**3GPP TSG RAN WG1 Meeting #102-e R1-200xxxx**

**E-meeting, August 17– 28, 2020**

**Source: Moderator (vivo)**

**Title: Discussion summary #2 of [102-e-NR-52-71-Evaluations]**

**Agenda item: 8.2.3**

**Document for:** [Status]

# Introduction

In this contribution, we summarize issues regarding evaluation assumptions and parameters in the Study Item (SI) of supporting NR from 52.6 GHz to 71 GHz for the following email discussion in RAN1 #102-e.

[102-e-NR-52-71-Evaluations] Email discussion/approval on link and system level evaluation assumptions, scenarios and results until 8/20; address any remaining aspects by 8/26 – Huaming (vivo)

Section 2 contains the summary of issues on evaluation assumptions and simulation parameters based on the submitted contributions from agenda 8.2.3 (with several other contributions discussing evaluation related aspects from agenda 8.2.1 and 8.2.2 as well). Section 3 contains some proposed templates for companies to use in the future to report their evaluation results.

# Remaining issues of evaluation assumptions & parameters

In this section, we provide a summary of remaining issues of evaluation assumptions and simulation parameters discussed in the submitted contributions.

## 2.1. Link Level Simulation

### Subcarrier spacing and number of RBs

Table 1. LLS Parameter Set 1

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| **Parameter**  **Set 1** | **Evaluation Objectives** | **Carrier Frequency [GHz]** | **Subcarrier Spacing [kHz]** | **Bandwidth [MHz]** | **Number of RB** | **Waveform** |
| **Description** | Primary Objective:  - Evaluation of PDSCH/PUSCH performance including study of phase noise impairment impact for various numerology (i.e. subcarrier spacing, CP length) and possibly for various carrier frequencies.  Evaluation KPI(s) include BLER.  Secondary Objective:  - Evaluation of SSB/PRACH performance including study of phase noise impairment impact for various numerology (i.e. subcarrier spacing, CP length) and possibly for various carrier frequencies.  Evaluation KPI(s) include miss-detection, false alarm. | 60 GHz    Optional: 70 GHz | PDSCH/PUSCH:  - {120, 240, 480, 960} kHz  - FFS: 1920 kHz  Optional:  - if evaluated companies are asked to provide information on other channels/signals and subcarrier spacing | PDSCH/PUSCH:  - {400, 2000} MHz    Optional:  - Companies are asked to provide information if other bandwidths are evaluated  Note: Evaluation of listed channel bandwidth does not mean RAN1 has agreed to support such channel bandwidth and are only for evaluation purposes to obtain useful insights. | For 400 MHz:  - 256 (120 kHz),  - 128 (240 kHz),  - 64 (480 kHz),  - 32 (960 kHz),  - N/A (1920 kHz)  For 2000 MHz:  - N/A (120 kHz),  - N/A (240 kHz),  - FFS (480 kHz),  - 160 (960 kHz),  - 80 (1920 kHz),    For other channel bandwidths:  - Companies are asked to provide information. Companies are encouraged to utilize linearly scaled PRB sizes for a given bandwidth based on above. | For PDSCH:  CP-OFDM  For PUSCH:  CP-OFDM and DFT-s-OFDM |

The above table was agreed in last RAN1 meeting with FFS on 1920 KHz subcarrier spacing and the number of RBs for 480 KHz subcarrier spacing for 2000 MHz channel bandwidth.

It is proposed in [[60], Intel] to add 1920 kHz subcarrier spacing to the subcarrier spacing list for LLS assumptions and to add 320 PRB for 480 kHz subcarrier spacing for 2000 MHz bandwidth with the motivation to gain useful insights on performance. It is further noted these additions to the list are for evaluation purpose only.

On the same topic, it is proposed in [[63], Samsung] to put 1920 kHz SCS as secondary study point, and it is needed only when 960 kHz is not sufficient. It is also proposed no need to further study using 480 kHz SCS for 2000 MHz carrier bandwidth for the concern of the required FFT size would exceed the supported maximum FFT size in Rel-15.

Moderator’s comment:

With the understanding that the list of subcarrier spacing, bandwidth and number of RBs are for evaluation purpose only, having 1920 KHz subcarrier spacing and 320 PRB for 480 kHz subcarrier spacing for 2000 MHz bandwidth as optional in the LLS assumption/parameter list will allow interested companies to evaluate these configurations.

Proposal #1 for discussion:

* For link level evaluation purpose, keep 1920 KHz subcarrier spacing as optional in Table 1.
* For link level evaluation purpose, keep 320 PRB for 480 kHz subcarrier spacing for 2000 MHz bandwidth as optional in Table 1.

Companies are encouraged to provide comments if any.

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| Company Name | Comments/Views |
| NTT DOCOMO | We support both of above as optional. |
| Intel | Agree with Moderator suggestion |
| vivo | Support moderator’s proposal |
| InterDigital | Support Moderator’s proposal |
| Nokia | Agree on proposal |
| Futurewei | We note that under the current limit of 275 PRBs, 480 kHz SCS will allow to operate a 2GHz (1.966 GHz) channel with 79.2% (80.5%) OCB.  We are OK with moderator’s proposal. |
| Ericsson | Support Moderator's proposal.  In order to cover more possibilities for bandwidth (other than just 400 and 2000 MHz), it is beneficial to include 256 PRBs for SCS >= 120 kHz as well. Since it is important to select SCS and BW together, these additional values would allow comparison and selection amongst several viable candidates. |
| Huawei, HiSilicon | We do not think it is necessary to evaluate 1920 kHz. It is shown that 120/240kHz SCS works well with ICI compensation and 960kHz SCS can achieve more than 2GHz channel bandwidth. There is no strong motivation to introduce 1920kHz SCS.  As for the 320 PRB for 480 kHz SCS for 2GHz, it should be N/A from our perspective. We agree with no increase of FFT size beyond 4096 even for the evaluations. The spectrum utilization for such combination is not technically feasible. |
| Samsung | We are OK with the proposal |
| Qualcomm | We support the Moderator’s proposal. |

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| LG Electronics | Although we have the same view with Huawei, we are ok to keep them as optional for evaluation purpose only, if majority companies support. |
| ZTE, Sanechips | Support Moderator’s proposal. |
| Charter | With 480kHz SCS and 1.966 GHz bandwidth a configuration with 320 PRBs will lead to OCB of approx.. 94%, with approx.. 255 unused SCs. While [[61] Ericsson] argues that 960 kHz SCS is redundant.  We are open to both as optional |
| Lenovo/Motorola Mobility | We do not support proposal #1. Based on our LLS evaluations, we do not see any significant performance gain with 1920kHz SCS in comparison to lower SCS values such as 480kHz and 960kHz.  In general, we already have quite extensive set of simulation parameters and we think we should aim to remove unessential parameters. |
| Apple | We also do not think it is necessary to evaluate 1920 kHz but are okay with keeping it as optional. |

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| Moderator | Seems proposal #1 is agreeable to most companies other than Huawei and Lenovo.  In response to Ericsson’s comment:  I believe notes of “Optional:- Companies are asked to provide information if other bandwidths are evaluated” in Bandwidth column and “For other channel bandwidths:- Companies are asked to provide information.” allow more possibilities for bandwidth and RB allocation.  In response to Huawei’s comment:  Whether it is necessary or not to evaluate 1920 kHz and/or 320 PRB for 480 kHz subcarrier spacing for 2000 MHz is subject to each company as different companies have different opinion. They are proposed to be optional choices.  The proposal clear says for link level evaluation purpose only. Debate on whether there’s strong motivation or feasibility to specify them can happen in other agenda.  In response to Lenovo’s comment:  The comparison of 1920 KHz SCS compared to other SCS and determination of whether significant gain or not is obtained after the evaluation. Again, proposal #1 is list optional values for LLS purpose only. |

Outcome of discussion on this topic:

The following agreement was made in online session on 8/20.

Agreement:

* For link level evaluation purpose, keep 1920 KHz subcarrier spacing as optional in Table 1.
* For link level evaluation purpose, keep 320 PRB for 480 kHz subcarrier spacing for 2000 MHz bandwidth as optional in Table 1.
  + Note: A BW of 2 GHz can be achieved with a smaller number of PRBs
* Add to the note in the number of RBs column: “Other BW and sub-carrier spacing combinations can be optionally used.”

### (High priority) Channel model

Table 2. LLS Parameter Set 2

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| **Parameter**  **Set 2** | **CP Type** | **Channel Model** | **Antenna Configuration (Mg,Ng,M,N,P)** | **Mobility** |
| **Description** | Normal CP  Extended CP  Note: ECP is not expected to be applicable in all SCS and channel conditions, and companies providing results for ECP are encouraged to provide evaluation results with motivation/justification of simulated ECP cases | TDL model as defined in of TR38.901 Section 7.7.2:  - TDL-A (5ns, 10ns, DS)  - optional DS for consideration: 20ns, 40ns, 60ns DS  CDL model as defined in of TR38.901 Section 7.7.1:  - CDL-B (20ns, 50ns DS)  - CDL-D (20ns, 30ns DS) with K-factor = 10 dB  - optional DS for consideration: 100ns DS  FFS: modification CDL-B/D model  (a) Indoor Office NLOS: CDL-B (20 ns DS), and Indoor Office LOS: CDL-D (20 ns DS)   * Use mean angular spread values from Table 7.5.6-Part2 (for ASD, ASA, and ZSA) and Table 7.5-10 (for ZSD) * Use mean angles of CDL-B/D for desired mean angles as baseline (no angle translation) * Note that the angular spread values in the table are quoted in log units * Mean K-factor for CDL-D from Table 7.5.6-Part2 (~~9~~ 7 dB)   (b) UMi – Street Canyon NLOS: CDL-B (50 ns DS), and UMi – Street Canyon LOS: CDL-D (30 ns)   * Use mean angular spread values from Table 7.5.6-Part1 (for ASD, ASA, and ZSA) and Table 7.5-8 (for ZSD). * Use mean angles of CDL-B/D for desired mean angles as baseline (no angle translation) * Note that the angular spread values in the table are quoted in log units * Use mean K-factor for CDL-D from Table 7.5.6-Part1 (~~7~~ 9 dB)   Note: Mean angular spread values are used as desired AS value to scale the ray angles as described in TR38.901 section 7.7.5.1. As baseline, the ray angles are not translated, meaning (TR38.901 section 7.7.5.1). If companies perform translation of the ray angles they are encouraged to report the details. The mean K-factor is used to scale the tap powers as described in TR38.901 section 7.7.6.  Note: for TDL/CDL model, the delay spread (DS) value mentioned is the delay spread scaling value (i.e. corresponding to normalized delay of 1.0).  Note2: Other models (either TDL or CDL) with DS values not listed are optional.  Note3: Companies are encouraged to provide evaluation results with motivation/justification of simulated DS values. | For TDL model:  - 2x2  - 1x2 (optional)  For CDL model:  Configuration 1:  - (Mg,Ng,M,N,P) = (1,1,8,16,2) BS with (0.5 dv, 0.5 dH)  - (Mg,Ng,M,N,P) = (1,1,4,4,2) UE with (0.5 dv, 0.5 dH)  Configuration 2:  - (Mg,Ng,M,N,P) = (1,1,4,8,2) BS with (0.5 dv, 0.5 dH)  - (Mg,Ng,M,N,P) = (1,1,2,2,2) UE with (0.5 dv, 0.5 dH) | 3 km/hr |

The above table was agreed in last RAN1 meeting with FFS on modification to CDL models.

In [[15], Ericsson], it is observed that without proper randomization of the relative UE-gNB array orientations, the delay spread statistics can be substantially under-estimated. It is also observed that a single panel UE, or a dual panel UE with one panel fully/partially blocked, experiences larger delay spreads than a dual panel UE without any blocking.

Regarding the modification to CDL channel models, it is observed in [[60], Intel] that the measured RMS delay spread after Tx/Rx beamforming from the scaled ray angles based on indoor office scenario and UMi street canyon of the modified models are similar to the measured RMS delay spread after Tx/Rx beamforming for original CDL-B/CDL-D model. Furthermore, it is observed that the scaling of the power and angle values using Indoor office LOS or UMi street canyon LOS for the modified models have little impact to the power delay profile (as the power of the tap wih larger delays are below -30 dB compared to the main tap). Based on the observation that TDL-A model with some delay spread value is a good approximation of the channel characteristics modeled by CDL-B model, [[60], Intel] proposes that the FFS modification to CDL-B is not needed and instead of the FFS modification, add 20 ns DS to the TDL-A channel model in addition to 5 ns and 10 ns.

