude on the pathloss aspects in this meeting. The original plan for the SI was to give companies time to perform survey and measurements until Q3. However, it would be good to get comments from companies to collect and summarize the potential aspects for consideration.

Based on the comments, moderator will try to formulate some summary of the current state of the discussions.

|  |  |
| --- | --- |
| Company | Comments |
| Sharp | Discussion on proposal #1-1 should cover this as well. Companies can use proposal #1-1 as a starting point to report their observations. Thus, it’s important to have discussion on proposal #1-1 as it covers different aspects and helps in building a general understanding of when a parameter should be update/not updated. |
| CATT | The gap between the measurement results of Sharp/NYU in indoor-office scenario and the model in TR38.901 is up to 10dB, and Sharp/NYU proposes to update pathloss modeling. However, other results thinks 15dB gap is tolerable. Some principles or metrics can be discussed to determine the necessity of the channel model updates. |
| Apple | For UMa NLOS PL, we may consider both the case of with building clutter and the case of without building clutter. |
| Moderator | Given that there are more measurement results to be provided by companies in Q3 of this year, it does not seem appropriate to try to conclude on measurements from this meeting.  However, it might good to have a summary of measurement results provided so that the available results could be reviewed and discussed further in future meetings.  Moderator has provided Proposal #3-1 to capture and list measurements information available in RAN1 #117 for further discussion. (in Section 4.3.7) |

### 4.3.3 Delay Spread

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| --- | --- |
| **Company** | **Proposals & Observations** |
| Sharp, NYU Wireless [2] | **Observation 8:** The delay spread predicted by TR 38.901 is valid in the 7-24 GHz frequency range for InH-Office scenario in LOS channel condition and further minor changes may be required.  **Observation 9:** Measured data in InH-Office scenario for LOS channel condition shows that standard deviation of delay spread decreases with increase in frequency. However, TR 38.901 does not capture this observed frequency dependence. Further investigation and measurements are recommended to accurately model the frequency dependency for the standard deviation of delay spread that accounts for its variation with frequency.  **Observation 10:** The mean values of delay spread predicted by TR 38.901 for InH-Office scenario in LOS channel condition shows a decrease with increase in frequency and is in close agreement with the measured values.  ***Proposal 6:*** The LOS delay spread predicted by TR 38.901 for InH-Office scenario is valid in the 7-24 GHz frequency range.  ***Proposal 7:*** Further investigation is required to model the frequency dependency of the standard deviation of delay spread in TR 38.901 for InH-Office scenario in LOS channel condition. However, the mean value of delay spread in TR 38.901 for InH-Office scenario in LOS channel condition is in close agreement with measurement data and no further changes are required.  **Observation 11:** The NLOS delay spread predicted by TR 38.901 is valid in the 7-24 GHz frequency range for InH-Office scenario and no further changes are required.  **Observation 12:** Measured data in InH-Office scenario for NLOS channel condition shows that standard deviation of delay spread increases with increase in frequency. Similarly, TR 38.901 also captures the observed frequency dependence of the delay spread standard deviation.  **Observation 13:** The mean values of NLOS delay spread predicted by TR 38.901 shows a decrease with increase in frequency and are in close agreement with the measured values.  ***Proposal 8:*** The NLOS delay spread predicted by TR 38.901 for InH-Office scenario is valid in the 7-24 GHz frequency range and no changes are required.  ***Proposal 9:*** The mean and standard deviation of delay spread for InH-Office scenario in NLOS channel condition shows close agreement with the measurement data and no further changes are required. |
| Huawei, HiSilicon [4] | Table 1 Fast fading parameters   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Scenario** | | **InH @10 GHz** | | | | **UMi @10 GHz** | | | | **UMa @6.5 GHz** | | | | | **TR 38.901** | | **Measurement** | | **TR 38.901** | | **Measurement** | | **TR 38.901** | | **Measurement** | | | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | | Delay spread (DS) lgDS=log10(DS/1s) | lgDS | -7.7 | -7.46 | -7.79 | -7.45 | -7.39 | -7.08 | -7.47 | -7.37 | -7.03 | -6.45 | -7.32 | -7.01 | | [ns] | 20 | 34.7 | 16.2 | 35.5 | 40.7 | 83.2 | 33.9 | 42.7 | 93.3 | 354.8 | 47.9 | 97.7 | | lgDS | 0.18 | 0.16 | 0.11 | 0.07 | 0.38 | 0.45 | 0.28 | 0.1 | 0.66 | 0.39 | 0.38 | 0.28 |   **Observation1:** The sparsity characteristics can be observed at least for 6-13 GHz:   * The measured DSs are smaller than that in 3GPP TR 38.901 at 6-13 GHz   **Proposal 1:** At least the following fast fading parameters require updates for 6-24 GHz frequencies:   * Delay spread (mean, variance) |
| Nokia, Anritsu [7] | A graph of a speed limit  Description automatically generated with medium confidence  Figure 8. RMS delay spread in factory LOS links.  A graph of a signal  Description automatically generated with medium confidence  Figure 9. RMS delay spread in factory NLOS links.  Observation 3: RMS delay extracted from the measured data in an indoor factory environment does not exhibit dependence on center frequency.  Observation 4: The recommend RMS delay spread suggested in 3GPP, which indicates no frequency dependence, aligns with measurements. However, the suggested RMS delay spread is larger than what is measured, possibly because 3GPP suggests more multipath components than realistic.  Proposal 1: RAN1 should further validate the RMS delay spread and the number of multipath components suggested in TR 38.901, to ascertain whether updates are necessary.  A graph of a signal  Description automatically generated with medium confidence  Figure 13. RMS delay spread in courtyard LOS links.  A graph of a line graph  Description automatically generated with medium confidence  Figure 14. RMS delay spread in courtyard NLOS links.  **Observation 6:** An increase RMS delay spread as the center frequency increases is observed in the measured data from an outdoor courtyard scenario. This is in contrast to 3GPP Umi (Urban street canyon) model, which predicts a decrease in RMS delay spread as center frequency increases.  **Proposal 2:** Study the necessarily of introducing modelling scenarios like sub-urban Macro and outdoor courtyard/parking lot. |
| ZTE [10] | DS_diffTxNum  Figure 10: Measured delay spread in Indoor scenario  Observation 2: For 7~24 GHz, the fitting curves based on the measurement results of delay/angular spread are very close to the curves given by TR 38.901 in UMi LOS/NLOS scenario.  **Observation 3:** At least at the frequency range from 6 GHz to 10 GHz, the measured DS in Indoor scenario is within the standard deviation range and exhibits similar trends as in TR 38.901.  **Observation 4:** The measurement results of large-scale parameters (e.g., DS) highly depend on the set-up for channel measurement and processing.  **Proposal 6:** No need to update delay spread and angular spread for the frequency range from 7 to 24 GHz according to the measurement results for Indoor/UMi scenario. |
| Apple [11] | A graph showing a distance  Description automatically generated with medium confidenceA graph with a line  Description automatically generated  Figure 7: Distributions of RMS delay spread in UMa LOS scenario  **Observation 4:** The mean RMS delay spread of UMa LOS scenario in TR 38.901 is not aligned with our measurement results.(13GHz, UMa)  A graph with numbers and a line  Description automatically generated  A graph with a line  Description automatically generated  Figure 8: Distributions of RMS delay spread in UMa NLOS scenario without building clutter  **Observation 5:** The mean RMS delay spread of UMa NLOS scenario in TR 38.901 is almost aligned with our measurement results without building clutter at frequency of 13 GHz.  A graph with blue dots  Description automatically generated  A graph with a line  Description automatically generated  Figure 9: Distributions of RMS delay spread in UMa NLOS scenario with building clutter  **Observation 6:** The mean RMS delay spread of UMa NLOS scenario in TR 38.901 is aligned with our measurement results with building clutter at frequency of 13 GHz. |
| CATT [13] | **Observation 3:** In indoor-office scenario, the gap between the delay spread related mean value measurement results for 7-24GHz and the model in TR38.901 is not evident.    **Observation 4:** In indoor-office scenario, the gap between the delay spread related standard deviation measurement results 7-24GHz and the model in TR38.901 cannot be ignored for. |
|  |  |

