**b3GPP TSG RAN WG1 Meeting #101-E R1-2004754**

**e-Meeting, May 25 – June 05, 2020**

**Source: Moderator (Intel Corporation)**

**Title: Summary of email discussions for [101-e-NR-52\_71\_GHz]**

**Agenda item: 8.1**

**Document for: Discussion**

# Introduction

In this contribution, we summarize the email discussion approved for discussion during RAN1 #101-E. Chairman has approved one email discussion thread for RAN1 #101-E for Agenda 8.1. The guidance was to focus on evaluation assumptions and if time allows (and feasible to conclude) to discuss high-level issues for NR 52.6 GHz to 71 GHz SI.

A summary of evaluation assumptions and simulation parameters from submitted contribution is available in R1-2004703 [1]. The following sections have been tagged with outline levels so that companies can easily search and move between tables and sections. Companies can go to ‘View’ panel of the Office Ribbon and select ‘Navigation Pane’ to show the outline bookmarks and click on specific outlines to go to the specific text or table.

# Email Discussion [101-e-NR-52\_71\_GHz]

It would be useful to categorize the discussion into three components, evaluation methodology for link level simulation, evaluation methodology for system level simulation, and high-level issues for supporting NR from 52.6 GHz to 71 GHz SI. The third topic, high-level issues, will be de-prioritized compared to the first two. The feature lead suggests to only aim for conclusion if wide support from numerous companies are available for specific issues.

## 2.1 Evaluation Methodology for Link Level Simulation

Moderator suggests identifying some of the evaluation objective (i.e. purpose) and related evaluation assumptions. Identification of the objective could be crucial to understand whether a single evaluation assumption is sufficient for all objectives or whether RAN1 needs to define multiple link level evaluation assumptions targeting different objective sets.

Based on contributions submitted, Moderator has identified the following evaluation objectives:

* Phase noise impact for various numerology (i.e. subcarrier spacing, and CP type)
* Performance analysis for PDSCH/PUSCH
* Performance analysis for SSB
* Channel delay spread impact for various CP type/lengths

Also put together a table for initiating discussions on the evaluation assumptions.

Table 1. Suggested harmonized link level simulation parameters as baseline for discussion

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Notes** |
| Carrier Frequency [GHz] | 60 GHz  Optional: 70 GHz |  |
| Subcarrier Spacing [kHz] | 240 kHz, 480 kHz, 960 kHz  Optional: 60 kHz, 120 kHz, 1920 kHz, 3840 kHz |  |
| Bandwidth [MHz] | 2000 MHz  Optional: 400 MHz, 500 MHz |  |
| Number of RB | For 2000 MHz:  320 (480 kHz), 160 (960 kHz), 80 (1920 kHz), 40 (3840 kHz)  For 400 MHz:  256 (120 kHz), 128 (240 kHz), 64 (480 kHz), 32 (960 kHz), 16 (1920 kHz), 8 (3840 kHz)  For 500 MHz:  330 (120 kHz), 165 (240 kHz), 82 (480 kHz), 41 (960 kHz), 20 (1920 kHz), 10 (3840 kHz) | Do not exceed 4k FFT size |
| CP Type | Normal CP, Extended CP |  |
| Channel Model | TDL-A (5ns, 10ns DS)  Optional:  TDL-D (1ns, 10ns DS)  Optional:  CDL-A (10ns, 30ns DS)  CDL-B (10ns, 20ns, 50ns DS)  CDL-D (20ns, 30ns, 40ns, 50ns DS) |  |
| Antenna Configuration (Mg,Ng,M,N,P) | For TDL model:  2x2  Optional: 1x2  For CDL model:  (1,1,8,16,2) BS, (1,1,4,4,2) UE with (0.5 dv, 0.5 dH)  Optional BS configuration:  (1,1,4,8,2), (2,2,4,8,2), (1,1,4,8,2)  Optional UE configuration  (1,1,2,4,2), (1,2,2,4,2), (1,1,2,2,2) |  |
| PA Model | Optional:  Companies to provide modeling | In lieu of pre-loaded Tx EVM |
| Tx PN Model | 3GPP TR38.803 example 2 BS  Optional:  3GPP TR38.803 example 1  Companies to provide modeling |  |
| Rx PN Model | 3GPP TR38.803 example 2 UE  Optional:  3GPP TR38.803 example 1  Companies to provide modeling |  |
| Pre-loaded Tx EVM | Optional:  3% at Tx | In lieu of PA model |
| Additive Rx EVM | Optional:  5% at Rx |  |
| I-Q Imbalance | Optional:  -26dBc, -31dBc |  |
| Channel Estimation | Realistic channel estimation |  |
| Mobility | 3 Km/hr |  |
| Transmission Rank | Rank 1  Optional: Rank1+2 adaptive, Rank 2 |  |
| PDSCH SLIV | (S=2, L=12)  Optional:  (S=3, L=11), (S=0, L=14) | Starting symbol, S, (indexed from 0) and length, L. |
| DMRS Configuration | Front loaded, 1 DMRS symbol  Optional:  2 DMRS symbol at (2,11) symbol index |  |
| PTRS Configuration | (K = 4, L = 1)  Optional:  (K = 2, L = 1) | PTRS per K number of PRBs, and PTRS every L number of OFDM symbols |
| MCS/TBS | MCS 16 (16QAM), MCS 22 (64QAM)  Optional:  MCS 1 (QPSK), MCS 7 (QPSK),  MCS 23 (256QAM), MCS 27 (256QAM) |  |
| Frequency Offset | Optional:  0.1 ppm (for data channel)  10 ppm (for initial access) |  |