Moderator’s comment:

Recall that this channel model and associated delay spread values have been extensively discussed in the last RAN1 meeting, it would be good to finalize the channel and associated delay spread values so that companies can evaluate and submit results. It seems reasonable to keep original CDL models without modifications and add 20 ns DS to the TDL-A channel model as baseline to investigate large delay spread impact.

Proposal #2 for discussion:

* Keep modification CDL-B/D model in Table 2 as optional and add 20 ns DS to the baseline TDL-A channel model in addition to 5 ns and 10 ns.

Proposal #2a for discussion:

* FFS in this meeting whether to add 40 ns DS to the baseline TDL-A channel model and to remove one or both of DS values in the baseline CDL-D model

Companies are encouraged to provide comments if any.

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| Company Name | Comments/Views |
| NTT DOCOMO | Support |
| Intel | Agree with moderator suggestion.  On the UE antenna field pattern rotation which was newly proposed by Ericsson, while we understand the motivation for this, it order to properly model the UE antenna field pattern, we would need to implement 2 back to back panels and panel selection such that UE may have some good EIS. This will complicate the model quite significantly, without proper modeling it just mimic something with fixed cluster position, which just generates bias in the channel statistics.  The more straight forward approach would be to actually randomly generate the cluster rays using the SLS channel model.  For capturing the correct ISI impact, we suggest to utilize SLS and derive meaningful metric in SLS, instead of changing the LLS channel model. |
| vivo | Support moderator’s proposal |
| InterDigital | Support Moderator’s proposal |
| Nokia | Agree with the proposal. |
| Futurewei | Agree to add 20ns for TDL-A and keep CDL-B/D changes as optional. |
| Ericsson | As we analyzed in our contribution, the effect of randomized UE orientation and single vs. dual UE antenna panel (or partially blocked dual-panel) has a large impact on the delay spread distribution. We also investigated delay spread distributions from system-level simulations, and found a large dependence on LOS probability which varies with the site density. Depending on all of these factors, we have seen 90th percentile post-beam forming delay spread values ranging from a few ns up to >50 ns.  We understand that companies may be reluctant to adopt the angle scaling in the modified CDL-B/D models. We also understand that companies may be reluctant to adopt randomized angle translation in link simulation in order to model randomized UE orientation.  **Hence, as a compromise, we are willing to accept that the modified CDL-B/D models that we proposed remain optional. However, to make sure that we capture a suitable range of deployment scenarios, LOS probabilities, UE antenna designs, # of panels, etc. then we strongly prefer that 40 ns is added to the baseline TDL-A channel model in addition to 20 ns.**  To lessen the simulation load it could be discussed whether or not all of the DS values for CDL-B/D are needed. For example, one or both of the CDL-D DS values could be removed. |
| Huawei, HiSilicon | Support the proposal |
| Samsung | OK with the proposal. |
| Qualcomm | We support the Moderator’s proposal. |

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| LG Electronics | Agree with moderator’s proposal |
| ZTE, Sanechips | Support Moderator’s proposal. |
| Charter | Support Moderator’s Proposal 2 |
| Lenovo/Motorola Mobility | Agree with Moderator’s proposal |
| Apple | Support Moderator’s proposal |

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| Moderator | Seems all companies other than Ericsson are okay with original proposal #2.  On the proposal from Ericsson to add 40 ns in addition to 5, 10 and 20 ns DS into TDL-A model while remove one or both of the CDL-D DS values, given it’s a new proposal, I suggest to discuss further in this meeting to resolve which I added as proposal #2a. |

Outcome of discussion on this topic:

The following agreement was made in online session on 8/20.

Agreement:

Keep modification CDL-B/D model in Table 2 as optional and add 20 ns DS to the baseline TDL-A channel model in addition to 5 ns and 10 ns.

* FFS in this meeting whether to add 40 ns DS to the baseline TDL-A channel model

Proposal #2b for discussion:

* Keep modification CDL-B/D model in Table 2 as optional and add 20 ns DS to the baseline TDL-A channel model in addition to 5 ns and 10 ns.
  + - FFS in this meeting whether to add 40 ns DS to the baseline TDL-A channel model

Companies are encouraged to provide comments on the sub-bullet of proposal #2b to resolve FFS in this meeting.

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| Company Name | Comments/Views |
| InterDigital | We are not fine with the FFS bullet. In our view, CDL-B with 50 ns can be used for link level evaluation with higher delay spread case. |
| Ericsson | Support addition of 40 ns DS for the baseline TDL-A channel model. This is important so that when SCS/BW combinations are selected, we have evaluated a range of practical values. Otherwise, there is a risk over-optimistic design decisions.  From system simulations with representative ISD values e.g., 100, 150 m, we have captured delay spread distributions that properly take into account random UE orientation, LOS/NLOS probability, single panel/dual panel UEs, etc. We have seen, 90th percentile post-beamforming delay spread values in the several 10s of ns range for a variety of outdoor cases. The 3GPP InF-DL model also has significant delay spread.  Disagree with Interdigtal's comment – this is comparing apples and oranges. TDL-A models are bein＾g used by companies to model post-beamforming delay spread. The agreed 50 ns delay spread for CDL-B is a pre-beamforming value. Post-beamforming delay spread is much less. |
| InterDigital | We may understand Ericsson’s intention, but still don’t agree adding 40 ns DS. In this meeting, we already have added 20 ns DS for TDL-A to prevent a risk over-optimistic design decisions. Please note that 20 ns is double of previous maximum DS value for TDL-A model. Also, there is no proof that 40 ns DS can provide exactly same post-beamforming delay spread values in the several 10s of ns range. Given that, we see a risk to over-pessimistic design decisions with the 40 ns. In addition, we are concerning the progress of this SI. RAN1 is already passing half of RAN1#102-e and only one meeting is left for this SI. However, companies are continuously proposing additional simulation assumptions without progress. We understand that having accurate evaluation assumptions is important, but please remember that out objectives are study of required changes and channel access mechanism not having evaluation assumptions which are exactly same with practical implementation. |
| Intel | On the suggestion of addition of 40ns for TDL-A. We find this bit strange to only add for TDL-A. Since TDL channel models are modeling the effective channel response after beamforming, and 40ns is something that is useful to simulate, similar DS values should exist for CDL model. With this said, we don’t think we need to add more values at this point. Other values are available as options.  If the goal to get information about how delay spread can potentially impact performance with more SLS like deployment scenario setups. We suggest to conduct the study directly in the SLS. As this will provide much better picture than adding some DS values for LLS. Not sure what the addition of the 40ns just for TDL channel model will bring. |
| CATT | We don’t see the need to have large delay spread value with additional 40 ns to TDL-A. |
| Ericsson 2 | Response to Intel, IDC, and CATT:   * Agree with Intel's comment that the TDL models are modeling the effective DS *after* beamforming. But we are confused by the claim "similar DS values should exist for CDL model". As we show in our contribution, the 90th percentile *post-beamforming* delay spread for CDL-B is 20 ns (see blue curve in the plot below). But the problem is that this is a single snapshot where the UE is perfectly oriented toward the gNB (AoA = 180). This does not take into account that in a real system, UE orientations are random, thus different sets of clusters are illuminated with different delays depending on the orientation.      * To get an understanding of how much difference it makes with randomization, the red curves show that the 90th percentile DS increases to 40 ns when the UE orientation is randomized (randomized AoA). We have cross-checked this by capturing DS distributions from system simulation (which include randomized orientation) investigating the following scenarios for both single and dual panel UEs where we see that LOS/NLOS probability affects the DS distribution significantly   + Outdoor B, 100 ms ISD   + Outdoor A, 100 m and 150 m ISD   + Outdoor A, single site * From the system simulations, we see that 90th percentile *post-beamforming* delay spreads can easily be in the 40 ns range. * We understand that companies do not want to run link-level simulations with randomized UE orientation for CDL-B. That is why we are proposing that 40 ns is added for TDL-A instead. (To ease simulation burden, one option could be to reduce the number of DS values that are studied for CDL) * As we stated above, adding 40 ns for TDL-A is important so that we study a range of DS values that would be seen in practice to avoid over-optimistic design decisions. |
| Intel 2 | Response to Ericsson’s comments:  From our understanding the current CDL model nor the modified CDL model randomly changes the UE antenna directions. If it did, it would mean we are changing the AoA and ZoA angles defined in the CDL table as a function of UE orientation, which is clearly what is being done.  So the current CDL models and modified CDL model do not generate effective channel delay spread of 40ns, and this is where we are stating it weird to add this just to the TDL model.  If Ericsson is applying random rotation of the antenna field patterns or adding more panels to generate simulation results for CDL, that is one thing, but from my understanding this is something that no company has done or what is actually described by “CDL model from 38.901”.  So that is why it is strange to compare a new modification of CDL model (with random UE antenna rotation, and changing the AOA, ZOA angles, respectively) that we have not agreed to with TDL channel model with 40ns. I mean this is not the CDL model that all other companies will be simulating. So where is the balance?  Also obtaining the DS from rotating the UE directions with CDL-B is bit artificial, and that is why we suggested to directly look into the DS from SLS. |
| Qualcomm | We are okay with having TDL-A with 40ns DS as an optional scenario, but don’t think it should be mandated.  In our contribution (R1-2006797), we have also performed a set of system-level evaluation. In a UMi scenario with 100m ISD, which is similar to Scenario A in Ericsson’s contribution, we have also observed that a non-negligible portion of UEs in the cell have post-BF RMS delay spread larger than the NCP length of 960kHz SCS (73ns). However, from a different viewpoint, we observed that those UEs with large post-BF DS are nearly out of coverage (noise/interference limited, near the cell edge) and thus the excessive delay spread is not a concern. On the other hand, from the CDF of post-BF SINR, we saw that the SINR degradation by ISI with NCP is marginal in most cases, except some cases with very small bandwidth and very high EIRP. Therefore, we don’t think we need too much focus on the tail of the distribution. |
| Ericsson 3 | Response to Intel 2's comments:  We agree, neither the current CDL models nor modified CDL models generate post-beamforming DS of 40 ns, and that is precisely the problem. We must clarify that we are not suggesting that the modified CDL models be used by anyone either with or without angle randomization. We are fine to stay with the current CDL B/D models with no modifications. In fact if we drop the modified CDL-B/D altogether, that is fine. What we are after is one evaluation setting that exercises the 40 ns DS scenario. Since many companies prefer to use TDL models to model post beamforming DS, that is why we have suggested to add 40 ns to TDL-A.  Regarding the statement about directly looking into DS from SLS, is the intention to simulate link level performance within a system level evaluation? I don't think so. Intel must mean capturing delay spread distributions and using those as a guide for choosing a DS value for TDL models to be used in LLS. Could Intel confirm?  Response to Qualcomm comments:  Thank-you for confirming that 40 ns delay spread is observable from system simulation; this matches what we have seen too. However, we do not share the view about "focusing too much on the tail of the distribution." As Qualcomm points out, for higher EIRP scenarios, UEs with higher delay spread are in fact not out of coverage. Higher EIRP scenarios for outdoor are indeed relevant to the SI/WI where NR is to be evolved for both unlicensed AND licensed operation. Hence, scenarios applied to licensed must not be ignored. |
| InterDigital | As well as Qualcomm, Intel also provided their evaluation results on DS in R1-2005868 as follows:    According to the result, TDL-A with 13.5 ns DS shows similar delay profiles with CDL-B with 50 ns DS. Given that we already agreed to support 20 ns DS for TDL-A, RAN is considering beyond 40 ns DS for TDL-A evaluation. So, in our view, necessity of 40 ns is clearly not a common understanding of RAN1 as two other companies observe in opposite direction. Please remember that we already opened the door to the companies which want to evaluate TDL-A with 40 ns DS by allowing 40 ns DS as an optional value for TDL-A. |
| Intel 3 | I think I now better understanding where some differences of opinion stemmed from.  From Intel’s perspective, we mentioned from the beginning that TDL channel model was sufficient. However, some companies argued that CDL is better as it provided better representation of channel statistics and beamforming effects. Now, after further analysis, it looks like some people are realizing that was not true (at least not the way current CDL model is defined), and in the end was providing similar channel characteristics as TDL model as we originally stated.  So, to compensate for this, I understand that Ericsson is suggesting adding 40ns to the TDL. My point was if so, why are we even performing simulation for CDL? Why leave the CDL as is, and only change TDL model. That is the weird part for me. The whole point of the CDL as explained to us last meeting was to have better representation, but if that cannot be done, why are we asking companies to spend valuable resource to obtain results for this channel model.  Companies wanted to have CDL, and so we respected this. Furthermore, it was Intel who suggested to add the 20ns for TDL, so that it can match some of the statistics that are generated from CDL 20ns and 50ns, so that we have a balanced models for TDL and CDL. To be precise, TDL model with 13.5ns is sufficient to mimic CDL-B of 50ns, but we thought since we have 10ns, having another 13~14ns isn’t great. So, we suggested a much higher rounded number of 20ns.  Now having said this, we agree with Qualcomm and Interdigital’s observations. As we noted in our contribution R1-2005866, the users with high delay spread are mostly dominated by noise and not by ISI. In fact, if we look at the INR distribution, there are no UEs that are significantly impacted from higher delay spread even for 960kHz NCP for Indoor Hot Spot and UMi. There could be some challenges to some subset of Indoor Factor Hall environments, but this isn’t even being considered by companies other than us (Intel).  This is the primary reason why we believe just adding 40ns TDL to baseline is not right way to approach to resolve this issue. For companies who believe the 40ns (or any other DS for TDL or CDL) is important because their SLS delay spread results inform them so, can certainly perform LLS simulations for this case (since it is optional) and provide motivation and justification for them.  Follow up of Ericsson’s question:  Yes, if companies wish to do so, companies can gather statistics from the SLS and simulate appropriate DS in LLS for the appropriate SNR ranges. I think this was the whole point of having other DS values as optional, and explicitly having a note that state “Note3: Companies are encouraged to provide evaluation results with motivation/justification of simulated DS values.” Otherwise, what is the whole point of the Note 3? And what is the point of optional DS values? |
| Nokia | We appreciate the discussion and results presented by Ericsson, Intel, Qualcomm and IDC. We agree with Qualcomm that we should not focus on the tail and therefore do not support adding 40 ns DS to TDL. Moreover, we note the lower SINR, which will be correlated with the higher delay spreads, will utilize lower MCS levels which are more robust to ISI. It does not make sense to evaluate this higher MCS’s levels at the high delay spreads. |
| NTT DOCOMO | We also appreciate the discussion and results presented by Ericsson, Intel, Qualcomm and IDC. We are supportive to add 40 ns DS for TDL-A. |
| ZTE, Sanechips | We share similar view with Qualcomm, Intel, IDC and Nokia, we don’t support to add 40ns DS to TDLA mandatory values. |
| Huawei, HiSilicon | As for outdoor scenario, 40ns DS for TDL-A is necessary. |
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### RF impairment modelling