#### Summary of Issues

Companies have provided measurements for delay spread for various deployment scenarios.

InH-Office LOS DS

* Similar with current model: Sharp, NYU Wirelss (mean), Huawei, HiSilicon, ZTE, CATT (mean)
* Different from current model: Sharp, NYU Wirelss (std dev increase with freq), CATT (std dev)

InH-Office NLOS DS

* Similar with current model: Sharp, NYU Wirelss (mean, std dev), Huawei, HiSilicon, ZTE, CATT (mean)
* Different from current model: CATT (std dev)

UMi LOS DS

* Similar with current model: Huawei, HiSilicon, ZTE
* Different from current model:

UMi NLOS DS

* Similar with current model: ZTE
* Different from current model: Huawei, HiSilicon

UMa LOS DS

* Similar with current model:
* Different from current model: Huawei, HiSilicon, Apple

UMa NLOS DS

* Similar with current model: Apple
* Different from current model: Huawei, HiSilicon

InF LOS DS

* Similar with current model:
* Different from current model: Nokia, Anritsu

InF NLOS DS

* Similar with current model:
* Different from current model: Nokia, Anritsu

Moderator suggests further discussions on the measurements and try to build consensus among companies on the delay spread modeling.

#### 1st Round Discussion

Moderator asks companies to provide comments on delay spread aspects. Please note moderator does not have plans to conclude on the delay spread aspects in this meeting. The original plan for the SI was to give companies time to perform survey and measurements until Q3. However, it would be good to get comments from companies to collect and summarize the potential aspects for consideration.

Based on the comments, moderator will try to formulate some summary of the current state of the discussions.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | In our contribution R1-2402613 to the RAN1#116b meeting we provided measurements of the UMa delays spread that were very similar to the current model.  We would also like to point out that it is very important to align the antenna assumptions and method for computing the delay spread between the model and the measurements. For instance, if a directional antenna was used in the measurements, then the same antenna should be applied to the modeled channel before estimating the delay spread. Similarly, the same estimator should be used on both measured and modeled data to avoid biases. Otherwise, there is a risk that what appears to be a potential difference between measurements and the model is actually just bias introduced in the processing and analysis. |
| CATT | The delay spread modeling can be validated for UMa, UMi, indoor-office and indoor-factory scenarios. Measurement gaps exist for all these mentioned scenarios from submitted results. |
| Apple | For UMa NLOS delay spread, we may consider both the case of with building clutter and the case of without building clutter. |
| Moderator | Given that there are more measurement results to be provided by companies in Q3 of this year, it does not seem appropriate to try to conclude on measurements from this meeting.  However, it might good to have a summary of measurement results provided so that the available results could be reviewed and discussed further in future meetings.  Moderator has provided Proposal #3-1 to capture and list measurements information available in RAN1 #117 for further discussion. (in Section 4.3.7) |