**Discussion Summary:**

Companies are encouraged to provide comments on

* Evaluation objectives
  + Including whether we should define a separate evaluation parameter set for a group of objective(s) separately or whether single set of evaluation parameters is sufficient.
* Comment on individual parameters, including whether anything is missing from the evaluation parameter set.
  + Including whether or not to define ‘optional’ values or whether RAN1 should just simply provide a list of parameters without providing optionality.

Table 2. LLS Parameter Set 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter**  **Set 1** | **Evaluation Objectives** | **Carrier Frequency [GHz]** | **Subcarrier Spacing [kHz]** | **Bandwidth [MHz]** | **Number of RB** | **Waveform** |
| **Value** | Phase noise impact for various numerology (i.e. subcarrier spacing, and CP type)  Performance analysis for PDSCH/PUSCH  Performance analysis for SSB  Channel delay spread impact for various CP type/lengths | 60 GHz    Optional: 70 GHz | 240 kHz, 480 kHz, 960 kHz    Optional: 60 kHz, 120 kHz, 1920 kHz, 3840 kHz | 2000 MHz    Optional: 400 MHz, 500 MHz | For 2000 MHz:  320 (480 kHz), 160 (960 kHz), 80 (1920 kHz), 40 (3840 kHz)    For 400 MHz:  256 (120 kHz), 128 (240 kHz), 64 (480 kHz), 32 (960 kHz), 16 (1920 kHz), 8 (3840 kHz)    For 500 MHz:  330 (120 kHz), 165 (240 kHz), 82 (480 kHz), 41 (960 kHz), 20 (1920 kHz), 10 (3840 kHz) | CP-OFDM  DFT-s-OFDM |
| **Huawei, HiSilicon** | Performance analysis should refer to quantifiable KPIs. So we suggest changing to BLER analysis for PDSCH/PUSCH.  Is performance analysis for SSB about BLER of PBCH, or is the intention to look at other metrics such as detection probability or false alarm rate? We think that looking at the BLER is sufficient, and could be inferred from the BLER of PDSCH. Thus we think we may not need to add a KPI for evaluation of SSB. | It is not clear why evaluations at two nearby frequencies is needed. ITU-R selected 70 GHz for IMT-2020 evaluations, so we suggest 70 GHz as mandatory, and no need to provide optional values. | 120 kHz is the largest SCS already available in FR2, so it should be evaluated by companies and serve as a baseline. | 2000 MHz is too large to evaluate using a single carrier with SCS smaller than 960kHz. If 2000 MHz is useful for SCS, we could use a smaller value for LLS, e.g. 400/ MHz. it is not clear why more than one value is needed. |  |  |
| **Lenovo /Motorola Mobility** | Obj1: Primary evaluation objective of the LLS should be see the impact of PN with normal cyclic prefix length with different SCS:   * For this objective, BLER for PDSCH/PUSCH should be prioritized and SSB evaluation could be optional   Obj2: In addition, it is also important to study if and for what SCS, extended cyclic prefix will be needed.   * For this objective, different ECP values should be evaluated at least for 960 kHz SCS and higher, if needed   Obj3: Optionally, the impact/necessity of different SCS values could be evaluated for different carrier frequencies i.e. if the same set of SCS values are needed for entire range of 52.6 GHz to 71 GHz | We agree to keep 60 GHz as the main candidate value for carrier frequency for Obj 1 and Obj2.  For Obj 3, it could be useful to simulate additionally for ~50GHz and ~70GHz to see the variation with SCS across the entire range of carrier frequencies in this SI | We also have similar view has Huawei/HiSilicon to simulate 120 kHz as the baseline.  We agree with other required SCS values i.e. 240 kHz, 480 kHz, 960 kHz.  For Optional value, we think 1920 kHz could only be evaluated | We also agree with Huawei/HiSilicon. We think at least one value i.e. 400 MHz should be required to allow performance comparison without considering CA. 2000 MHz could be optional | As suggested 400 MHz as required value for BW size, the following # of RBs should be required corresponding to required SCS values as recommended by us:  For 400 MHz:  256 (120 kHz)  128 (240 kHz)  64 (480 kHz)  32 (960 kHz)  16 (1920 kHz) (optional) | We suggest keeping CP-OFDM as mandatory for evaluations  DFT-s-OFDM can be optional |