Table 3. LLS Parameter Set 3

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| **Parameter Set 3** | **PA Model** | **gNB TRP PN Model** | **UE PN Model** | **Pre-loaded Tx EVM** | **Additive Rx EVM** | **I-Q Imbalance** | **Frequency Offset** |
| **Description** | Optional:  - Companies to provide modeling (in lieu of pre-loaded Tx EVM) | 3GPP TR38.803 example 2 BS PN profile  Optional:  - If other PN profile is used, companies to provide information on the modeling used  Note: companies to provide information about the LO distribution model assumed in the simulations. | 3GPP TR38.803 example 2 UE PN profile  Optional:  - If other PN profile is used, companies to provide information on the modeling used  Note: companies to provide information about the LO distribution model assumed in the simulations. | Optional:  - 3% at Tx (In lieu of PA model),  - If other values are used companies are asked to provide information on the values selected for simulation. | Optional:  - 5% at Rx,  - If other values are used companies are asked to provide information on the values selected for simulation. | Optional:  - (-26dBc),  - (-31dBc),  - If other values are used companies are asked to provide information on the values selected for simulation. | Optional:  - 0.1 ppm (for PDSCH/PUSCH)  - 5, 10, 20 ppm (for initial access) |

The above table was agreed in last RAN1 meeting. In [[4], vivo], it is proposed to model I/Q imbalance in LLS.

Moderator’s comment:

Currently, companies are allowed to model I/Q-imbalance and other RF impairments with optional modeling. It seems no need to discuss further.

Companies are encouraged to provide comments if any.

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| Company Name | Comments/Views |
| Intel | Agree with moderator suggestion |
| vivo | Fine with moderator’s proposal. However, it should be clarified that the problem identified by optional modeling still needs to be studied. |
| InterDigital | Support Moderator’s proposal |
| Nokia | No further requirements. |
| Ericsson | Agree with moderator’s suggestion |
| Huawei, HiSilicon | Agree with Moderator’s comment |
| Samsung | OK with the proposal. |
| Qualcomm | We support the Moderator’s proposal. |

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| LG Electronics | Agree with moderator’s comment |
| ZTE, Sanechips | Support Moderator’s proposal. |
| Charter | Support Moderator’s comment, as vivo seems to, as well. (N.B.: vivo’s comment above might be somewhat ambiguous on what requires further clarification and/or study.) |
| Lenovo/Motorola Mobility | We agree with moderator’s comment to keep I/Q-imbalance modeling and other RF impairments as optional and no need to discuss further. |
| Apple | Agree with moderator’s proposal |
| CATT | We agree with moderator’s proposal that no further discussion on modeling of I/Q-imbalance and RF impairments |

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| Moderator | In response to vivo’s comment:  I think it’s a common understanding that any problem/issue identified by optional modeling can be raised and studied in RAN1. |

### Other issue(s)

Please provide other issue(s) if any on LLS that requires resolution in this meeting.

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| Company Name | Comments/Views |
| Ericsson | * There are 2 issues that were overlooked when the link level evaluation scenarios were decided. We need to agree on a baseline on these issues in order to have comparable results between companies. * Issue #1:   + It was not specified whether or not other reference signals are included in the evaluation, e.g., CSI-RS for tracking (TRS) or other CSI-RS.   + We need to agree on a baseline. Should TRS/CSI-RS be ON or OFF? * Issue #2:   + It was not specified what assumptions should be made on the higher layer parameter (see TBS determination procedure in 38.214 Section 5.1.3.2).   + We need to agree on a value (0, 6, 12, or 18), since it affects the effective code rate. For example, if the default =0, then the effective code rate will be greater than the value corresponding to MCS 7, 16, or 22 due to the presence of PTRS overhead. This is particularly important for MCS 22. |
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For discussion:

* Should TRS/CSI-RS be ON or OFF in LLS? If on, what configuration?
* What is the assumed value of the higher layer parameter in LLS?

Companies are encouraged to provide comments/answers to the above questions.

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| Company Name | Comments/Views |
| InterDigital | Issue#1  - To us, the motivation of the issue is not clear. Is this to model actual CSI and tracking implementation or just to reflect TRS and CSI-RS overhead?  Issue#2  - We support =0. |
| Intel | We think what Ericsson suggesting deserves conclusion.  For issue #1, unless companies are performing live T/F tracking with TRS and other CSI-RS to perform close loop link adaption, it would be preferred to not have those signals in the evaluation. Having those additional signals could create difficulties in obtaining insight for specific impairments. Since we are simulating fixed MCS, the need for CSI-RS might not be useful. The only reason we may want to consider this is for overhead considerations. Which may be addressed by issue #2.  So we suggest to leave TRS/CSI-RS un-modeled in LLS evaluations.  For issue #2, we agree the overhead value should be specified. Our preference would be use 0 for simplicity. However, if companies wish to account for some TRS/CSI-RS overhead, we think 6 might be acceptable as well. |
| Apple | We think that for Issue #1, TRS/CSI-RS should be off.  We agree with Ericsson that Issue #2 should be clarified. A simple option would be to a define an overhead based on averaging the number of PTRS symbols in the entire band over the number of RBs and use that as the overhead. This will ensure that the TBS calculated is as close to the target rate as possible. |
| CATT | For Issue #1, our view is that TRS and CSI-RS would not be assumed in the LLS to simply the evaluation of other aspects.  For Issue #2, we agree that overhead should be specified to get correct coding rate for each MCS |
| Qualcomm | For CSI-RS/TRS, unless the intention is to evaluate the CSI-RS/TRS performance and to identify any potential issues/improvements, we don’t think it is necessary.  Regarding the overhead parameter for TBS determination, we think =0 is a good reference. Some companies have already provided performance comparisons with and w/o PTRS, or with PTRSs of different densities. Thus, using a common reference, i.e., same TBS, for all compared cases would be necessary for fair comparison. |
| Nokia | We propose that TRS/CSI-RS is OFF in LLS  We propose a compromise value for the higher layer parameter:= 6 in LLS |
| NTT DOCOMO | For Issue #1, we also propose that TRS/CSI-RS is OFF in LLS.  For Issue #2, we agree it should be aligned among companies. We are quite open for this issue. In our understanding, another way to go could be to select N\_oh^PRB which best matches the actual RX overhead being used in the evaluation. |
| ZTE, Sanechips | For Issue #1, we think TRS/CSI-RS should be off.  For Issue #2, we agree that PTRS overhead should be properly counted for each MCS, so that the PTRS estimation accuracy could be compared between each PTRS pattern. Then as for the coding loss due to different PTRS overhead, this could be compared using throughput vs SNR. |
| Huawei, HiSilicon | For issue #1, we do not think it is necessary to switch on the TRS/CSI-RS.  For issue #2, we think =0 as TRS/CSI-RS is disabled. |
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## 2.2. System Level Simulation

### Evaluation metric, subcarrier spacing, bandwidth and number of RB

Table 4. SLS Parameter Set 1

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| **Parameter Set 1** | **Evaluation Objectives** | **Carrier Frequency [GHz]** | **Subcarrier Spacing [kHz]** | **Bandwidth [MHz]** | **Number of RB** |
| **Description** | Primary objective:  - Evaluation of single operator and multi-operator deployments including study of interference impact and coexistence between nodes.  Evaluation KPIs include user throughput, latency, average buffer occupancy, ratio of mean served throughput and offered cell throughput, and resource utilization.  Secondary objective:  - obtain delay spread profiles (and inter-symbol interference statistics) for deployment scenarios of interest (note: performance impact from delay spread should be conducted in LLS, the SLS would be used to supplement findings) | 60 GHz    Optional: 70 GHz | For 2000MHz BW:  960 kHz  FFS: 120, 240, 480 kHz  For 400MHz BW:  120 kHz  FFS: 240, 480, 960 kHz  Note: Other than value above, companies are encouraged to evaluating using subcarrier spacing values determined to be feasible from LLS study. Values for the subcarrier spacing may be revisited after further investigation from LLS study. | 2000 MHz  400 MHz (FFS: optional)  Note: Channel bandwidth evaluated may be revisited after further investigation. | For 2000 MHz:  - N/A (120 kHz),  - N/A (240 kHz),  - FFS (480 kHz),  - 160 (960 kHz),  - 80 (1920 kHz),  For 400 MHz:  - 256 (120 kHz),  - 128 (240 kHz),  - 64 (480 kHz),  - 32 (960 kHz),  - N/A (1920 kHz)    For other channel bandwidths:  - Companies are asked to provide information. Companies are encouraged to utilize linearly scaled PRB sizes for a given bandwidth based on above. |

#### Evaluation metrics

It is proposed in [[60], Intel] to use root mean square effective channel delay spread at the receiver as a metric for system level evaluation of NR in 52.6–71GHz. [[60], Intel] also proposes to use intersymbol interference signal to interference ratio as a metric for system-level evaluation with details given on assumptions of the acceptable intersymbol interference level criteria and of the dynamic FFT window placement for intersymbol interference SIR calculation.

Moderator’s comment:

Obtaining delay spread profiles and inter-symbol interference statistics are already agreed to be the secondary objective for SLS. Interested companies can for sure use them as the metrics in their evaluation. It seems no need for further discussion and agreement.

Companies are encouraged to provide comments if any.