### 4.3.4 Angle Distribution

|  |  |
| --- | --- |
| **Company** | **Proposals & Observations** |
| Huawei, HiSilicon [4] | Table Fast fading parameters   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Scenario** | | **InH @10 GHz** | | | | **UMi @10 GHz** | | | | **UMa @6.5 GHz** | | | | | **TR 38.901** | | **Measurement** | | **TR 38.901** | | **Measurement** | | **TR 38.901** | | **Measurement** | | | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | | AOD spread (ASD) lgASD=log10(ASD/1°) | lgASD | 1.6 | 1.62 | 1.21 | 1.27 | 1.16 | 1.29 | 1.04 | 1.14 | 1.15 | 1.41 | 0.82 | 1.26 | | [deg] | 39.8 | 41.7 | 16.2 | 18.6 | 14.5 | 19.5 | 11 | 13.8 | 14.1 | 25.7 | 6.6 | 18.2 | | lgASD | 0.18 | 0.25 | 0.18 | 0.14 | 0.41 | 0.44 | 0.2 | 0.07 | 0.28 | 0.28 | 0.28 | 0.27 | | AOA spread (ASA) lgASA=log10(ASA/1°) | lgASA | 1.58 | 1.75 | 1.29 | 1.5 | 1.65 | 1.73 | 1.19 | 1.37 | 1.81 | 1.86 | 1.67 | 1.72 | | [deg] | 38 | 56.2 | 19.5 | 31.6 | 44.7 | 53.7 | 15.5 | 23.4 | 64.6 | 72.4 | 46.8 | 52.5 | | lgASA | 0.24 | 0.18 | 0.13 | 0.23 | 0.29 | 0.35 | 0.13 | 0.08 | 0.2 | 0.11 | 0.19 | 0.15 | | ZOD spread (ZSD) lgZSD=log10(ZSD/1°) | lgZSD | 0.74 | 1.08 | 0.99 | 1.1 | 0.11 | -0.11 | 0.54 | 0.61 | 0.54 | 0.69 | 0.7 | 0.78 | | [deg] | 5.5 | 12 | 9.8 | 12.6 | 1.3 | 0.8 | 3.5 | 4.1 | 3.5 | 4.9 | 5 | 6 | | lgZSD | 0.44 | 0.36 | 0.13 | 0.12 | 0.35 | 0.35 | 0.12 | 0.09 | 0.4 | 0.49 | 0.33 | 0.34 | | ZOA spread (ZSA) lgZSA=log10(ZSA/1°) | lgZSA | 1.17 | 1.23 | N/A | N/A | 0.63 | 0.88 | N/A | N/A | 0.95 | 1.25 | 1.08 | 1.15 | | [deg] | 14.8 | 17 | N/A | N/A | 4.3 | 7.6 | N/A | N/A | 8.9 | 17.8 | 12 | 14.1 | | lgZSA | 0.22 | 0.65 | N/A | N/A | 0.3 | 0.34 | N/A | N/A | 0.16 | 0.16 | 0.17 | 0.12 |   **Observation1:** The sparsity characteristics can be observed at least for 6-13 GHz:   * The measured ASDs/ASAs are smaller than that in 3GPP TR 38.901 at 6.5/10 GHz   **Proposal 1:** At least the following fast fading parameters require updates for 6-24 GHz frequencies:   * AoD spread (mean, variance) * AoA spread (mean, variance) |
| Samsung [8] | **Observation 3** Comparing the angular power spectrum of the 6 – 7 GHz band and of the 13 – 14 GHz band, it was observed that angular region of dominant power decreases as the frequency increases.  **Proposal 2** RAN1 to study the impacts on the angular spread |
| ZTE [10] | Observation 2: For 7~24 GHz, the fitting curves based on the measurement results of delay/angular spread are very close to the curves given by TR 38.901 in UMi LOS/NLOS scenario.  **Proposal 6:** No need to update delay spread and angular spread for the frequency range from 7 to 24 GHz according to the measurement results for Indoor/UMi scenario. |
| Vodafone, Ericsson [15] | Figure 2 Vertical angular spread (ZSD) as observed at the base station  **Observation 1** The measured elevation angular spreads (ZSD) at 3.4 GHz for a very large number of communication links in an operational urban macro 5G NR network match the 38.901 UMa model.    Figure 3 Horizontal angular spread (ASD) as observed at the base station  **Observation 2** The measured azimuth angular spreads (ASD) at 3.4 GHz for a very large number of communication links in an operational urban macro 5G NR network are several times lower than predicted by the 38.901 UMa model.  Table 1 Parameters of the TR 38.901 UMa ASD model   | Scenarios | | UMa | | | | --- | --- | --- | --- | --- | | LOS | NLOS | O2I | | AOD spread (ASD)  lgASD=log10(ASD/1°) | **lgASD | 1.06 + 0.1114 log10(*fc*) | 1.5 - 0.1144 log10(*fc*) | 1.25 | | **lgASD | 0.28 | 0.28 | 0.42 | | Cluster *ASD* () in [deg] | | 5 | 2 | 5 |   Table 2 Suggested updates to the TR 38.901 UMa ASD model   | Scenarios | | UMa | | | | --- | --- | --- | --- | --- | | LOS | NLOS | O2I | | AOD spread (ASD)  lgASD=log10(ASD/1°) | **lgASD | 0.39 + 0.1114 log10(*fc*) | 0.83 - 0.1144 log10(*fc*) | 0.58 | | **lgASD | 0.4 | 0.7 | 0.7 | | Cluster *ASD* () in [deg] | | 1.5 | 1.5 | 1.5 |   **Proposal 1:** The ASD parameters for the UMa model are adjusted according to Table 2 to better represent measurements. |

#### Summary of Issues

Companies have provided measurements for angle distributions for various deployment scenarios.

InH

* Similar with current model: Huawei/HiSilicon (ZOD, ZOA), ZTE (LOS,NLOS)
* Different from current model: Huawei/HiSilicon (AOD, AOA)

UMi

* Similar with current model: Huawei/HiSilicon (ZOD, ZOA, AOD), ZTE (LOS,NLOS)
* Different from current model: Huawei/HiSilicon (AOA)

UMa

* Similar with current model: Huawei/HiSilicon (ZOD, ZOA), Vodafone/Ericsson (ZSD)
* Different from current model: Huawei, HiSilicon (AOD, AOA), Samsung (frequency dependency aspects) Vodafone, Ericsson (ASD)

Moderator suggests further discussions on the measurements and try to build consensus among companies on the angular distribution modeling.

#### 1st Round Discussion

Moderator asks companies to provide comments on angular distribution aspects. Please note moderator does not have plans to conclude on the angular distribution aspects in this meeting. The original plan for the SI was to give companies time to perform survey and measurements until Q3. However, it would be good to get comments from companies to collect and summarize the potential aspects for consideration.

Based on the comments, moderator will try to formulate some summary of the current state of the discussions.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | We would like to reiterate our comment above, that it is very important to align the antenna assumptions and method for computing the delay spread between the model and the measurements. For instance, if a directional antenna was used in the measurements, then the same antenna should be applied to the modeled channel before estimating the delay spread. Similarly, the same estimator should be used on both measured and modeled data to avoid biases. |
| Sharp | Discussion on proposal #1-1 should cover this as well. Companies can use proposal #1-1 as a starting point to report their observations. Thus, it’s important to have discussion on proposal #1-1 as it covers different aspects and helps in building a general understanding of when a parameter should be update/not updated. |
| BT | We agree with Ericsson’s comment earlier regarding alignment of the antenna assumptions with measurement setup. In addition, we would encourage companies to consider the measured and modelled properties of angular distributions per polarization to ensure spatial consistency of this aspect. |
| Samsung | As we commented in our contribution (R1-2404129), the delay/angular spread stochastics will be impacted on measurement set-up (e.g., related to EIRP) and surrounding environments. So, we prefer to discuss the possibility of updates when the measurement results are collected, sufficiently |
| Moderator | Given that there are more measurement results to be provided by companies in Q3 of this year, it does not seem appropriate to try to conclude on measurements from this meeting.  However, it might good to have a summary of measurement results provided so that the available results could be reviewed and discussed further in future meetings.  Moderator has provided Proposal #3-1 to capture and list measurements information available in RAN1 #117 for further discussion. (in Section 4.3.7) |