| **Ericsson** | A single set of evaluation objectives is sufficient as a starting point. The primary objectives of the link level evaluation are performance with phase noise impairment and effect of delay spread. |  |  | It is our view that it is too early for 3GPP to decide on 2000 MHz as the primary focus. We suggest giving equal priority to at least 3 candidate bandwidths, e.g., 500, 1000 and 2000 MHz BW evaluation to guide further discussion on selecting a combination of SCS and max BW. | We suggest replacing the 400 MHz list with a 1000 MHz list. We further suggest removing cases with fewer than 20 RBs (SSB BW) and simplifying the BW/PRB combinations (since exact guard band sizes are to be decided by RAN4).  For 2000 MHz:  320 (480 kHz), 160 (960 kHz), 80 (1920 kHz), 40 (3840 kHz)  For 1000 MHz:  320 (240 kHz), 160 (480 kHz), 80 (960 kHz), 40 (1920 kHz), 20 (3840 kHz)  For 500 MHz:  320 (120 kHz), 160 (240 kHz), 80 (480 kHz), 40 (960 kHz), 20 (1920 kHz) |  |
| **Futurewei** | Phase noise impact for various numerology (i.e. subcarrier spacing, and CP type)  Performance analysis for SSB (with beamform)  Channel delay spread impact for various CP type/lengths  Performance analysis for PDSCH/PUSCH | 60 GHz as the main target, and optional 70GHz | 240 kHz, 480 kHz, 960 kHz    Optional: 120 kHz (already supported in FR2) | 800 MHz  Optional: 400 MHz, Optional: 1600 MHz  Larger bandwidth such 2000 MHz can be obtained with CA | 128 (480 kHz, 800 MHz),  256 (240 kHz, 800 MHz)  64 (960 kHz, 800 MHz) |  |
| **vivo** | Our understanding is that 1st, 2nd and 4th objective can be combined into one where PDSCH/PUSCH BLER performance with RF impairment and effect of delay spread is investigated.  We also support the 3rd objective on the impact of SCS on SSB/initial access performance. | Support Moderator’s proposal | Support Moderator’s proposal | On bandwidth, if the intention is to see the impact of bandwidth, we suggest 500 MHz and 1 GHz in additional to 2 GHz.  400 MHz is so close to 500 MHz to see any difference. | Similar view as Ericsson to  replace the 400 MHz list with a 1000 MHz list.  For 2000 MHz:  320 (480 kHz), 160 (960 kHz), 80 (1920 kHz), 40 (3840 kHz)  For 1000 MHz:  320 (240 kHz), 160 (480 kHz), 80 (960 kHz), 40 (1920 kHz), 20 (3840 kHz)  For 500 MHz:  320 (120 kHz), 160 (240 kHz), 80 (480 kHz), 40 (960 kHz), 20 (1920 kHz), 10 (3840 kHz) | We also support to evaluate PUSCH with DFT-s-OFDM as optional |
| **InterDigital** | Agree with Huawei. PDSCH/PUSCH BLER analysis should be prioritized | We support the moderator’s proposal | We also agree that 120 kHz should be baseline and 1920 kHz can be added in addition to the suggested values from the moderator | Considering the available bandwidth from 52.6 GHz to 71 GHz, 2000 MHz should be mandatory. In addition, 400 MHz should be mandatory as well to evaluate performance of smaller bandwidth implementation | We support the moderator’s proposal | CP-OFDM as mandatory and DFT-s-OFDM as optional |
| **ZTE** | Prioritize the evaluation of different SCS and CP length on PDSCH/PUSCH, including the effect of Phase noise and Delay spread, the performance metrics could be PDSCH/PUSCH BLER.  SSB evaluation could be considered in the second stage as new SSB patterns have not been discussed yet.  Separate parameter set for a group of objective(s). | 60 GHz | 240 kHz, 480 kHz, 960 kHz  Using 120 kHz as the baseline for performance comparison | 400 MHz as a baseline  Further evaluate 2000 MHz | OK if the RB number is only for simulation purpose.  For 2000 MHz:  320 (480 kHz), 160 (960 kHz)  For 400 MHz:  256 (120 kHz), 128 (240 kHz), 64 (480 kHz), 32 (960 kHz) |  |