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| Company Name | Comments/Views |
| Intel | We understand moderator comments. We would like to note that such secondary metric should be also captured into the TR so that useful information could be shared as part of this SI. |
| vivo | Support moderator’s proposal |
| InterDigital | Support Moderator’s proposal |
| Ericsson | We have observed that the 90th percentile RMS delay spread is an important metric, and since this metric varies significantly depending on at least deployment scenario, LOS probability, UE antenna design, # of panels, etc., then it is important to capture this metric from system evaluations. |
| Huawei, HiSilicon | Agree with Moderator’s view |
| Samsung | OK with the proposal. |
| Qualcomm | We agree with moderators comment. |

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| LG Electronics | Agree with Moderator’s comment |
| ZTE, Sanechips | Support Moderator’s proposal. |
| Charter | We note that, while we agree that rms DS is the meaningful performance parameter (vs. maximum DS); and that a dynamic placement of the FFT window may alleviate ISI; it is unclear to us how SLS can provide this insight better than LLS, which is mapped to SLS.  Support Moderator’s comment. |
| Lenovo/Motorola Mobility | Agree with Moderator’s proposal |
| Apple | Agree with moderator’s proposal |
| CATT | We agree with moderator’s proposal |

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| Moderator | On reporting delay spread profile and inter-symbol interference statistics as the secondary metric of SLS, companies are allowed and encouraged to do so.  On whether such results should be captured into the TR, I believe it will be subject to typical 3GPP routine and need to be discussed and agreeable to all when we have the results (in the next meeting). |
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#### Subcarrier spacing, bandwidth and number of RBs

It is proposed in [[63], Samsung] that no need to further study using 480 kHz SCS for 2000 MHz carrier bandwidth for the same concern as expressed for LLS evaluation. There’s no other explicit proposals made in the submitted contributions on these FFS aspects in Table 4.

Moderator’s comment:

There’re several companies submitted their preliminary SLS evaluation results in the contributions to this meeting. On the used subcarrier spacing and bandwidth for submitted SLS results, it is observed that six sources [[59], ZTE; [66], Nokia; [67], Huawei; [33], vivo; [54], Qualcomm; [41], Ericsson] used (960 KHz SCS, 2000 MHz BW) for SLS. One source [[25], NTT DOCOMO] used (120 KHz with 400 MHz BW and 960 KHz SCS with 2000 MHz BW). It may be good to have a small set of configurations as baseline and keep other FFS configurations as optional so that more companies may be able to generate SLS results with baseline configurations while still allowing interested companies to evaluate with other parameters.

Proposal #3 for discussion:

* For SLS performance evaluations purpose, keep 120, 240 and 480 kHz as optional subcarrier spacing for 2000 MHz BW and keep 240, 480 and 960 kHz as optional subcarrier spacing for 400 MHz BW in Table 4.
* For SLS performance evaluations purpose, keep 400 MHz as optional bandwidth in Table 4.
* For SLS performance evaluations purpose, keep 320 PRB for 480 kHz subcarrier spacing for 2000 MHz bandwidth as optional in Table 4.

Proposal #3a for discussion:

* For SLS performance evaluations purpose, keep 120, 240 and 480 kHz as optional subcarrier spacing for 2000 MHz BW and keep 240, 480 and 960 kHz as optional subcarrier spacing for 400 MHz BW in Table 4.
* For SLS performance evaluations purpose, keep 400 MHz as a baseline bandwidth in Table 4.
* For SLS performance evaluations purpose, keep 320 PRB for 480 kHz subcarrier spacing for 2000 MHz bandwidth as optional in Table 4.

Companies are encouraged to provide comments if any.

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| Company Name | Comments/Views |
| NTT DOCOMO | We support 1st and 3rd bullet.  For the 2nd bullet, we prefer to keep 400 MHz BW as mandatory. |
| Intel | We are ok with moderator’s proposal #3 |
| Vivo | Support moderator’s proposal |
| InterDigital | Support Moderator’s proposal |
| Nokia | Okay with bullet #1.  For bullet #2, we have a similar view to DOCOMO to have 400 MHz as a mandatory bandwidth.  Okay with bullet #3. |
| Futurewei | We would like to have 400 MHz BW mandatory. OK with the proposal with this amendment. |
| Ericsson | To draw meaningful conclusions based on enough evaluation sets, it would be good if companies focus on the baseline configuration. It seems now we have all possible configurations as optional. Why not agree on the baseline only and remove the other options? Companies are still allowed to run with other configurations and share any concerns they might find. |
| Huawei, HiSilicon | We support the first bullet in the proposal #3. Actually we could just keep the primary SCS for SLS evaluation and no need to have optional for simplicity. In any case, companies have seen which SCS are of interest to other companies, so this should be some encouragement for all companies to provide results for several numerologies.  For the 2nd bullet, we do not agree to make 400MHz as optional. According to the agreement in last meeting, it is already agreed both 400MHz and 2GHz is the primary configuration and it is not under FFS. We should not judge the configuration as primary or secondary from the number of submission from companies, especially when this is the first meeting after we have a common simulation assumption. |
| Samsung | OK with the proposal. |
| Qualcomm | Bullet 1: Agree with Moderator’s proposal  Bullet 2: We would prefer 400 MHz to be mandatory  Bullet 3: Agree with Moderator’s proposal |

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| LG Electronics | We share the view with NTT DOCOMO |
| ZTE, Sanechips | Support Moderator’s proposal. For bullet #2, we don’t think 400MHz or 2GHz will show different behavior on the relative performance comparison for the SLS objectives, for sake of workload, we’d better focus on only one of the candidate bandwidth and try to draw a meaningful conclusion, other choices could be optional. |
| Charter | Support Moderator’s Proposal 3 |
| Lenovo/Motorola Mobility | Agree with Docomo/Nokia, we prefer to keep 400 MHz as mandatory in Table 4. |
| Apple | Agree with bullet #1 and #3. Would prefer 400 MHz as mandator for #2. |

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| Moderator | I interpreted Ericsson’s comment as not to object proposal #3 but stated their preference of whether listing optional values or not.  In response to Huawei’s comment. 400 MHz is listed as baseline in Table 1 for LLS. While the discussion here is on 400 MHz (FFS: optional) as BW for SLS in Table 4.  For all companies, the 1st bullet seems agreeable.  Companies have split view on the 2nd bullet whether 400 MHz should be baseline or optional.  On the 3rd bullet, it’s not clear whether Huawei is against or support. Note that Huawei stated that they prefer not to have 320 PRB for 480 kHz subcarrier spacing for 2000 MHz for LLS in Table 1. Other than Huawei, seems other companies are okay with it.  Proposal #3a is formulated with 400 MHz as baseline BW for SLS as well in the 2nd bullet. |

Outcome of discussion on this topic:

The following agreement was made in online session on 8/20.

Agreement:

* For SLS performance evaluations purpose, keep 120, 240 and 480 kHz as optional subcarrier spacing for 2000 MHz BW and keep 240, 480 and 960 kHz as optional subcarrier spacing for 400 MHz BW in Table 4.
* For SLS performance evaluations purpose, keep 400 MHz as baseline bandwidth in Table 4.
* For SLS performance evaluations purpose, keep 320 PRB for 480 kHz subcarrier spacing for 2000 MHz bandwidth as optional in Table 4.

### Scenarios

Table 5. SLS Parameter Set 2

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| **Parameter Set 2** | **Deployment Scenario** | **UE distribution** | **Channel Model** |
| **Description** | **Primary scenarios:**  - Scenario indoor-A or C (FFS: which scenario is primary)  **Secondary scenarios:**  - Scenario indoor-C or A (FFS: which scenario is secondary)  - Scenario outdoor-B  **Optional:**  - other scenarios listed below  **Indoor Office:**  **Scenario Indoor-A)** InH open office model:  Office box 120m x 50 m, 12 BS per operator, 2 operator, BS height at 3m (ceiling), UE height 1m, ISD = 20m, BS randomly deployed within 10m x 10m virtual box  FFS: if the office box can be reduced down to 50m x 50m  FFS: minimum distance between BS    **Scenario Indoor-B)** small InH open office model:  Office box 20m x 20 m, 1 BS per operator, 2 operator, BS height at 3m (ceiling), UE height 1m, BS randomly deployed within 10m x 10m virtual box  FFS: minimum distance between BS    **Scenario Indoor-C)** InH open office model:  Office box 120m x 50 m, 12 BS per operator, 1 operator, BS height at 3m (ceiling), UE height 1m, BS fixed position, ISD = 20m  FFS: if the office box scenario can be reduced down to 50m x 50m    **Scenario Indoor-D)** InH open office model:  Office box 120m x 50 m, 6 BS per operator, 2 operator, BS height at 3m (ceiling), UE height 1m, BS fixed position, ISD = 20m  FFS: if the office box scenario can be reduced down to 50m x 50m    **Scenario Indoor-E)** InH open office model:  Office box 120m x 80 m, 3 BS per operator, 2 operator, BS height at 3m (ceiling), UE height 1m, BS fixed position, a=20m, b=40m, c=20m, and d=40m  image001  **Dense Urban:**  **Scenario Outdoor-A)** Dense Urban with 1 layer  Hexagonal grid, single layer, 3 sectors per site, 7 sites locations, BS height 10m, UE height 1.5m, ISD = 150m  FFS: whether ISD needs to be smaller  FFS: Reducing deployment size from 7 sites to 1 site for performance evaluations with both single and two operator scenarios.    **Scenario Outdoor-B)** Dense Urban with 2 layers  Macro layer (sub 7GHz – not necessarily need to be simulated for the 60GHz evaluation):  Hexagonal grid, single layer, 3 sectors per site, 7 sites locations  BS height 25m, UE height 1.5m, ISD = 100m, fixed BS position  Micro layer (above 52.6 GHz):  BS height 10m, UE height 1.5m, 2 operator, 2 BS per hexgrid per operator, random position within macro hexagonal grid per operator, minimum distance between TRP and UE: 10m  FFS: Reducing deployment size from 7 sites to 1 site for performance evaluations with both single and two operator scenarios.    **Scenario Outdoor-C)** Dense Urban with 1 layer  Hexagonal grid, single layer, 3 sectors per site, 3 sites locations, BS height 10m, UE height 1.5m, ISD = 150m    **Indoor Factory Hall:**  **Scenario Factory-A)** Indoor factory with Dense cluster & low BS (InF-DL)  Grid, 300m x 150m x 10m factor hall  ISD 50m, BS height 1.5m, UE height 1.5m, Typical clutter size 2m, Clutter height 6m, Clutter density 60%  **Scenario Factory-B)** Indoor factory with sparse clutter & High BS (InF-SH)  Grid, 300m x 150m x 10m factor hall  ISD 50m, BS height 8m, UE height 1.5m, Typical clutter size 10m, Clutter height 2m, Clutter density 20% | Average of 5 or 10 UE per BS    UE are either 100% indoor or 100% outdoor depending on deployment scenario. | InH open office:  - gNB-to-gNB and gNB-to-UE links: InH – office channel & PL model from TR38.901  - UE-to-UE links: [InH – office channel & PL model from TR38.901]    Dense Urban:  - gNB-to-gNB and gNB-to-UE links: UMi street canyon channel & PL model from TR38.901  - UE-to-UE links: [D2D channel & PL model from TR36.843 Section A.2.1.2]    Indoor factor:  - gNB-to-gNB and gNB-to-UE links: InF channel & PL model from TR38.901  - UE-to-UE links: [InF channel & PL model from TR38.901]  Note: 3D distance between an gNB and a UE is applied. 3D distance is also used for LOS probability and break point distance.  Note: channel models in brackets, [ ], are working assumption and may be revisited. |

The above table was agreed in last meeting regarding evaluation scenarios with several FFS left. In this meeting, multiple contributions have provided their views and proposals on these aspects.

#### Primary scenario

It is proposed in [[63], Samsung] to take both indoor-A and indoor-C scenarios as primary scenarios for different number of operators in SLS. While [[60], Intel] proposes to have indoor scenario C as the primary scenario and indoor scenario A as secondary scenario with the reason hoping to get more evaluation results in primary scenario for alignment and draw meaningful conclusions.

Moderator’s comment:

Considering the reason to define a primary scenario is to encourage more companies to submit results with an aligned scenario and hopefully to draw meaningful conclusion, it’s important to resolve this issue in this meeting. Regarding this primary and secondary scenario issue, multiple options below were discussed with no agreement in the last RAN1 meeting:

* Option 1) Indoor-A as primary, Indoor-C as secondary
* Option 2) Indoor-C as primary, Indoor-A as secondary
* Option 3) Indoor-A or Indoor-C as primary
* Option 4) Indoor-A and Indoor-C as primary

Without further discussion on the placement of the 2nd operator’s BS, Indoor-C may be fine only for single operator deployment evaluation. Though that single operator evaluation can be implemented with Indoor-A as well as shown in some submitted contributions. There’re several companies submitted their preliminary SLS evaluation results in the contributions to this meeting. On the used scenarios for the submitted SLS results, the following is observed.