### 4.3.5 Clusters

|  |  |
| --- | --- |
| **Company** | **Proposals & Observations** |
| Huawei, HiSilicon [4] | Table Fast fading parameters   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Scenario** | **InH @10 GHz** | | | | **UMi @10 GHz** | | | | **UMa @6.5 GHz** | | | | | **TR 38.901** | | **Measurement** | | **TR 38.901** | | **Measurement** | | **TR 38.901** | | **Measurement** | | | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | **LOS** | **NLOS** | | Number of clusters | 15 | 19 | 10 | 11 | 12 | 19 | 5 | 7 | 12 | 20 |  |  |   **Observation1:** The sparsity characteristics can be observed at least for 6-13 GHz:   * The measured numbers of clusters are smaller than that in 3GPP TR 38.901 at 10 GHz   **Proposal 1:** At least the following fast fading parameters require updates for 6-24 GHz frequencies:   * Number of clusters |
| Ericsson [6] | Proposal 5 Encourage companies to perform measurements to further study whether the existing mechanisms for generating clusters and rays are inaccurate when simulating large antenna arrays. |
| vivo [9] | Proposal 2: RAN1 studies the impact of channel sparsity on the existing channel model based on the experiment result. |
| CATT [13] | **Observation 5:** In indoor scenario, the gap between the number of clusters measurement results for 7-24GHz and the model in TR38.901 cannot be ignored. |

#### Summary of Issues

Several companies provided inputs on cluster structure and number of cluster aspects.

InH number of clusters

* Similar to current model
* Different to current model: Huawei/HiSilcon(LOS,NLOS), CATT

UMi number of clusters

* Similar to current model
* Different to current model: Huawei/HiSilcon(LOS,NLOS)

Moderator suggests further discussions on the measurements and try to build consensus among companies on the number of cluster modeling.

#### 1st Round Discussion

Moderator asks companies to provide comments on cluster modeling aspects. Please note moderator does not have plans to conclude on the cluster modeling aspects in this meeting. The original plan for the SI was to give companies time to perform survey and measurements until Q3. However, it would be good to get comments from companies to collect and summarize the potential aspects for consideration.

Based on the comments, moderator will try to formulate some summary of the current state of the discussions.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | Same comment as we made above applies also here. If e,g, the number of clusters are estimated from measurements then exactly the same cluster estimation algorithm with the same thresholds should be applied also to model realizations. Comparing estimated clusters from measurements with nominal clusters from modeling will not give a fair comparison. |
| Sharp | Discussion on proposal #1-1 should cover this as well. Companies can use proposal #1-1 as a starting point to report their observations. Thus, it’s important to have discussion on proposal #1-1 as it covers different aspects and helps in building a general understanding of when a parameter should be update/not updated. |
| CATT | Cluster modeling can be validated, since the number of clusters in measurement results is much smaller than the model in TR 38.901. |
| BT | Similarly to our comment to 4.3.5 above, we would encourage companies to consider the consistency of cluster modelling per polarization while conducting the measurements. The rationale is to support evaluation and benchmarking of spatial multiplexing-related features for the bands in question. |
| Samsung | From our measurement contribution (R1-2404129), we could see the possibility of different cluster structures compared to existing channel model. However, as we commented in section 4.3.4 discussion, we prefer to discuss the possibility of updates when the measurement results are collected, sufficiently |
| Moderator | Given that there are more measurement results to be provided by companies in Q3 of this year, it does not seem appropriate to try to conclude on measurements from this meeting.  However, it might good to have a summary of measurement results provided so that the available results could be reviewed and discussed further in future meetings.  Moderator has provided Proposal #3-1 to capture and list measurements information available in RAN1 #117 for further discussion. (in Section 4.3.7) |

### 4.3.6 LOS Probability

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| --- | --- |
| **Company** | **Proposals & Observations** |
| Ericsson [6] | Table 3 LOS probability for a generic Suburban Macro (SMa) scenario.   |  |  | | --- | --- | | Scenario | LOS probability (distance is in meters) | | SMa |  |   **Proposal 3:** The parameters in Table 3 may be considered as a starting point for specifying the LOS probability for a generic Suburban Macro (SMa) scenario. |
| ZTE [10] | **Observation 7:** The LoS probability varies significantly with different BS antenna height:   * For the case that BS antenna height is 10m, the LoS probability of SMa scenario is more aligned with the LoS probability of UMa scenario * For the case that BS antenna height is 21m, the LoS probability of SMa scenario is much larger than the LoS probability of UMa scenario.   Proposal 3：No need to update the LOS probability since no additional BS height is required. |

#### Summary of Issues

Ericsson has provided information on LOS probability for SMa, which may have different BS and building height distribution compared to UMa and RMa settings.

Moderator suggests further discussions on the measurements and try to build consensus among companies on the LOS probability modeling for SMa.

#### 1st Round Discussion

Moderator asks companies to provide comments on LOS probability modeling for SMa.

So far other than SMa, there doesn’t seem to be any proposal to update the LOS probability. If so, it may be even possible to try to reach agreement on whether LOS probability needs to be revisited for all other deployment scenarios. Companies are asked to provide any comments regarding LOS probability modelling.