| **Qualcomm** | We support the general scope of the suggested objectives. However, as vivo also pointed out, the boundaries of different objectives are not very clear, and it may need further discussion. | We support 60GHz as the mandatory evaluation setting. | We think the existing FR2 design should be the baseline. At least 120kHz SCS should be mandated. | 400MHz, which is the largest bandwidth supported with 120kHz SCS in FR2, should be the baseline and mandated, Keeping 400MHz and 2000MHz as mandatory will be desirable. | As the baseline is existing FR2 design, any options with FFT size exceeding 4k (or number of PRBs larger than 275) should be optional. |  |
| **Nokia** | BLER analysis for PDSCH/PUSCH   * phase noise impact for various numerology (i.e., subcarrier spacing and bandwidth) * Results with different channel delay spread values   NCP is mandatory  ECP is optional. It needs to be considered only for certain data/control channel scenarios (e.g. for those with the highest SCS).  Performance analysis for SSB/PRACH  Channel delay spread impact for various CP type/lengths | 60 GHz  70 GHz is optional | Data/control channels:   * [120 240 480 960] kHz * Optional: [1920 3840] kHz   PRACH:   * 120 kHz * Optional: [240 480 960] kHz   SSB:   * 240 kHz * Optional: [480 960] kHz | Also 400MHz should be mandatory, because PN impact depends on the BW  400 MHz  2.16 GHz  Optional: [800, 1200, 1600] MHz | 400 MHz proposal is acceptable for studying the impact of phase noise and CP length (RAN1).    For 2.16 GHz we propose the following:   * 180 (SCS ≤ 960 kHz) * 90 for 1920 kHz SCS * 45 for 3840 kHz SCS   We propose not to include simulation cases having more than 275 PRBs / BWP | Both CP-OFDM and  DFT-s-OFDM need to be considered, because phase noise impact is different.  Our results show that DFT-S-OFDM is more robust against phase noise compared to CP-OFDM |
| **Samsung** | We are OK in general on the objectives, and suggest to add “Performance analysis for PRACH” | 60 GHz should be sufficient. | We didn’t see a need for SCS larger than 960 kHz, but OK to study. | Support Moderator’s proposal | Support Moderator’s proposal |  |
| **Apple** | Phase noise impact should include effect of subcarrier spacing, CP type and bandwidth as the total BW affects the total PN seen by the system.  BLER analysis of PDSCH/PUSCH should be prioritized. Agree with previous companies that SSB should be a secondary priority. CP study should include Channel delay spread impact for various CP type/lengths | 60 GHz  70 GHz optional | 240 kHz, 480 kHz, 960 kHz  Using 120 kHz as the baseline for performance comparison | 2000 MHz should be studied with 400 MHz as baseline. Other BWs should be multiples of 400 MHz and optional. | support moderator’s proposal as basis for study if used only for simulations. Scale 400 MHz values based on simulated BWs. | support moderator’s proposal. |
| **LG** | We are generally OK with the above evaluation objectives suggested by Moderator. | We share the same view with other companies.  60 GHz should be sufficient. | We have similar view with Nokia that the SCS values used for evaluation need to be differentiated between SSB and other channels.  - For SSB, the existing 240 kHz should be baseline.  - For other channels, the values 240/480/960 kHz are OK as baseline. | We share the same with other companies that the bandwidths of 400/800 MHz should be baseline.  1600 MHz or larger bandwidth can be considered as optional. | According to the combinaton of SCS and BW, the following values are to be considered as the number of RBs.  - For 400 MHz:  128 (240 kHz), 64 (480 kHz), 32 (960 kHz)  - For 800 MHz:  256 (240 kHz), 128 (480 kHz), 64 (960 kHz) | CP-OFDM is to be considered as baseline. |