Three contributions [[59], ZTE; [66], Nokia; [33], vivo] used indoor-A. [[54], Qualcomm; [57], Nokia] used a layout half of the size of indoor-A with 2 operators each with 6 gNBs. [[41], Ericsson] submitted results for both indoor-A and indoor-C. [[67], Huawei] submitted results for indoor-A, indoor-B and indoor-C scenarios. [[25], NTT DOCOMO] submitted results for indoor-C. Furthermore, on the minimum distance between BS of different operators, it is stated as 3 m in [[67], Huawei], 2 m in [[57], Nokia] and 1 m in [[41], Ericsson].

Proposal #4 for discussion:

* For SLS performance evaluations purpose, choose one of the following options as the primary scenario in Table 5.
  + Option 1) Indoor-A as primary, Indoor-C as secondary
  + Option 2) Indoor-C as primary, Indoor-A as secondary
  + Option 3) Indoor-A or Indoor-C as primary
  + Option 4) Indoor-A and Indoor-C as primary
* For SLS performance evaluations purpose, the minimum distance between BS of different operators is [2] m for indoor-A and indoor-B scenario in Table 5.

Proposal #4a for discussion:

* For SLS performance evaluations purpose, Indoor-A or Indoor-C is primary scenario in Table 5.
* For SLS performance evaluations purpose, the minimum distance between BS of different operators is [2] m for indoor-A and indoor-B scenario in Table 5.

Companies are encouraged to provide comments on their preference of the above options and on the value of minimum BS distance.

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| Company Name | Comments/Views |
| NTT DOCOMO | For the 1st main bullet, we support option 2. |
| Intel | Our preference is option 2, as mentioned that main motivation to encourage more companies to bring results for a slightly more simple deployment setup. We do not mean to say that Indoor-A is less prioritized or less important.  For the minimum distance for BS-BS, we are ok with the suggestion |
| vivo | Support Option 1; Support minimum distance=2m |
| InterDigital | Support option 2. |
| Nokia | Option 1) Indoor-A as primary, Indoor-C as secondary  Nokia supports a minimum distance of 2 m for indoor-A. |
| Futurewei | We support Option 1 and minimum distance of 2m for indoor-A. |
| Ericsson | Our preference is option 2 (Indoor C as primary, Indoor A as secondary). As we said during last meeting, single operator scenario is a more likely deployment. Besides, even in the rare case of having 2 operators, it is obviously better to operate on different channels to avoid any issues. |
| Huawei, HiSilicon | We support option 1). Just as commented by moderator, it can support both single and dual operator deployment. For the minimum distance between BS, we are fine to adopt any number larger than 1m because the channel model does not support such small distance.  As for the channel model, it should be clarified whether “InH – office channel & PL model from TR38.901” means “indoor - open office” or “indoor - mixed office” channel model. “InH open office” represents the deployment scenario where there is no wall in the area. In NRU R16, “indoor - mixed office” is used for BS-BS, BS-UE and UE-UE links. For 60GHz evaluation, the deployment topology is not changed significantly. We think “indoor - mixed office” should be used at least for UE-UE links considering all UEs are at the same height and there might be some blockage between them. It should be noted that there are “[]” for the UE-UE links for all scenarios. |
| Samsung | Option 3) or Option 4) (we didn’t see a difference between the two, since anyway company is not mandatory to simulate all the primary scenarios), or we don’t need to distinguish primary or secondary at all (up to company to choose the interested scenarios for simulation).  For inter-BS distance, the suggested number 2 m is OK (can remove the bracket of the proposal if final agreed). |
| Qualcomm | For Proposal 4 scenario we would support option 1. Further, we would support a minimum distance of 2m as proposed by the moderator. |

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| LG Electronics | We share the view with Intel |
| ZTE, Sanechips | We support Option 1. The minimum distance of 2m is OK for us. |
| Charter | Support option 2., one operator |
| Lenovo/Motorola Mobility | Support option 2. |
| Apple | Support option 2 |

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| Moderator | Seems the same situation as in the last meeting with split views on the primary scenario.  If we cannot agree on option 1 or option 2 in this meeting, then effectively, we end up with option 3 where indoor-A or indoor-C is primary scenario.  Revised into proposal#4a. |

Outcome of discussion on this topic:

The following agreement was made in online session on 8/20.

Agreement:

* For indoor SLS performance evaluations, Indoor-A for the two operator case and Indoor-C for the single operator case are baseline scenarios in Table 5.
  + - Indoor-A for the single operator case can be optionally used in the evaluations
* For indoor SLS performance evaluations purpose, the minimum distance between BS of different operators is 2 m for indoor-A and indoor-B scenario in Table 5.

#### Indoor scenario area reduction

There was an FFS on reducing the simulation layout for indoor scenarios to help with simulation complexity In [[60], Intel], RSRP CDFs were compared on different size of layouts. Then it proposes to have indoor deployment scenario A and C to be 50 m x 100 m deployment with 10 BS per operator.

Moderator’s comment:

It is noted [[54], Qualcomm; [57], Nokia] used a layout half of the size of indoor-A (i.e. 50 m x 60 m) with 2 operators each with 6 gNBs in their submitted SLS results but no proposal on the area reduction was made.

Proposal #5 for discussion:

* Regarding indoor scenario area reduction for indoor-A and indoor-C in Table 5, choose one of the following options:
  + Option 1) Keep 50 m x 120 m as it is
  + Option 2) Change into 50 m x 100 m deployment with 10 BS per operator

Companies are encouraged to provide comments on their preference of the above options or other values.

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| Company Name | Comments/Views |
| NTT DOCOMO | We prefer option 1. |
| Intel | We are ok with either option 1 or 2. Option 2 was suggested in case companies did want to simulation something smaller scale without meaningfully impacting overall signal/interference strength statistics. |
| vivo | Option 1. We don’t see strong motivation to change the layout. |
| InterDigital | Option 1. |
| Nokia | Nokia prefers third option with ½ size reduction of Indoor-A (50 m x 60 m) with 6 gNBs per operator as this provides similar results to the full size Indoor-A The motivation is reduce the simulation times.  Option 2 is only 17% smaller than Option 1 so there is effectively little difference in the choice between options 1 or 2. In the last meeting, there was an FFS: if the office box can be reduced down to 50m x 50m. That would be preferred if we cannot agree on ½ size |
| Futurewei | Option 1 |
| Ericsson | Between 10 or 12 BSs, we do not think the simulation time will change significantly. But if other companies are OK with option 2, we can go for it.  Companies should be required to submit the RSRP CDFs for the evaluated scenario to be able to align and draw meaningful conclusions. Based on the (few) CDFs reported in the contributions, the RSRP distribution differ from one company to another and that has significant impact on the results. |
| Huawei, HiSilicon | We prefer option 1. Only 2 out of 12 blocks can be saved by option 2. If companies hope to reduce simulation complexity, using scenario B is more straightforward. |
| Samsung | Prefer option 1. It has been served as baseline from last meeting for developing the SLS, so there is no strong need to change it and re-simulate it. Unless there is a serious issue, we prefer to keep the layout. |
| Qualcomm | We would support Option 1 for Indoor A and Indoor C scenarios. |

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| LG Electronics | Option 1 |
| ZTE, Sanechips | We don’t see much difference on the simulation time between Option 1 or 2, so they are both OK for us.  As for RSRP CDFs, we share similar view as Ericsson. Under the condition that each company has the same RSRP CDF, the CCA threshold and interference analysis could be meaningful. |
| Charter | Support Option 1 |
| Lenovo/Motorola Mobility | Significant area reduction of half-size preferred, otherwise option 1. |
| Apple | No significant difference between option 1 and option 2. Based on the options, we are fine with either. |

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| Moderator | More companies prefer option 1. Given that option 1 is already agreed in the last meeting, propose to keep as it is. |

Outcome of discussion on this topic:

The following agreement was made in online session on on 8/20.

Agreement:

Indoor scenario area reduction for indoor-A and indoor-C in Table 5 is not discussed further

* Remove FFS in the table corresponding to this

#### Outdoor Scenario

For outdoor scenario simulation, [[41], Ericsson] proposes to have the minimum distance between micro gNBs’ of same operator in the same sector as 10 m. [[41], Ericsson] also proposes for outdoor scenario simulation, reduce the deployment size from 7 sites to 1 site.

Moderator’s comment:

The minimum distance between micro gNBs of the same operator in the same sector is indeed a missing aspect. It also makes sense to reduce the number of sites for simulation burden consideration.

Proposal #6 for discussion:

* For SLS performance evaluations purpose, the number of sites in outdoor scenarios-A and B in the deployment scenario field of Table 5 is reduced from 7 to 1.
* For SLS performance evaluations purpose, the minimum distance between micro gNBs’ of the same operator in the same sector is 10 m for outdoor scenarios in the deployment scenario field of Table 5.

Companies are encouraged to provide comments if any.

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| Company Name | Comments/Views |
| NTT DOCOMO | For the 1st bullet, our current preference is 7 sites as mandatory and 1 site as optional since we think the number of sites may have considerable impacts on geometry distribution. If no/less impact is observed depending on the number of sites, we would be okay with 1 site. |
| Intel | We would like to have bit more time to conduct investigation on this issue. We suggest to leave this FFS. |
| vivo | Support moderator’s proposal |
| InterDigital | We are fine with the proposed minimum distance. But, we prefer to have 1 site scenario as optional to allow simpler evaluation but not mandate the scenario. |
| Nokia | Support reducing the scenario from 7 to 1 as a baseline with 7 sites as optional. For the 1 site case, we feel that outdoor scenario C is an equivalent and better solution as the transmitters are placed on the edge eliminating any need to model wrap-around. If 1-site scenario B is selected, than perhaps wrap-around will be necessary.  Support the minimum distance between micro gNBs of same operator as 10m. Further propose that the minimum distance between micro gNBs of different operators should also be 10m. Lastly, the 10m minimum distance should be true across sectors as well as in sectors. (Justification: 10m is the minimum distance (2D) supported by the UMi model.)  The microcell placement method should be further clarified. The minimum distance to the macro cell should also be specified and be 10 m. |
| Futurewei | Baseline scenario 1 site with 7 sites optional. Minimum distance in the same sector should be 10 m for outdoor scenarios. |
| Ericsson | Agree with the proposal  Additionally, for the secondary objective of obtaining delay spread profiles, it is recommended to consider a diversity of outdoor deployments, i.e., not only Outdoor Scenario B. Scenario A with 100 and 150 m ISD, Scenario C, Scenario Factory A/B should also be considered. |
| Huawei, Hisilicon | We support the moderator’s proposal on the site reduction and minimum distance. Considering the larger ISD in outdoor scenario, the interference from other sites should be negligible. |

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| Qualcomm | We believe that simulating 7 sites would provide opportunity for intra-operator, inter-operator, DL->DL, UL->DL, DL->UL and UL->UL interference conditions to be understood better. We support moderator’s suggestion of minimum distance between micro-gNBs within same sector to be 10m. We would consider the 1 site scenario as an optional scenario.  Further The FFS from last meeting also considered the option of reduced ISD. [‘FFS: whether ISD needs to be smaller’ ]  We would recommend considering ISD 100m so as not to have a largely isolated cell environment. When 7 cell evaluation is proposed, the intention was certainly not to select parameters to create isolated cells. |
| ZTE, Sanechips | We support Moderator’s proposal. |
| Charter | We agree with Moderator’s Proposal 6 and the potential stipulations in Nokia’s comment |
| Lenovo/Motorola Mobility | For 1 site, outdoor scenario-C is used. |
| Apple | We are fine with the moderator’s proposal |

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| Moderator | Outdoor-B scenario is secondary scenario for SLS. The intention of this discussion is not to reopen discussion for outdoor-B vs. other outdoor scenarios.  Split views from companies on whether 7 or 1 site as baseline for outdoor scenario SLS. With more companies prefer to reduce the number of sites hoping to reduce simulation load and in turn, maybe more companies can submit more evolution results, it is suggest reducing the number of site to be 1 and keep 7 as an optional number in proposal #6a. |

Proposal #6a for discussion:

* For SLS performance evaluations purpose, the number of sites in outdoor scenarios-A and B in the deployment scenario field of Table 5 is 1 with warp-around. 7 is an optional number of sites in outdoor scenarios-A and B.
* For SLS performance evaluations purpose, the minimum distance between micro gNBs’ of the same operator in the same sector is 10 m for outdoor scenarios in the deployment scenario field of Table 5.
* For SLS performance evaluations purpose, the minimum distance between micro gNBs’ of the same operator across sections is 10 m for outdoor scenarios in the deployment scenario field of Table 5.
* For SLS performance evaluations purpose, the minimum distance between micro gNBs’ of different operators is 10 m for outdoor scenarios in the deployment scenario field of Table 5.