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| --- | --- |
| Company | Comments |
| Ericsson | While we provided a curve-fit to our initial LOS probability experiments we acknowledge that the probability will depend on the antenna heights and environment description and hence may need further study. Getting agreements on the Suburban scenario parameters is needed before fine-tuning the LOS experiments and concluding on the LOS probability. |
| Sharp | We do not agree with discussion at this stage. As stated earlier we need to define the SMa scenario first (range of BS and UE heights, etc) for companies to be able to clearly evaluate the LOS probability. As stated in [18] a definition of SMa is needed to further understand this new deployment scenario. |
| CATT | Support not to update LOS probability modeling. |
| Huawei, HiSilicon | Regarding SMa, we prefer to discuss the corresponding channel modeling only if the necessity is solidly proved and recognized by the group.  Regarding other deployment scenarios, fine with current LOS probability modeling. |
| Moderator | Given that there are more measurement results to be provided by companies in Q3 of this year, it does not seem appropriate to try to conclude on measurements from this meeting.  However, it might good to have a summary of measurement results provided so that the available results could be reviewed and discussed further in future meetings.  Moderator has provided Proposal #3-1 to capture and list measurements information available in RAN1 #117 for further discussion. (in Section 4.3.7) |

### 4.3.7 Other Parameters

|  |  |
| --- | --- |
| **Company** | **Proposals & Observations** |
| Intel [5] | **Proposal 1:**   * Suggest to not revisit the following parameters   + LOS probability, Shadow fading, K factor (mean, variance), LSP cross correlations, Delay scaling parameter, XPR, Cluster ASD, Cluster ASA, Cluster ZSD, Cluster ZSA, Per Cluster shadowing, Correlation distances, Correlation distance for spatial consistency, Blockage region parameters/blocker parameters, spatial correlation for blockages   + Oxygen absorption loss   + Material properties for explicit reflection modeling   **Proposal 2:**   * Suggest to not revisit the antenna modeling parameters for all existing deployment scenarios.   + FFS antenna modeling parameters for potentially new deployment scenarios. |
| ZTE [10] | **Proposal 2:** For UMi, UMa and InH-Office scenarios, no additional extension of the channel model, e.g., including new BS height, is needed.  **Proposal 5:** No need to update the shadow fading for the frequency range from 7 to 24 GHz since shadow fading effect is independent to the frequency of radio signals.  **Proposal 7:** No need to separately model foliage loss since the foliage impact has already been considered in the NLOS pathloss model.  Table 7.6.3.4-1: Correlation type among TRPs   |  |  | | --- | --- | | Parameters | Correlation type | | Delays | ~~Site-specific~~ All-correlated | | Cluster powers | Site-specific | | AOA/ZOA/AOD/ZOD offset | Site-specific | | AOA/ZOA/AOD/ZOD sign | Site-specific | | Random coupling | Site-specific | | XPR | Site-specific | | Initial random phase | Site-specific | | LOS/NLOS states | Site-specific | | Blockage (Model A) | All-correlated | | O2I penetration loss | All-correlated | | Indoor distance | All-correlated | | Indoor states | All-correlated |   **Proposal 8:** To properly model the multi-TRP case, the correlation type of delays in Table 7.6.3.4-1 should be changed from “Site-specific” to “All-correlated”. |
| CATT [13] | Table 2 Potential list of parameters in the validation   |  |  | | --- | --- | | **Parameters** | **Whether validation is needed** | | Antenna modelling parameters (e.g. radiation power patterns, directional gain values, etc.) | FFS | | Pathloss | Not needed | | LOS probability | Not needed | | O-to-I penetration loss | Not needed | | Delay spread (mean, variance) | Focus on variance | | AoD spread (mean, variance)  AoA spread (mean, variance)  ZoA spread (mean, variance)  ZoD spread (mean, variance) | FFS | | ZoD offset | FFS | | Angle distribution characteristics (e.g. exponential, Gaussian, Laplacian distributions) | FFS | | Shadow fading | Not needed | | K factor (mean, variance) | Not needed | | LSP cross correlations | FFS | | Delay scaling parameter | Not needed | | XPR | Needed | | Number of clusters | Needed | | Number of rays per cluster | FFS | | Cluster delay spread | FFS | | Cluster ASD  Cluster ASA  Cluster ZSD  Cluster ZSA | Not needed | | Per Cluster shadowing | Not needed | | Correlation distances | Not needed | | LSP correlation type (e.g. site-specific or all correlated)  Oxygen absorption  Correlation distance for spatial consistency  Blockage region parameters/blocker parameters  Spatial correlation for blockages  Material properties for ground reflector model  Spatial consistency model A/B | FFS |   **Proposal 2:** The assessment of the necessity for validation for channel model parameters in Table 2 can be considered. |

#### Summary of Issues

There are number of various proposal from companies. Moderator does not believe the proposals are mature and stable enough for agreement. However, moderator would like to list the proposals so that discussion could be made for the proposals.

##### Proposal #3.7-1

* RAN1 to not revisit the following parameters
  + ~~LOS probability,~~ Shadow fading, K factor (mean, variance), LSP cross correlations, Delay scaling parameter, ~~XPR,~~ Cluster ASD, Cluster ASA, Cluster ZSD, Cluster ZSA, Per Cluster shadowing, Correlation distances, Correlation distance for spatial consistency, Blockage region parameters/blocker parameters, spatial correlation for blockages, foliage loss
  + Oxygen absorption loss
  + Material properties for explicit reflection modeling

##### Proposal #3.7-2

* RAN1 to not revisit the antenna modeling parameters for all existing deployment scenarios.
  + FFS antenna modeling parameters for potentially new deployment scenarios.

##### Proposal #3.7-3

* RAN1 to update the correlation type of the delay from site-specific to all correlated

|  |  |
| --- | --- |
| Parameters | Correlation type |
| Delays | ~~Site-specific~~ All-correlated |

#### 1st Round Discussion

Moderator asks companies to provide comments on proposal #3.7-1, #3.7-2, and #3.7-3.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | We agree with the moderator that these proposals are premature. |
| Sharp | Okay to support all the above proposals. |
| CATT | Proposal #3.7-1: Support.  Proposal #3.7-2: Support in principle. FFS related bullet can be removed, since new deployment scenarios are out of scope.  Proposal #3.7-3: We are open to discuss this issue. However, we need to first discuss how/whether mobility is supported.  In general, we are fine to discuss these at later stages. |
| Apple | Will the proposal #3.7-1 apply for SMa scenario? It may be clarified. |
| BT | Our view is that the updates to 38.901 (if any) should enhance the representativeness of the model when applied to evaluation of standardized features in the new bands. With that in mind, exclusion a set of parameters for a potential revision might be premature. |
| ZTE | Proposal #3.7-1  We are generally fine, but suggest to modify the main bullet a bit:   * RAN1 to not revisit the following parameters for all existing deployment scenarios.   Proposal #3.7-2: We are open to discuss the antenna assumption at UE side to reflect the reality, which is also related to the discussion in proposal 4-4.  Proposal #3.7-3: Support |
| LGE | For Proposal #3.7-1: As we commented in section 4.2, we are supportive with concluding not to revisit some parameters if RAN1 can make clear consensus.  For Proposal #3.7-2: Supportive.  For Proposal #3.7-3: Open to discuss further. |

#### Summary of 1st Round Discussion

Moderator has soften the language for Proposal #3.7-1 and updated as Proposal #3.7-1A. The contents of the proposal #3.7-2 has been merged into Proposal #3.7-1A as well.