| **Intel** | Support Moderator’s proposal | Support Moderator’s proposal | 240 kHz, 480 kHz, 960 kHz    Optional: 120 kHz, 1920 kHz, 3840 kHz  SCS=60 kHz should be excluded even from the Optional set. It was identified SCS=60 kHz is not enough for 52.6-71 GHz even with small modulation orders. | 800 MHz    Optional: 2000 MHz  The bandwidth of 800 MHz should be selected as Mandatory instead of 2000 MHz as a compromise between a larger BW and simulation complexity caused by BW increase. So, BW=2000 MHz could be Optional. We don’t see any reason to keep additional smaller BW sizes, e.g., 400 MHz and 500 MHz, even as Optional because they can be supported anyway by proper resource allocation in the frequency domain. Also, the values of 400 MHz and 500 MHz themselves are quite similar. | For 800 MHz:  264 (240 kHz), 132 (480 kHz), 66 (960 kHz), 32 (1920 kHz), 16 (3840 kHz) |  |
| **MediaTek** | PDSCH/PUSCH BLER performance for various numerologies under the impact of:   * Phase noise * Channel delay spread   Optional:   * SSB performance analysis * Impact of PA nonlinearity | 60GHz  Optional: 70GHz | |  |  | | --- | --- | | BW (MHz) | [SCS (KHz), #RBs] | | 500 | Mandatory: [120, 320], [240, 160], [480, 80], [960, 40] | | 1000 | Mandatory: [240, 320], [480, 160], [960, 80]  Optional: [1920, 40] | | 2000 | Mandatory: [480, 320], [960, 160]  Optional: [1920, 80] | | | | Mandatory: CP-OFDM and DFTS-OFDM |
| **NTT DOCOMO** | We support the general scope, and share the view with vivo and Qc. | We support the moderator’s proposal. | In addition to the moderator’s proposal (i.e. 240, 480 and 960 kHz), we think 120 and 1920 kHz should also be included as mandatory. | To consider the enhancement based on NR FR2, 400 MHz should be studied as mandatory. 500 MHz is also fine for us.  Also, we support the moderator’s proposal i.e. 2000 MHz, to consider how to coexist with 11ad/ay. | For 2000MHz:  320 (480 kHz), 160 (960 kHz), 80 (1920 kHz)  For 400 MHz:  256 (120 kHz), 128 (240 kHz), 64 (480 kHz), 32 (960 kHz), 16 (1920 kHz)  FFT size of less than 4k should be kept in our view. |  |
| **Sony** | We think the PDSCH/PUSCH and SSBs are important to be studied. The impact of phase noise on numerology is also critical. |  | We agree with the moderator’s proposal. | We agree with the moderator’s proposal on studying 2000 MHz bandwidth, especially for unlicensed band. 400 MHz is also important since it aligns with current FR2 bandwidth. |  | Both are important and need to be studied. |
| **TCL** |  | Support Moderator’s proposal | 240 kHz, 480 kHz, 960 kHz  960 kHz, 1920 kHz optional and only for 1000 MHz and above | We think that BW flexibility remains a key advantage of NR, therefore several BW must be supported.  400 MHz looks as natural candidate but other values should not be precluded.  We support 400 MHz mandatory and others , up to 2000MHz optional. | Number of PRB mut be kept high enough for the sake of eficient ressource signalling. Thus SCS above 480 kHz must be precluded at least for low BW ( < 1000MHz).    For 400 MHz:  256 (120 kHz), 128 (240 kHz), 64 (480 kHz)    For 500 MHz: (optional)  330 (120 kHz), 165 (240 kHz), 82 (480 kHz)  For 2000 MHz (optional):  320 (480 kHz), 160 (960 kHz), 80 (1920 kHz) | CP-OFDM as mandatory and DFT-s-OFDM as optional |
| **Charter** | The Moderator proposal reads like four separate objectives, whereas what is required is an “evaluation of physical shared channel BLER and SSB detection/decoding performance with representative modeling of PN and channel characterisitics.”  We support evaluation of SSB detection/decoding performance, otherwise it is difficult to determine if SSB time/freq.-domain enhancements are needed. | Agree with 60 GHz as primary choice. | For SSB, 240 kHz and 960 kHz  For data channels, 120 kHz and 960 kHz should be mandatory.regadless of BW. | Fine with at most two values for the BW, such as 400 MHz and 2000 MHz | Agree with Ericsson and vivo | Both waveforms should be analyzed |