Companies are encouraged to provide comments to the above proposal #6a.

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| Company Name | Comments/Views |
| InterDigital | We support Moderator’s proposal |
| Intel | We are ok with bullet 2, 3, 4 (on min distance).  For the first bullet, we would prefer DOCOMO and Qualcomm’s suggestion to have the 7 as baseline and 1 site as optional.  We are also ok with updating the ISD = 100m as Qualcomm suggested. |
| Apple | We are fine with the moderator’s proposal. |
| CATT | We are OK with moderator’s proposal |
| Ericsson | We agree to the first 3 bullets. We believe the last one is not needed. This type of coordination between networks is less probable for outdoor deployments.  Outdoor C is similar to outdoor A but with 3 sites. Since now we have scaled down scenario A, do we still need outdoor C ? |
| Qualcomm | We support Intel’s version of the set of proposals. |
| Nokia | We agree with all 4 bullets. |
| NTT DOCOMO | For the 1st bullet, we would prefer to have 7 sites as mandatory and 1 site as optional.  The other bullets are fine for us. |
| ZTE, Sanechips | We are fine with the moderator’s proposal. |
| Huawei, HiSilicon | We agree with all 4 bullets. Qualcomm’s suggestion to reduce ISD=100m is also fine.  There is a typo in the 3rd bullet  “For SLS performance evaluations purpose, the minimum distance between micro gNBs’ of the same operator across **sectors** is 10 m for outdoor scenarios in the deployment scenario field of Table 5.” |

### Traffic model and cell selection

Table 6. SLS Parameter Set 6

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter Set 6** | **TDD DL/UL Ratio** | **CSI feedback** | **Additive Rx EVM** | **Traffic Model** | **UE Receiver** | **Cell selection criteria** | **DL/UL Traffic Ratio** |
| **Description** | Companies to provide information (if applicable) | Ideal feedback | Note: additive Rx EVM values may be revisited after LLS study | FTP Model 3 (27Mbyte file)    Optional:  - Full buffer,  - FTP Model 1 (27 Mbyte file),  - FTP Model 3 (0.5, 2, 16 Mbyte file) | MMSE-IRC | Random select from strongest RSRP with 1 dB HO Margin  Note: UE with RSRP below a P\_threshold are not considered in simulation and counted toward UE distribution count  FFS: value of P\_threshold. (including the possibility of negative Inf) | 50% DL, 50% UL    Optional:  100% DL, 0% UL,  80% DL, 20% UL  0% DL, 100% UL |

#### UE cell selection

The above table was agreed in last RAN1 meeting for SLS. Regarding RSRP threshold for cell selection, there’re several contributions discussing this FFS issue.

[[41], Ericsson] proposes that UE with RSRP lower than -76 dBm are not considered in the simulations. The reason for that is in NR, UE is required to be able to detect SSBs with SNR as low as -5dB. Based on that, the UE association should at least be limited to UE that are able to detect DL RSRP of -76 dBm and higher.

The contribution [[60], Intel] proposes to adopt “-68 dBm + 10 log10( BW/2GHz )” as the RSRP threshold for user selection and “-infinity dBm” as optional RSRP threshold for user selection. The argument for -68 dBm (at 2 GHz system bandwidth) is that in unlicensed operations, system may need to operate with the assumption that UEs may only perform single shot detection of SSB, which would require the SSB detection requirement to be about 6 dB higher and near 0 dB SNR. The optional value of –infinity is to study the total implication of UE association in deployments.

Moderator’s comment:

For the contributions submitted with SLS results, not many details on UE cell selection criteria are described in the contributions submitted to this meeting. It may not be able to gain insight if no details are reported.

Proposal #7 for discussion:

* For SLS performance evaluations purpose, choose one of the following options as the baseline RSRP threshold for cell selection (UE with RSRP below this threshold are not considered in simulation and counted toward UE distribution count) in the Cell selection criteria field of Table 6.
  + Option 1) -76 dBm
  + Option 2) -68 dBm + 10 log10( BW/2GHz )
* For SLS performance evaluations purpose, “-infinity dBm” is an optional RSRP threshold for cell selection (UE with RSRP below this threshold are not considered in simulation and counted toward UE distribution count) in the Cell selection criteria field of Table 6.
* Note: companies are required to report what value is used as the RSRP threshold for cell selection

Companies are encouraged to provide comments on their preference of the above options or other values.

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| Company Name | Comments/Views |
| NTT DOCOMO | For the 1st bullet, assuming RSRP is measured with SSB, which should be common with any bandwidth, option 1 is reasonable in our view.  For the 2nd bullet, we think it could be considered as optional since it seems to evaluate a special case where only 60 GHz NW is deployed and UE has to connect even when measured RSRP is quite poor. |
| Intel | We are generally ok with moderator’s proposal #7. However, we should selection between option 1 or 2.  Between option 1 and 2, our preference is option 2. However, we are open for discussion on the reference value of -68dBm. The -68dBm was something that came from Ericsson in the last meeting. We agreed this could be used.  One thing to note is that if -76dBm is used for all system bandwidths, for 2 GHz system this would be having a threshold at -5dB SNR for 10dB NF Ues and -8dB SNR for 13dB NF Ues, and for 400 Mhz system, this would be having a threshold at 2dB SNR for 10dB NF Ues, and -1dB SNR for 13dB NR Ues. This seems to be selecting quite different deployment scenario just by fixing the RSRP threshold.  Therefore, if threshold is to be introduced, we should have one for different system bandwidths.  As for NTT DOCOMO’s comments on RSRP measurement. We are not entirely sure if companies are actually performing RSRP measurement using SSB. We note that depending on setup the SSB SCS could be different and this could lead to different bandwidth. Our understanding is that SSB is abstracted in the SLS and the RSRP is performed directly using the equations provided for SLS using the system bandwidths configured. Therefore, there would be some impact from different system bandwidths.  In any case, we thinks there is value for some discussion here. |
| Vivo | Option 2 |
| InterDigital | Option 2 |
| Nokia | Nokia supports “-infinity dBm” as a primary RSRP threshold and report how many Ues in the coverage fall below the -76 dBm. |
| Futurewei | We support Option 1 for cell selection. We are open for discussion on the RSRP threshold. There is not any agreement yet on the BW for initial channel access therefore we think Option 1 is a better choice for SLS. |
| Ericsson | We prefer Option 1.  The reason for that is in NR, UE is required to be able to detect SSBs with SNR as low as -5dB. Based on that, the UE association should at least be limited to UE that are able to detect DL RSRP of -76 dBm and higher. Intel’s observation about needing to operate with the assumption that Ues may only perform single shot detection of SSB may be true in the 5/6 GHz unlicensed band; however, in the 60 GHz band, the situation is different. There is much less of a chance that the gNB will not be able to transmit SSBs due to LBT failure, hence we expect that Ues will be able to operate closer to the FR2 detection requirement of -5 dB. This is important for outdoor coverage, for example. For this same reason, we don’t expect that defining a DRS transmission window is needed for operation in the 60 GHz band. |
| Huawei, HiSilicon | We would propose a merged version between option1 and 2, i.e.  Option 3) -76 dBm + 10 log10 ( BW/2GHz ).  As 400MHz is also a primary configuration, the UE dropping threshold should be scalable according to the channel bandwidth. |
| Samsung | In the SLS, the RSRP measurement may not always be from SSB, so Option 2 is better. |

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| Qualcomm | The FFS from last meeting also considered the option of reduced ISD. [‘FFS: whether ISD needs to be smaller’ ]  We would recommend considering ISD 100m and then applying an RSRP threshold.  For large ISDs the coverage holes are expected to be large and the resulting cells are isolated.  We support ISD 100m in combination with applying option 1, namely -76 dBm RSRP threshold for cell selection criterion with -infinity dBm threshold for statistics. |
| LG Electronics | Option 2 |
| ZTE, Sanechips | We prefer Option 1. We share similar view with Ericsson that 60GHz band situation is closer to FR2 detection requirement of -5dB. So at least for 2GHz bandwidth, -76dBm RSRP would be a more appropriate value. |
| Charter | We concur with Intel’s comment above that there is merit in a common understanding regarding SSB abstraction and RSR measurement.  We suggest to allow companies latitude in selecting the threshold, which should be reported. |
| Lenovo/Motorola Mobility | Option 1 |
| Apple | Option 2 |

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| Moderator | No clear majority of option 1 or 2.  Added option 3 as suggested by Huawei and option 4 in proposal #7a for further discussion in this meeting. |

Proposal #7a for discussion:

* For SLS performance evaluations purpose, choose one of the following options as the baseline RSRP threshold for cell selection (UE with RSRP below this threshold are not considered in simulation and counted toward UE distribution count) in the Cell selection criteria field of Table 6.
  + Option 1) -76 dBm
  + Option 2) -68 dBm + 10 log10( BW/2GHz )
  + Option 3) -76 dBm + 10 log10 ( BW/2GHz )
  + Option 4) Up to each company to choose the used RSRP threshold for UE cell selection
* For SLS performance evaluations purpose, “-infinity dBm” is an optional RSRP threshold for cell selection (UE with RSRP below this threshold are not considered in simulation and counted toward UE distribution count) in the Cell selection criteria field of Table 6.
* Note: companies are required to report what value is used as the RSRP threshold for cell selection

Companies are encouraged to provide comments on their preference of the above options in proposal #7a.

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| Company Name | Comments/Views |
| InterDigital | We support Option 2 |
| Intel 2 | To respond to Ericsson and ZTE’s comment on LBT situation being different in 60 GHz compared to 5/6 GHz. I can understand in some specific scenarios with specific antenna configuration, the blockage probability from LBT could be lower in 60 GHz.  However, this does not fundamentally change the challenges for the UE to perform accumulative SSB detection when UE may need to factor into account in some cases SSB do not exist. If the UE blindly performs accumulation when in fact SSB was not transmitted, this could lead to even worst performance. Therefore, significant logic space (including memory) and processing would need to implemented in order for the UE to perform accumulative detection on set of signal that may or may not be transmitted.  The issues stems from the fact when the UE is performing SSB detection, it has no way of knowing the deployment scenario or the setup and cannot assuming anything. Therefore, will need to account for the worst case, where some SSB may not be transmitted due to LBT failure. We are not sure if this is the base mode of operation we should be asking for the Ues.  Option 1 still doesn’t seem to address the issue of different user SNR cutoff for different system bandwidths. As we have mentioned, we are not sure how using SSB for RSRP calculation is going to solve this issue.  While we are not strictly stating we should use -68dBm bias component, if we are going to consider some RSRP threshold, we believe its only logical to consider the system bandwidths. We are somewhat open to the bias component of option 2. If the intent to maximize coverage as much as possible, we could possibly move it 2 ~ 3dB so that 10dB NF Ues are mainly targeted. So this would result in -70dBm or -71dBm + 10\*log10( BW/2GHz ). Something between -68 ~ -71dBm bias is ok to us.  In summary our preference would be option 2, but can consider -70dBm or -71dBm + 10\*log10( BW/2GHz ) as well. |
| Apple | Option 2 |
| CATT | Option 1. The threshold should be fixed. |
| Ericsson | We are fine with Option 3. |
| Qualcomm | We support Intel’s option of using bandwidth related adjustment applied to -71 dBm. Our next preference will be Option 3. |
| Nokia | Nokia supports option 3) -76 dBm + 10 log10(BW/2GHz). We agree that the BW scaling factor is required if we are to make this calculation.  We understand that the existing tables states: “Note: UE with RSRP below a P\_threshold are not considered in simulation and counted toward UE distribution count”.  We recommend companies be required to report the number of UEs that did not achieve the target RSRP as additional information representing the UEs that must be served by the macro system. |
| NTT DOCOMO | We are also okay to option 2/3 as well as option 1. We would like to clarify the RSRP model, especially how to model RSRP with different SCS and bandwidth. |
| ZTE, Sanechips | We prefer Option 3. |
| Huawei, HiSilicon | Option 3) |
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#### FTP traffic model packet size

In [[60], Intel], an issue was raised regarding traffic model packet size. It is observed that 27 Mbytes packet size causes long average packet delay and significant simulation run time. It is proposed to change the file/packet size from 27 Mbyte to [1] Mbyte.