Proposal #3.7-3 has been updated to #3.7-3A with soften language.

##### Proposal #3.7-1A

* RAN1 to further study whether the following parameters for all existing deployment scenarios can be concluded to be not updated as part of the SI:
  + Parameters that do not currently have frequency dependency:
    - ~~LOS probability,~~ Shadow fading, K factor (mean, variance), LSP cross correlations, Delay scaling parameter, ~~XPR,~~ Cluster ASD, Cluster ASA, Cluster ZSD, Cluster ZSA, Per Cluster shadowing, Correlation distances, Correlation distance for spatial consistency, Blockage region parameters/blocker parameters, spatial correlation for blockages, foliage loss
    - Material properties for explicit reflection modeling
    - antenna modeling parameters
  + Parameters that have frequency dependency:
    - Oxygen absorption loss

##### Proposal #3.7-3A

* RAN1 to further study whether ~~RAN1 to update the~~ correlation type of the delay can be changed from site-specific to all-correlated type

|  |  |
| --- | --- |
| Parameters | Correlation type |
| Delays | ~~Site-specific~~ All-correlated |

#### 2nd Round Discussion

Please provide further comments on Proposal #3.7-1A and #3.7-3A.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | With the softened language in the updated proposals the proposals seem quite uncontroversial, so we can support both #3.7-1A and #3.7-3A. |
| Moderator | Added Proposal #3-1 to capture inputs received in RAN1 #117 that should be further discussed in next RAN1 meeting. |

#### 3rd Round Discussion

Moderator asks companies to provide inputs/comments for Proposal #3-1, #3.7-1A, and #3.7-3A.

##### Proposal #3-1

Companies are encouraged to check and review the following results and measurement data provided in RAN1 #117 for further discussion in next RAN1 meeting. R1-240xxxx contains the list of data sources for the results and measurements provided in RAN1 #117.

* measurements for penetration loss for various materials, including drywall/wood, clear glass, IRR glass, and concrete
* measurements for pathloss for following scenarios: InH\_office LOS, InH-Office NLOS, InF LOS, InF NLOS, UMa LOS, UMa NLOS, Outdoor courtyard, RMa LOS, RMA NLOS, SMa NLOS
* measurements for DS for following scenarios: InH-Office LOS, InH-Office NLOS, UMi LOS, UMI NLOS, UMa LOS, UMa NLOS, InF LOS, Inf NLOS.
* Measurements for angular distributions, such as ZOD, ZOA, AOD, AOA for following scenarios: InH, UMi, UMa
* Measurements for number of clusters for following scenarios: InH, UMi
* Measurements for LOS probability for SMa deployment scenario

|  |  |
| --- | --- |
| Company | Comments |
|  |  |

## 4.4 Other Modeling Aspects

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| --- | --- |
| **Company** | **Proposals & Observations** |
| Intel [5] | **Proposal 3:**   * RAN1 to consider correcting the angle handling for MIMO simulation extension for CDL as part of the 7 – 24 GHz channel model validation SI. |
| Ericsson [6] | Table 1: Evaluation parameters for Suburban Macro (SMa).   |  |  | | --- | --- | | Parameters | Sma | | BS height | [22.5] m | | Layout | Hexagonal grid, 19 Macro sites, 3 sectors per site, ISD = [1732] m | | Typical building heights | [Up to two floors for residential buildings, up to five floors for commercial buildings] | | UT height | [1.5 or 4.5 m for residential buildings]  [1.5/4.5/7.5/10.5/13.5 m for commercial buildings] | | UT distribution | [Uniform horizontally, 70% indoor residential users are on ground floor, 30% are on upper floor]  FFS ratio between residential and commercial buildings | | Indoor/Outdoor | [80% indoor and 20% outdoor, FFS on in-car users] | | LOS/NLOS | LOS and NLOS | | Min BS – UT distance(2D) | [25] m |     **Proposal 1:** The parameters in Table 1 may be considered as a starting point for specifying a generic Suburban Macro (Sma) scenario.  **Observation 2**: In the TR 38.901 model, the two co-polar components in the channel always have exactly equal power, and the two cross-polar components are equally attenuated according to a stochastic XPR.  **Observation 3** Measurements show a slow variability around the mean co-polar and cross-polar power that is independent between different components.  **Proposal 4** Introduce a random variability of the co- and cross polar powers in the TR 38.901 model, such as an i.i.d zero-mean Gaussian with 3 dB standard deviation, via the following changes to step 9 and eqs (7.5-22) and (7.5-28) in clause 7.5 in TR 38.901.  --  Step 9: Generate the cross polarization power ratios  Generate the cross polarization power ratios (XPR) **for each ray *m* of each cluster *n*. XPR is log-Normal distributed. Draw XPR values as  , (7.5-21)  where  is Gaussian distributed with and  from Table 7.5-6.  Note:  is independently drawn for each ray and each cluster.  Generate polarization variability powers , , and for each ray *m* of each cluster *n*. is log-Normal distributed. Draw values as  , (7.5-21b)  where is Gaussian distributed. Note that is independently drawn for each ray, cluster, and polarization component.  --    (7.5-22)  --  (7.5-28)  -- |
| BUPT, Spark NZ, vivo [12] | **Proposal 2:** The intra-cluster K factor will be modelled based on the measured results and its frequency-dependent properties should be investigated. It is recommended that intra-cluster K factor could be considered in TR38.901 to make modeling results more accurate.  **Proposal 3:** The number of clusters and paths in 3GPP TR 38.901 should be updated and their frequency dependence should be taken into account. |
| CATT [13] | **Proposal 3:** Random power variability in each polarization can be further validated and then modelled for 7 – 24GHz. |
| Qualcomm [18] | **Observation 1:** Ground reflection model in 38.901 offers a mode to realize polarization power imbalance in the channel realizations. Whether additional other factors such as specular reflections cause polarization power imbalance needs more study.  **Proposal 2:** For more realistic UE antenna modeling, RAN1 to consider the following aspects:   * UE antenna placement   + E.g. placement along edges of a rectangle reflecting UE form factor. * UE antenna orientation   + E.g. randomize UE antenna orientation * Antenna radiation pattern   + E.g. consider more realistic antenna patterns, including a phase component   + Potential reuse the parabolic pattern * Antenna imbalance |

#### Summary of Issues

There are number of various proposals on other modeling aspects from companies. Moderator does not believe the proposals are mature and stable enough for agreement. However, moderator would like to list the proposal so that discussion could be made for the proposals.