| **CATT** | The KPI(s) needs to be quantified, such as BLER, miss-detection performance.  PRACH performance needs to be included in addition to the performance of SSB/PDSCH/PUSCH. | 60 GHz is mandatory  70 GHz is optional | For SSB evaluation, 480KHz,960KHz since 240Khz pattern already supported.  For PDSCH/PUSCH/PDCCH/PRACH : 240 kHz, 480 kHz, 960 kHz | Maximum BW = 1 GHz  Optional: 400 MHz,  Larger bandwidth such 2.16 Hz can be achieved through CA | For 400 MHz:  256 (120 kHz), 128 (240 kHz), 64 (480 kHz), 32 (960 kHz), 16 (1920 kHz), 8 (3840 kHz)  we have not seen the benenfit for 2000MHz on evlauaiton |  |
| **Potevio** | Support Moderator’s proposal | Support Moderator’s proposal |  | We share the same view with some companies that the bandwidths of 400 MHz should be studied as baseline, |  | Mandatory: CP-OFDM and DFTS-OFDM |
| **OPPO** | We think the following simulations can be considered:  1. PDSCH/PUSCH simulation, the evaluation metric could be BLER performance.  2. SSB simulation, the evaluation metrics may include PCI detection probability and PBCH DMRS detection probability.  To evaluate the performance of the above LLS, the impacts of phase noise, various numerologies, channel delay spread, etc., can be considered. | 60 GHz | 240 kHz, 480 kHz, 960 kHz | 2000 MHz, 500 MHz | For 2000 MHz:  160 (960 kHz)    For 500 MHz:  165 (240 kHz), 82 (480 kHz) | MCS 16 (16QAM), MCS 22 (64QAM)  MCS 23 (256QAM) |
| **Parameter**  **Set 1** | **Evaluation Objectives** | **Carrier Frequency [GHz]** | **Subcarrier Spacing [kHz]** | **Bandwidth [MHz]** | **Number of RB** | **Waveform** |
| **Moderator Summary/Suggestion** | 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, 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 bandwidhts are evaluated  [Moderator notes: There was wide spread of view on this parameter. From the feedback it was generally observed that companies wish to evaluate something small, e.g. 400, 500, and something large, e.g. 1000, 1600, or 200. Moderator suggest 400, 2000 to capture the two extremes. Also note that evaluation of a bandwidth does not necessarily mean RAN1 specification will automatically support it. Support of channel bandwidth will need separate discussion. The motivation for having common bandwidths agreed for evaluation to try to align results among companies and obtain insights for different bandwidths.] | 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),  - 320 (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 |
| **Lenovo/ Motorola Mobility** |  |  |  |  | For BW size of 2000 MHz, 480 kHz SCS should be N/A as well to follow the current restriction of maximum 275 PRBs in NR.  [Moderator comments: I think we can discuss later whether RB size beyond 275 should be valid or not. For the evaluation purposes, I think it ok to leave it as is. The purpose of the evaluation to get insights on phase noise impact and not trying to agree to specific RB sizes anyway. I would suggest leaving the value as they are for now] | We think that only CP-OFDM should be only be mandatory, and DFT-s-OFDM should be optional. Currently we don’t have separate set of SCS values for each waveform type and we think this should be avoided even for B52.6 GHz.  [Moderator comments: I’ve updated so that it reflects the current waveforms supported for PDSCH and PUSCH] |
| **InterDigital** |  |  |  |  |  | DFT-s-OFDM mandatory may be fine for UL, but DFT-s-OFDM should be optional for UL since DFT-s-OFDM is not existing waveform in DL  [Moderator comments: I’ve updated so that it reflects the current waveforms supported for PDSCH and PUSCH] |