Moderator’s comment:

There’re several companies submitted their preliminary SLS evaluation results in the contributions to this meeting. On the used FTP traffic model packet size for submitted SLS results, it is observed that several contributions [[59], ZTE; [66], Nokia; [67], Huawei; [33], vivo; [41], Ericsson; [25], NTT DOCOMO] used 27 Mbytes as in baseline for SLS while [[54], Qualcomm] used optional 2 Mbytes.

Proposal #8 for discussion:

* Regarding the baseline FTP traffic model packet size, choose one of the following options:
  + Option 1) Keep 27 Mbytes as it is
  + Option 2) Change into [1] Mbytes

Companies are encouraged to provide comments on their preference of the above options or other values.

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| Company Name | Comments/Views |
| NTT DOCOMO | Support Option 1, since it can be considered as higher throughput services which are typical for application on high frequency range in our view. |
| Intel | This was an issue that we brought up. Basically, 27Mbyte file sizes for packet generation does not seem to depict any real traffic packet sizes. Furthermore, cause some instability issues at the beginning of the simulation.  The high throughput traffic can be modeled with higher arrival rate, and it was not immediately clear why the file size was increased. We suggest using something small and increase the arrival rate to control flow of the traffic load.  We are open to the exact size, as long as it is around 0.5 ~ 2 MB size region. |
| Vivo | Option 1 but open to Option 2 |
| InterDigital | We are fine with changing the packet size, but we have concerns that opening new issues would delay the progress of the SI. Given the limited time of the SI, we are fine with Option 2 if we can make a quick consensus. Otherwise, we prefer Option 1. |
| Nokia | Option 1) Keep 27 Mbytes as baseline with an option to simulate smaller packet sizes. |
| Futurewei | Support Option 1, but we are OK to have Option 2 as optional. |
| Ericsson | We are OK with option 2 |
| Huawei, HiSilicon | Option 1) is preferred. It is closer to the typical use case in 60GHz band. |
| Samsung | Option 1. If no serious issue observed, we should keep the same evaluation assumption to save simulation effort. |

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| Qualcomm | FTP Model 1 can be used with option 1 27 Mbytes as file size. On the other hand, for FTP Model 3 with need for sufficient statistics per UE in reasonable simulation duration, a smaller file size appears suitable. A key consideration is the relationship of typical file delivery time with numerologies involved, namely bandwidth, COT durations assumed, and processing delays modeled. For small file sizes the perceived throughput performance may be dominated by Mac delays involved rather than link and interference conditions. We believe that both aspects (e.g. Mac and overhead delays, as well as link and interference conditions) can be studied by the choice of file sizes. As a compromise solution, we propose 8Mbytes as an intermediate file size to be used for all bandwidths, and numerologies. In absence of agreement, we support 2 Mbyte as the file size. |
| LG Electronics | No strong opinion but Option 2 (or 2 MB as Intel suggested) could be fine. |
| ZTE, Sanechips | We prefer Option 1. OK to have Option 2 as optional. |
| Charter | Support Option 2; okay with Option 1 |
| Lenovo/Motorola Mobility | Prefer option 2 with packet size in range 0.5-2 Mbytes, and higher arrival rate for higher throughput services. |
| Apple | Option 1 with option 2 optional. |
| CATT | Option 1 |

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| Moderator | Almost even split view on preference of option 1 vs, option 2. As commented by InterDigital, if not a quick consensus on one option, suggest to keep as it is (option 1 already agreed in last meeting). |
| Intel 2 | While we can understand companies’ reluctance to change agreed values, could the companies in favor of 27 Mbyte file sizes provide some technical rational for this file size? We weren’t able to understand where this value came from.  We are not aware of any typical traffic flows that are identified in modern communications that match 27MB file sizes. In fact, in many network implementations any packets larger than 1500 Byte are usually segmented into 1500 Byte or smaller packets. So, the value seemed quite random and very far from what we can observe in real traffic. Additionally, we did notice potential issues with simulation stability with 27MB file sizes. So, we would like just better understand technically where the 27 MB came from. |
| Ericsson 2 | Agree with Intel's questioning |

### Channel access modelling

Table 7. SLS Parameter Set 7

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| **Parameter Set 7** | **Channel access modeling** | **Synchronization Assumption** |
| **Description** | Companies to report details of LBT procedure and parameters (e.g. ED, CWmax, COT, etc.) if LBT procedure is used in the evaluations. | Companies are asked to provide information on the synchronization assumption made between operators for 2 operator deployment scenarios. |

The above table was agreed in last meeting. In contribution [[33], vivo], it was proposed to align the LBT procedure and parameters in coexistence evaluation between companies to facilitate the calibration.

Moderator’s comment:

It might be useful to decide a baseline LBT procedure and parameters for evaluation result calibration purpose. However, considering the discussion on channel access mechanism in agenda 8.2.2 and related regulations are still on-going, such a baseline LBT procedure and parameters may be hard to be agreed upon in limited time. Given companies are required to report details of LBT procedure and parameters if used in SLS from last meeting’s agreement. It seems no need to discuss further on a baseline LBT procedure and parameters if it’s for evaluation purpose only.

If a baseline LBT procedure and parameters can be agreed in agenda 8.2.2, then it’s beneficial to have the same baseline LBT procedure and parameters in evaluation.

Companies are encouraged to provide comments if any.

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| Company Name | Comments/Views |
| Intel | We agree with vivo’s suggestion. We noticed that in channel access discussion thread there is different understanding our how LBT needs to be performed. We believe it will be extremely valuable to have a reference LBT model for evaluations. |
| Vivo | Agreed that the baseline LBT procedure and parameters in 8.2.2 could be used in SLS evaluation. However, the method of energy calculation for directional LBT should be clarified, i.e. with or without beamforming gain when CCA check. |
| InterDigital | We support having the same baseline LBT procedure and parameters in evaluation. |
| Futurewei | We support having the a baseline for LBT procedure. |
| Ericsson | Enforcing certain LBT parameter values (COT, Cwmax) is not necessary. But it might be a good idea to at least agree that the LBT procedure is aligned with EN 302 567 [i.e. fixed CW size] |
| Huawei, HiSilicon | It should depend on the discussion in 8.2.2. |
| Samsung | Agree with moderator’s suggestion, although the detailed discussion may not take place in this agenda. |
| Qualcomm | We would propose to let companies describe the LBT procedures they used for simulations and the impact of their chosen parameters. On the other hand we agree with Ericsson’s proposal that a sample LBT procedure inline with EN 302 567 can be modeled. |
| LG Electronics | Agree with Moderator’s suggestion. |
| ZTE, Sanechips | Agree with moderator’s suggestion, we should align with the discussion in 8.2.2. |
| Charter | We support Moderator’s comment for the merits of a baseline LBT procedure |
| Lenovo/Motorola Mobility | Agree with Moderator’s suggestion to use the same baseline LBT procedure and parameters of 8.2.2 |

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| Apple | Agree with moderator’s observation on the ongoing discussions on a baseline LBT and conclusion. |

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| Moderator | Formulated proposal #8a below in case a baseline LBT procedure can be agreed. |

Proposal #8a for discussion:

* If a baseline LBT procedure and parameters were to agree in agenda 8.2.2, then at least the same baseline LBT procedure is used in SLS evaluation.

Companies are encouraged to provide comments to the above proposal #8a.

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| Company Name | Comments/Views |
| InterDigital | We support Moderator’s proposal |
| Apple | Agree with moderator’s proposal |
| CATT | We agree with moderator’s proposal |
| Ericsson | We support Moderator’s to align the LBT procedure. |
| Qualcomm | We support Moderator’s proposal |
| NTT DOCOMO | We support Moderator’s proposal. |
| ZTE, Sanechips | We support Moderator’s proposal |
| Huawei, HiSilicon | Agree moderator’s proposal |

### Other issue(s)

Please provide other issue(s) if any on SLS that requires resolution in this meeting.

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| Company Name | Comments/Views |
| Ericsson | * Companies should be required to submit RSRP distribution for the evaluated scenario otherwise it will be difficult to understand why results differ from one company to another, if there are such cases. * We believe that UE antenna orientation and randomization has also impact on the RSRP distribution, it would be preferred to align this setting among companies. This also affects the delay spread distribution. |

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| Qualcomm | 1. We support Ericsson’s comment above regarding RSRP distribution 2. Use of more antenna elements at gNB and UE for indoor environments. The lower wavelengths at 60GHz permit the consideration of larger number of antenna elements for the indoor environment deployments as well. We would propose to use (Mg,Ng,M,N,P) = (1,1,8,16,2) per pol with (0.5 dv, 0.5 dH) as an optional setting for indoor environment. 3. We would encourage companies to also consider any Multi-user multi-beam deployments for these studies. |

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| Ericsson | * Companies should also report if COT sharing is being used, and if yes,   + according to what rules. We see that companies are assuming an MCOT of 5ms, and it is not clear how this can be reached if the HARQ processes are limited to 16. Specifically, for the UL.   + When operating with LBT, how often no LBT is being utilized. (i.e., ratio of transmitted slots after performing LBT, e.g. assuming an MCOT of 5ms, a node performs LBT and can transmit continuously for at most 16 slots (0.25ms, for DL Time multiplexing of UE it can be longer) without waiting for feedback, is it so that the companies are assuming that DL and UL transmissions within the remaining 4.75 ms of the COT are happening without LBT ? in principle, it is not a wrong assumption, but our concern is that with this setup, even though the simulations are labeled as with LBT, majority of the transmissions are happening without LBT, which goes against the argument that LBT is needed to mitigate interference. |

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| Moderator | Proposal #8b and #8c added below for further discussion. Added notes to SLS template for COT sharing. |

Proposal #8b for discussion:

* Companies are required to submit RSRP distribution for the evaluated scenario in SLS.

Companies are encouraged to provide comments to the above proposal #8b.

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| Company Name | Comments/Views |
| InterDigital | We propose following update.   * Companies are encouraged to submit RSRP distribution for the evaluated scenario in SLS. |
| Intel | We support Ericsson and Interdigital’s suggestion to provide RSRP distribution for calibration purposes. RSRP distributions reported should contain not only serving cell BS-toUE link RSRP distribution, but also interfering BS-to-BS UE-to-UE link RSRP distributions.  Also asking companies to provide information on COT sharing (Ericsson’s 2nd suggestion) seems to be good idea.  In addition to information about COT sharing information, we would like to also ask companies to provide information about the following:  - whether shared COT contained transmissions with gNB/UEs with Tx/Rx beams that were not utilized during CCA process to obtain the COT,  - the UL transmissions used (e.g. scheduled grants or configured grants), and whether PDCCH grants were explicitly modeled.  - how the scheduling request (or buffer status report) was modeled, as the SR does impact the transmission behavior under LBT. |
| Apple | Agree with InterDigital’s update |
| CATT | We agree with moderator’s proposal |
| Ericsson | We believe that we should agree on aligned UE antenna orientation and randomization which has also impact on the RSRP distribution. UE antenna orientation should be randomized and same fixed orientation for all UEs should not be assumed. |
| Qualcomm | We support RSRP reporting but prefer language proposed by InterDigital. |
| Nokia | Nokia also supports submitting RSRP and is fine with the language proposed by Interdigital |
| NTT DOCOMO | We support submitting RSRP and are fine with the language by IDC. |
| ZTE, Sanechips | We support to report RSRP and the comment from InterDigital. |
| Huawei, HiSilicon | We agree the moderator’s proposal and InterDigital’s update.  It will also be helpful to calibrate the SLS scenarios if companies can also provide CDF for BS-to-BS and UE-to-UE link.  The channel models for UE-to-UE is still within bracket []. We suggest using InH – mixed office channel considering UE are at same height and there is blockage among them.. |

Proposal #8c for discussion:

* Add (Mg,Ng,M,N,P) = (1,1,8,16,2) per pol with (0.5 dv, 0.5 dH) as an optional antenna setting for gNB for indoor environment.

Companies are encouraged to provide comments to the above proposal #8c.

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| Company Name | Comments/Views |
| InterDigital | Support |
| Intel | support |
| Qualcomm | We support moderator’s proposal. |
| Nokia | Agree with the proposal |
| NTT DOCOMO | We agree with the proposal. |
| ZTE, Sanechips | Support. |

# Template for evaluation results

## 3.1. Link Level Simulation

There’re several companies submitted their LLS evaluation results to this meeting. Due to different result presentations and different assumptions/parameters are used in the contributions, it is hard to compile and collect all the submitted results. Furthermore, it is difficult to compare results in contributions by reading directly from for example, BLER curves.