##### Proposal #4-1

* RAN1 to consider correcting the angle handling for MIMO simulation extension for CDL as part of the 7 – 24 GHz channel model validation SI.

##### Proposal #4-2

* Introduce a random variability of the co- and cross polar powers in the TR 38.901 model, such as an i.i.d. zero-mean Gaussian with 3 dB standard deviation, via changes to step 9 and eqs (7.5-22) and (7.5-28) in clause 7.5 in TR 38.901.

##### Proposal #4-3

* Introduce intra-cluster K factor to the TR38.901 models
  + FFS: which deployment scenarios the parameter will be introduced for

##### Proposal #4-4

* RAN1 to consider following UE antenna modelling aspects:
  + UE antenna placement, e.g. placement along edges of a rectangle reflecting UE form factor,
  + ~~UE antenna orientation, e.g. randomize UE antenna orientation,~~
  + Antenna radiation pattern, e.g. consider more realistic antenna patterns, including a phase component, potential reuse the parabolic pattern,
  + Antenna imbalance.

#### 1st Round Discussion

Moderator asks companies to provide comments on proposal #4-1, #4-2, #4-3, and #4-4.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | We support proposals #4-1 and #4-2.  More measurements and analysis, including of the necessity of model changes, are needed before progressing further on proposal #4-3.  We agree that all of the listed antenna characteristics may be more realistic for UE antenna modeling. However, it should be noted that the antenna modeling in clause 7.3 of 38.901 is only captured for calibration purposes. Other study or work items in 3GPP that may utilize 38.901 are therefore free to agree other antenna models as part of their respective evaluation assumptions. Therefore we do not believe that this proposal is needed. |
| Sharp | Support proposal #4-1 and proposal #4-4. Further investigation is needed for proposal #4-2 and #4-3. Hence, we do not agree with proposal #4-2 and #4-3 at this stage. |
| QC | We are open to looking at all 4 issues closely. For us, from a UE vendor perspective, we think improving the basics of UE antenna modelling is a rather important consideration. We hope other companies can give it more thought.  We wonder why the orientation aspect has been crossed out --- we intended that to capture the fact that the different antennas at the UE can all have different orientations. It is a rather important consideration.  For 4-2 and 4-3 more measurement data is required before introducing any changes. 4-3 in particular would be a big change and we would like to look be a bit more careful. For 4-1, the issue is understood, but as discussed earlier a straightforward resolution does not seem possible. One option would be to refocus our attention from AS\_desired and AS\_model to AS\_range\_desired and AS\_range\_model where the focus shifts to the range (based on max and min angles) and a simple scaling should work. This also has the added benefit of providing a lot more engineering intuition to hw to use this scaling. |
| Vivo | Several companies addressed the issue on the number of clusters defined in TR38.901. According to our investigation, two phenomena are indicated by some companies and universities in the last meeting. One is the number of clusters or rays in the channel varies in the different frequency bands. Particularly in the medium or high frequency, this number decreases significantly. The other is the power among the rays in the same cluster is lopsided rather than uniform allocated once the frequency increases. Most of the power is biased on several dominant rays, due to the channel sparsity. Therefore, the proposal capturing such an issue should be considered. |
| CATT | Proposal #3.7-1: Correcting the angle handling for MIMO simulation extension for CDL can be considered after validation works are finished.  Proposal #3.7-2: Support.  Proposal #3.7-3: Intra-cluster K factor modeling depends on cluster modeling. We prefer to discuss this proposal after the cluster modeling.  Proposal #3.7-4: open to discuss. |
| ZTE | For Proposal #4-3, it’s a fundamental change on the 901 channel model structure, if the ray power is changed from equal distribution to unequal distribution with intra-cluster K factor, the ray angles should also be changed accordingly, then the definition of cluster/ray would also be different from previous. So, unless there is clear justification that current 901 channel model cannot work, we prefer to not modify the cluster structure. |
| Nokia | In general we are supportive of further study on all 4 proposals, but feel it is too early commit to their introduction at this point. |

#### Summary of 1st Round Discussion

Moderator has updated Proposal #4-1, #4-2, and #4-4 to soften the language a bit. Proposal #4-2A is similar to agreement made in last RAN1 meeting. However, it provides further level of details of the changes being asked to be introduced and therefore moderator think even a study could be potentially valuable.

For proposal #4-3, if the proposal is changed to study, then there is no material difference compared to agreement from previous meeting. **Moderator asks proponents of Proposal #4-3 to provide some high level details of the changes of the intra-cluster K.** Once provided, moderator will formulate the suggestion into a proposal for further study.

For proposal #4-4A, UE antenna orientation was removed by moderator. Moderator assume UE antenna orientation is left up to evaluations and the channel model does not seem to limit how UE antenna are orientated. Therefore, was not sure what aspect need to be further studied. **If the proponents could clarify what aspects of the orientation that need to be studied, then moderator can update the description and update the proposal.**

##### Proposal #4-1A

* RAN1 to study further on ~~consider~~ correcting the angle handling for MIMO simulation extension for CDL as part of the 7 – 24 GHz channel model validation SI.

##### Proposal #4-2A

* RAN1 to study to introduce a random variability of the co- and cross polar powers in the TR 38.901 model, such as an i.i.d. zero-mean Gaussian with 3 dB standard deviation, via changes to step 9 and eq (7.5-22) and (7.5-28) in clause 7.5 in TR 38.901.

##### Proposal #4-4A

* RAN1 to study ~~consider~~ following UE antenna modelling aspects:
  + UE antenna placement, e.g. placement along edges of a rectangle reflecting UE form factor,
  + ~~UE antenna orientation, e.g. randomize UE antenna orientation,~~
  + Antenna radiation pattern, e.g. consider more realistic antenna patterns, including a phase component, potential reuse the parabolic pattern,
  + Antenna imbalance.