Table 3. LLS Parameter Set 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter**  **Set 2** | **CP Type** | **Channel Model** | **Antenna Configuration (Mg,Ng,M,N,P)** | **Mobility** |
| **Value** | Normal CP, Extended CP | TDL-A (5ns, 10ns DS)    Optional:  TDL-D (1ns, 10ns DS)    Optional:  CDL-A (10ns, 30ns DS)  CDL-B (10ns, 20ns, 50ns DS)  CDL-D (20ns, 30ns, 40ns, 50ns DS) | For TDL model:  2x2  Optional: 1x2  For CDL model:  (1,1,8,16,2) BS, (1,1,4,4,2) UE with (0.5 dv, 0.5 dH)  Optional BS configuration:  (1,1,4,8,2), (2,2,4,8,2), (1,1,4,8,2)  Optional UE configuration  (1,1,2,4,2), (1,2,2,4,2), (1,1,2,2,2) | 3 Km/hr |
| **Huawei, HiSilicon** |  | We would propose CDL-D and CDL-B as mandatory because beam-based transmission is inevitable in this frequency range. | For CDL, we would suggest making mandatory one of the BS configurations with fewer antennas, e.g. (1,1,4,8,2) for InH.  For TDL with 2x2 link for rank 1 transmission, what would be the assumption on the precoding matrix for the link-level? |  |
| **Lenovo /Motorola Mobility** | NCP should be considered for all the SCS value and ECP should be considered for SCS value of at least 960 kHz and higher | CDL-B with 10ns, 30ns and 50ns DS and CDL-D with 20ns, 30ns, 50ns DS should be required  CDL-A with 10ns and 30ns DS could be optional | We suggest having one required configuration i.e. BS (1,1,4,8,2) & UE (1,1,2,2,2) with (0.5dv, 0.5 dH) | We agree with 3Km/hr |
| **Ericsson** | We suggest NCP should be the baseline and ECP as optional. Please see further our comments on the MCS. | The TDL models are intended for simplified evaluations [38.901]. They are not suitable choices for the NR operations in 60 GHz study where the distributions of delay spreads and impacts of beamforming play utmost importance in the decisions of SCS selection and other essential system designs. We see two immediate flaws in the proposed TDL-A 5 or 10 ns DS models:  We attached below comparisons of delay spread distributions before and after beamforming. It can be observed that the DS distribution after beamforming cannot be well approximated by using just one pre-BF DS distribution.  Assuming very short DS of 5 or 10 ns does not match the actual DS after beamforming and underestimates the negative impact of inter-symbol interference. Using such short DS can lead to a SCS choice that performs poorly in a real deployment.  Moreover, since beam forming is an inherent aspect in the evaluations, it is essential to model the spatial characteristics of the channel. The CDL model accounts for the angle spreads and mean angle of arrival/departure in both the azimuth and zenith dimensions. It is important to capture the interplay between these parameters and beamforming at the gNB and UE in order to provide post-beamformed channels with the proper characteristics. These characteristics, which are crucial to consider, can only be obtained using CDL channel; the TDL model does not account for these characteristics. Hence, TDL should not be the primary model used for evaluations.  In conclusion, we suggest adopting the following way forward:  CDL as the primary model and TDL as optional:  CDL-B (20ns, 50ns DS)  CDL-D (20ns, 30ns DS)  The 20 ns delay spread is consistent with the indoor office environment (see comments in next column) and the {30,50} ns delay spread values correspond to the outdoor environment  Optional:  TDL-A (4ns, 8ns, 16ns, 32ns, 48ns, 64ns DS) | In our view, the assumption of (1,1,8,16,2) BS, (1,1,4,4,2) UE is not representative of indoor applications. We suggest adopting a framework that treats indoor and outdoor applications separately:  (1,1,8,16,2) BS, (1,1,4,4,2) UE with (0.5 dv, 0.5 dH) for the UMi outdoor environment CDL-B (50ns) CDL-D (30ns)  (1,1,4,8,2) BS, (1,1,2,2,2) UE with (0.5 dv, 0.5 dH) for the indoor office environment CDL-B (20ns) CDL-D (20ns) |  |
| **Futurewei** | Normal CP, Extended CP | TDL-A (5ns,10ns DS)  CDL-B (10ns, 20ns, 50ns DS) | For TDL model:  2x2  For CDL model:  (1,1,8,16,2) BS, (1,1,4,4,2) UE with (0.5 dv, 0.5 dH) |  |
| **vivo** | Support NCP as mandatory and keep ECP to be optional for evaluation | Support Moderator’s proposal | OK with Moderator’s proposal  This is for LLS. Don’t see the need to have antenna configurations targeting for outdoor and indoor scenario separately |  |
| **InterDigital** | Normal CP should be mandatory and ECP can be considered as optional | We propose to evaluation CDL-B and CDL-D as mandatory with 20ns, 40 ns and 100 ns delay spread. | For gNB configuration, (2,2,4,8,2) with (dv,dH) = (0.5,0.5)  For UE configuration, (1,2,2,4,2) with (dv,dH) = (0.5,0.5) | We also agree with 3Km/hr |