To facilitate collecting results into the TR for meaningful observations and conclusions, it is recommended for companies to at least use a template to capture LLS results for next meeting. Note that, in additional to the templates/tables, companies can still submit results in other forms (e.g., BLER curves). Some templates similar to what are used in [[26], Qualcomm] have been proposed in below.

Proposal #9 for discussion:

* It is recommended to use the following template in Table 8 to capture the primary LLS performance metric of PDSCH/PUSCH BLER.
* It is recommended to use the following templates in Table 9 and Table 10 to capture the secondary LLS performance metrics of SSB and PRACH performance.

Table 8. LLS template: SINR in dB achieving PDSCH/PUSCH BLER of 10% /1%

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Tdoc /  Source | MCS | Channel | 120KHz /400MHz | 240KHz /400MHz | 480KHz /400MHz | 960KHz /400MHz | 960KHz /2GHz |
| R1-xxxxxxx / Source 1 | 7 | TDL-A, 5ns | X / Y (X for 10% BLER, Y for 1% BLER) |  |  |  |  |
| TDL-A, 10ns |  |  |  |  |  |
| TDL-A, 20ns |  |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |  |
| CDL-D, 20ns |  |  |  |  |  |
| CDL-D, 30ns |  |  |  |  |  |
| 16 | TDL-A, 5ns |  |  |  |  |  |
| TDL-A, 10ns |  |  |  |  |  |
| TDL-A, 20ns |  |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |  |
| CDL-D, 20ns |  |  |  |  |  |
| CDL-D, 30ns |  |  |  |  |  |
| 22 | TDL-A, 5ns |  |  |  |  |  |
| TDL-A, 10ns |  |  |  |  |  |
| TDL-A, 20ns |  |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |  |
| Additional report/notes:   1. CP type 2. antenna configuration for CDL model 3. waveform in case of PUSCH 4. PTRS configuration 5. DMRS configuration 6. any optional or other assumption/parameters used not as in the baseline | | | | | | |

Table 9. LLS template: SINR in dB achieving cell ID detection probability of 90% by one-shot detection from PSS/SSS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tdoc /  Source | Channel | 120KHz | 240KHz | 480KHz | 960KHz |
| R1-xxxxxxx / Source 1 | TDL-A, 5ns |  |  |  |  |
| TDL-A, 10ns |  |  |  |  |
| TDL-A, 20ns |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |
| CDL-D, 20ns |  |  |  |  |
| CDL-D, 30ns |  |  |  |  |
| Additional report/notes:   1. frequency offset 2. the number and granularity of the frequency locations 3. antenna configuration for CDL model 4. any optional or other assumption/parameters used not as in the baseline 5. false alarm rate 6. criteria for PSS detection success | | | | |

Table 10. LLS template: SINR in dB achieving PRACH preamble misdetection probability of 1% with less than 0.1% false alarm

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tdoc /  Source | Channel | 120KHz | 240KHz | 480KHz | 960KHz |
| R1-xxxxxxx / Source 1 | TDL-A, 5ns |  |  |  |  |
| TDL-A, 10ns |  |  |  |  |
| TDL-A, 20ns |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |
| CDL-D, 20ns |  |  |  |  |
| CDL-D, 30ns |  |  |  |  |
| Additional report/notes:  1. PRACH format  2. values of  3. antenna configuration for CDL model  4. any optional or other assumption/parameters used not as in the baseline | | | | |

Companies are encouraged to provide comments if any.

|  |  |
| --- | --- |
| Company Name | Comments/Views |
| NTT DOCOMO | Support the templates above. |
| Intel | We are ok with moderator’s suggestion. For the PDSCH and PUSCH table, we think there could be value to also provide 1% SNR values, as just having 10% may not provide a full picture of the curvature of the BLER curves.  For each entry, we can have X, Y where X is for 10% and Y is for 1% BLER. |
| Vivo | Support moderator’s proposal |
| InterDigital | We are fine with the template, but 20ns for TDL-A may be needed if we agree |
| Futurewei | We agree with proposed templates. |
| Ericsson | * Consistent with our comment in Section 2.1.2. TDL-A 20 and 40 ns should be added. * SNR at 1% BLER should also be reported * Other SCS/BW combinations can be reported * For PSS/SSS false alarm rate and criteria for PSS detection success should be reported * For PRACH, typically the following metric are separately reported:   + mis-detection probability   + false alarm probability   + timing estimation error |
| Huawei, HiSilicon | * The BLER for PDSCH and PUSCH should be prioritized |
| Samsung | * For Table 9, the wording for title is suggested as: SINR in dB achieving cell ID ~~PSS/SSS~~ detection probability of 90% by one-shot detection from PSS/SSS. Also, the target FAR should be benchmarked as 1%. One more clarification, the sub-bullet “branch number” is a little bit confusing: does it the number of frequency locations for blind detection at the receiver? If so, the granularity of the frequency locations should also be clarified/reported (simply reporting the number may not be informatic). |
| LG Electronics | We share the same view with InterDigital |
| ZTE, Sanechips | We support Moderator’s proposal. |
| Lenovo/Motorola Mobility | We are generally fine to support the proposed template for collecting LLS results. Additionally, we also share the same view with Intel and recommend adding a similar template to collect required SNR for 1% BLER SNR values as well |
| Apple | We are fine with the moderator’s proposal. |
|  |  |
| Moderator | Will update other DS values for channel model(s) if new agreement of baseline configuration in LLS  1% PDSCH/PUSCH BLER added  It’s a template with only baseline combinations listed. Companies are encouraged to use them to report other SCS/BW combinations.  On template for PRACH, not clear what exactly is the proposal from Ericsson. If Ericsson have a better template, please elaborate. |
| Ericsson 2 | We disagree with the addition of "one-shot detection from PSS/SSS." This may be the case for 5/6 GHz band; however, for 60 GHz, the chance of LBT failure for SSB transmission is low. Instead, companies can state the assumptions used for detection.  Regarding the moderator's question:  Our suggestion is for companies to *separately* report SNR to achieve 1% mis-detection probability and false alarm probability corresponding to SNR for 1% mis-detection probability. This is in-line with what was done in the Rel-16 NR-U WI, and also Rel-15. The same template as above can be used, but the title should be modified. Then companies would fill in two values: an SNR and a false alarm rate. It can be further discussed if there is a need to report some metric of timing estimation error, e.g., 90th percentile. |

## 3.2. System Level Simulation

There’re several companies submitted their preliminary SLS evaluation results to this meeting. Due to different result presentations are used in the contributions to this meeting, it is hard to compile and collect all the submitted results. To facilitate collecting results into the TR for meaningful observations and conclusions, a template similar to what was used for NR-U SI/WI has been proposed for companies to use capturing SLS results for next meeting.

Proposal #10 for discussion:

* It is recommended to use the following template in Table 11 to capture SLS results.

Table 11. System level evaluation results for scenario

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tdoc /  Source | Cases | | Case 1 | | | Case 2 | | |
| R1-xxxxxxx / Source 1 | Traffic load  Metrics | | Low load  10%~25% BO | Medium load  35%~50% BO | High load  above 55% BO | Low load  10%~25% BO | Medium load  35%~50% BO | High load  above 55% BO |
| DL UPT (Mbps) | 5%ile |  |  |  |  |  |  |
| 50%ile |  |  |  |  |  |  |
| 95%ile |  |  |  |  |  |  |
| mean |  |  |  |  |  |  |
| DL delay (s) | 5%ile |  |  |  |  |  |  |
| 50%ile |  |  |  |  |  |  |
| 95%ile |  |  |  |  |  |  |
| mean |  |  |  |  |  |  |
| UL UPT (Mbps) | 5%ile |  |  |  |  |  |  |
| 50%ile |  |  |  |  |  |  |
| 95%ile |  |  |  |  |  |  |
| mean |  |  |  |  |  |  |
| UL delay (s) | 5%ile |  |  |  |  |  |  |
| 50%ile |  |  |  |  |  |  |
| 95%ile |  |  |  |  |  |  |
| mean |  |  |  |  |  |  |
| Arrival rate (files/s) | |  |  |  |  |  |  |
| 𝜌DL | |  |  |  |  |  |  |
| 𝜌UL | |  |  |  |  |  |  |
| RU | |  |  |  |  |  |  |
| BO | |  |  |  |  |  |  |
| Additional report/notes:  1. LBT procedure and parameters  2. any assumptions/parameters used not as in the agreed baseline  3. Details of case: e.g., single or two operators; no-LBT, omni-directional LBT, directional LBT schemes etc.  4. Definition of RU  5. Details of COT sharing if used in evaluation | | | | | | | |

Companies are encouraged to provide comments if any.

|  |  |
| --- | --- |
| Company Name | Comments/Views |
| NTT DOCOMO | Support the templates above. |
| Intel | We are ok with moderator suggestion. Companies should provide detail information about the different cases being simulated (case 1 and 2 above).  In addition to above, we would like to also to provide RMS delay spread CDF figures, and corresponding ISI or INR figures. The SLS provides a lot of meaningful channel statistics that LLS cannot provide. We are not sure if a template is needed, but we should allow companies to provide such figures and have them captured in the TR as well. |
| Vivo | Support moderator’s proposal |
| InterDigital | We are fine with the template. |
| Futurewei | We agree with the proposed templates. |
| Ericsson | 1. Definition of low, medium, and high load should be clarified. Traditionally, they represented 10%~25% BO, 35%~50% BO, above 55% BO corresponding to the baseline scenario that we are comparing to. 2. Ratio of mean served cell throughput and offered cell throughput independently for DL and for UL. The table is missing 𝜌UL 3. RU is not needed since 𝜌DL and 𝜌UL and BO already capture the load situation in unlicensed in a better way than RU. 4. Report and capture the reported RSRP distribution for the evaluated scenario. 5. Capturing and reporting delay spread distribution from system level simulation is agreed as additional objective |
| Huawei, HiSilicon | It should clarify whether the results are from single operator or dual operators.  The BO corresponding to low/medium/high defined in NRU can be reused.  The definition of RU should be clarified especially when there might be LBT failure. |
| Samsung | To clarify, what is case 1 and case 2 in the table? Is it or will it be a specified case in the TR, or just a case up to company to report? |

|  |  |
| --- | --- |
| Qualcomm | We are fine with the template. We would support including RU in addition to the metrics outlined. For comparing schemes involving SINR vs Reuse tradeoff, it might be useful to know the resource utilization. A larger relative difference in RU metric vs that in BO metric may indicate the cost of overheads such as LBT countdown and silencing due to LBT failure. We agree with Ericsson on the utility of RSRP distributions and loading levels modeled. |
| LG Electronics | Support Moderator’s proposal and as Intel pointed out, detailed information about case 1 and case 2 needs to be provided. |
| ZTE, Sanechips | We support moderator’s template. As for RU, we suggest to keep it in the template, as it could show the specific resource allocation level. |
| Apple | We are fine with the moderator’s proposal. |
| CATT | We are OK with moderator’s proposal |

|  |  |
| --- | --- |
|  |  |
| Moderator | Updated template to address most comments.  I interpret Ericsson and Qualcomm’s comments as not to request defining a template for RSRP. Then whether to report RSRP CDF is in separate discussion.  I interpret Intel and Ericsson’s comments as not to request defining a template for delay spread rather to report CDF curves as in [[68], Intel] and [[70], Ericsson]. |
| Intel 2 | Yes, not adding the DS related information to the template was the intention. Just wanted to make sure, we do not leave out such information in the TR just because we do not have a template to do so. |
| Ericsson 2 | It is not clear how the RU value can be used for the unlicensed channel operation. A low RU value does not mean that the system is not loaded, instead it could be that the nodes are not able to access because of deferral. For this reason, we think that the served to offered traffic ratio and BO are a better metric to highlight if the load in the system is high.  Regarding the moderators statement: our view is that borh RSRP CDF and RMS DS CDF should be captured in the TR. Agree with the moderator and Intel that we may not need a template to do so. However, to make sure we don't forget this, we think Proposal 10 should be updated as follows:  Proposal #10 for discussion:   * It is recommended to use the following template in Table 11 to capture SLS results. * Companies to report CDF of RSRP and CDF of RMS delay spread (no template needed) |
| Qualcomm | We support moderator’s proposal. As in the template, BO is the right metric to use to determine loading levels. |

# Conclusion of the Discussion [102-e-NR-52-71-Evaluations]

**Summary of email discussion outcome:**

* TBD

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