#### 2nd/3rd Round Discussion

Please provide further comments on Proposal #4-1A, #4-2A, and #4-4A.

For Proposal #4-3, moderator asks proponents to provide further details of the intra-cluster K value modeling that could be described for further study.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | With the softened language in the updated proposals #4-1A and #4-2A the proposals seem quite uncontroversial, so we can support both #4-1A and #4-2A.  Regarding #4-4A, we reiterate our comment above: We agree that all of the listed antenna characteristics may be more realistic for UE antenna modeling. However, it should be noted that the antenna modeling in clause 7.3 of 38.901 is only captured for calibration purposes. Other study or work items in 3GPP that may utilize 38.901 are therefore free to agree other antenna models as part of their respective evaluation assumptions. Therefore, we do not believe that this proposal is needed. |
| Ericsson | In addition to the present proposals, if the FL agrees we would suggest a discussion on the following proposal based on the joint contribution [15] from Vodafone and Ericsson:  **Proposal: RAN1 to study whether the UMa NLOS ASD parameters **lgASD, **lgASD, and *cASD* should be modified** |

## 4.5 Capturing measurement data

Companies are asked to provide inputs to the data source collection based on the template provided in R1-2403969.

Each company may update the excel sheet in ftp://tsg\_ran/WG1\_RL1/TSGR1\_117/Inbox/drafts/9.8(FS\_NR\_7\_24GHz\_CHmod)/source data collection

Moderator will time to time clean up the excel sheet updates and ask companies to clarify information. The following table will be used to request updates or clarifications to the companies. Company do not need to fill in the table unless there is a request from the moderator.

#### Data Source Update Discussion

|  |  |  |  |
| --- | --- | --- | --- |
| **Data Entry Row** | **Company** | **Moderator Comment/Request for Update/Clarification** | **Company Response** |
|  |  |  |  |
|  |  |  |  |

# Summary of Agreements/Conclusions from RAN1 #117

To be filled by moderator.

# Reference

1. R1-2403856, “Discussion on Channel Model Validation of TR38.901 for FR3,” InterDigital, Inc.
2. R1-2405339, “Views on Channel model validation of TR38.901 for 7-24GHz,” SHARP
3. R1-2403907, “Discussion on channel model validation of TR38.901 for 7-24GHz,” LG Electronics
4. R1-2403925, “Considerations on the 7-24GHz channel model validation,” Huawei, HiSilicon
5. R1-2403962, “Discussion on channel modeling verification for 7-24 GHz,” Intel Corporation
6. R1-2403991, “Discussion on validation of channel model,” Ericsson
7. R1-2403996, “Discussion on Channel model validation of TR38.901 for 7-24GHz,” Nokia, Anritsu
8. R1-2404129, “Discussion on channel model validation of TR38.901 for 7 - 24 GHz,” Samsung
9. R1-2404191, “Views on channel model validation of TR38.901 for 7-24GHz,” vivo
10. R1-2404212, “Discussion on the channel model validation,” ZTE
11. R1-2404304, “Initial Measurement Results for Channel Model Validation,” Apple
12. R1-2404331, “Discussion on channel model validation of TR38.901 for 7-24GHz,” BUPT, Spark NZ Ltd, vivo
13. R1-2404415, “On channel model validation of TR38.901 for 7-24GHz,” CATT
14. R1-2404514, “Discussion on channel model validation of TR38.901 for 7-24GHz,” Sony
15. R1-2404521, “Discussion on validation of channel model,” Vodafone, Ericsson
16. R1-2404543, “Channel model validation of TR 38901 for 7-24 GHz,” NVIDIA
17. R1-2404925, “Discussion on Validation of the Channel Model in 38901,” AT&T
18. R1-2405169, “Channel Model Validation of TR38.901 for 7-24 GHz,” Qualcomm Incorporated

# Appendix A: RAN1 Agreements

## RAN1 #116-bis (April-2023)

**Conclusion**

* To provide measurement data, and/or simulation results, and/or available publications with measurement information for frequencies 7 to 24 GHz to validate/update the channel model.
* For frequency continuity of the channel models, Measurement information outside 7 to 24 GHz is also encouraged

**Agreement**

The following provides list of modelling parameters for 7 – 24 GHz frequencies that could be further studied for validation. The parameters listed are starting point for further discussions and does not imply the parameters require validation nor imply parameters require updates for 7 – 24 GHz frequencies.

* Antenna modelling parameters (e.g. radiation power patterns, directional gain values, etc.)
* Pathloss
* LOS probability
* O-to-I penetration loss
* Delay spread (mean, variance)
* AoD spread (mean, variance)
* AoA spread (mean, variance)
* ZoA spread (mean, variance)
* ZoD spread (mean, variance)
* ZoD offset
* Angle distribution characteristics (e.g. exponential, Gaussian, Laplacian distributions)
* Shadow fading
* K factor (mean, variance)
* LSP cross correlations
* Delay scaling parameter
* XPR
* Number of clusters
* Number of rays per cluster
* Cluster delay spread
* Cluster ASD
* Cluster ASA
* Cluster ZSD
* Cluster ZSA
* Per Cluster shadowing
* Correlation distances
* LSP correlation type (e.g. site-specific or all correlated)
* Oxygen absorption
* Correlation distance for spatial consistency
* Blockage region parameters/blocker parameters
* Spatial correlation for blockages
* Material properties for ground reflector model
* Spatial consistency model A/B

**Conclusion**

RAN1 to continue discussion on the need for new modelling parameters/scenarios and modelling procedure. The following modelling parameters/aspects for 7 – 24 GHz frequencies that are currently not available in TR38.901 have been identified by companies in RAN1#116bis. At least the following is for further study, but does not imply parameters/scenarios and modelling procedure are required for 7 – 24 GHz frequencies.

* Intra-cluster K factor
* Random power variability in each polarization
* Addition of SMa deployment scenario

**Conclusion**

* RAN1 to compile measurement/simulation descriptions from companies into a Tdoc to be added as reference to TR38.901.
  + Rapporteur to update the Tdoc in each meeting based on inputs from companies.
* Rapporteurs to provide a template for the measurement/simulation descriptions capture to RAN1 #117 for initial review and endorsement.