| **ZTE** | Normal CP, Extended CP  For the purpose of CP type evaluation,both are needed; for other evaluation, Normal CP is mandatory | Channel model is related to the evaluation scenario. Generally we could choose one LOS channel and one NLOS channel. For example, TDL-A(10ns) and CDL-D(30ns) | For TDL model:  2x2  Optional: 1x2  For CDL model:  (1,1,8,16,2) BS, (1,1,4,4,2) UE with (0.5 dv, 0.5 dH) |  |
| **Qualcomm** | NCP as mandatory and ECP as optional | - To investigate the impact of beamforming, we think at least one CDL channel model (e.g., CDL-B) should be considered as mandatory.  - For the evaluation objective of “channel delay spread impact”, a larger delay spread for CDL (e.g., 100ns) should be considered. | Support the suggested configurations. | Support 3km/h |
| **Nokia** | NCP is mandatory  ECP is optional. It is considered only for certain data/control channel scenarios (e.g. for those with the highest SCS (>=1920kHz)) | TDL-D (1ns, 10ns DS)  TDL based model is enough to study the phase noise impact, and significantly simplifies the simulation burden. LOS channel should be main priority.  Optional:  TDL-A (5ns,10ns DS)  CDL-D (k-factor 10)  For CDL-model, the setup such as bearing angles/beam pointing directions should be agreed as common to get similar results. With CDL-D LOS AoA and ZoA should be reflecting corresponding AoD and ZoD angles (AoA=-AoD,ZoA=180-ZoD). | For TDL model:  2x2  For CDL model:  (1,1,8,16,2) BS, (1,1,4,4,2) UE with (0.5 dv, 0.5 dH)  fix arrays pointing each other. TX (azimuth 0, elevation 90), RX( azimuth -180, elevation 90). We do not support using multiple panels for this evaluation. | 3 Km/hr |
| **Samsung** | Support NCP as mandatory and ECP can be considered as optional | To clarify, the DS value here is the maximum DS after scaling or the scaling factor for CDL/TDL model? | In IMT-2020, (1,1,2,4,2) is the agreed antenna configuration for UE, so it would be good to be aligned with that assumption. | Support Moderator’s proposal |
| **Apple** | NCP mandatory, ECP optional | One CDL model should be selected as mandatory in addition to TDL model to investigate the effect of beamforming. | Support moderator’s proposal | Support moderator’s proposal |
| **LG** | NCP is to be baseline for all SCSs.  In addition, ECP also need to be evaluated for higher SCSs than the highest SCS (i.e., 240 kHz) of FR2. | We share the same view with other companies that CDL-B (20ns, 30ns, 50ns DS) and CDL-D (20ns, 30ns, 50ns DS) are to be baseline. | We have similar with Lenovo and Ericsson that the configuration of BS (1,1,4,8,2) & UE (1,1,2,2,2) with (0.5dv, 0.5 dH) needs to be evaluated. | OK with Moderator’s suggestion. |
| **Intel** | ECP could be Optional while NCP should be Mandatory | We prefer to use TDL over CDL channel model since CDL models defined use a fixed cluster arrangement and only reflect a single snapshot of the channel.  Furthermore, the received SNR changes as a function of beamforming used and antenna configurations and could cause difficulties in obtaining comparative results between configurations.  For CDL-A and CDL-B models we prefer to keep only the largest DS values, i.e., 30 ns and 50 ns, respectively, in order to reduce the number of Optional cases. With the same reason, for CDL-D model, we prefer to exclude DS = 50 ns | For TDL model, 1x2 should be Mandatory and 2x2 should be Optional.  The reason is that 2x2 would require specifying Tx precoding scheme, i.e., random/fixed precoding which would make the corresponding results less clear to analyze. Another reason is that for 2x2 and a LoS channel we would need a separate discussion on 2x2 channel matrix for LoS path. Our understanding is that all beamforming/precoding at the link-level should be done using CDL models. | Support Moderator’s proposal |
| **MediaTek** | NCP  Optional: ECP | We propose to mandate a CDL channel (e.g., CDL-B) with delay spread (DS\_desired in 38.900) up to 50ns. | For CDL: BS (1,1,4,8,2) and UE (1,1,4,2,2) with (0.5dv, 0.5 dH). Optional: UE (1,1,4,4,1) with (0.5dv, 0.5dH) | 3 Km/hr |
| **NTT DOCOMO** | We support both of moderator’s proposal, i.e. study both NCP and ECP. | For TDL-A, larger DS should also be studied as mandatory case, which include the short- and normal-delay profiles for Indoor office and UMi street-canyon scenarios defined in Table 7.7.3-2 of TR38.901, i.e., add 16, 27, and 55 ns DS for 60 GHz, or 16, 26, 53 ns DS for 70 GHz | Support the moderator’s proposal. 1x2 instead of 2x2 as mandatory is also ok. | Support 3km/h. |
| **Sony** |  | We think CDL channel models are essential for studying the beamforming and spatial properties in mmwave spectrum and can be used as the default model to be used. | For UE antenna panel, we think (1,2,2,4,2) is more reasonable to be set as a default assumption, which can show the effect from multiple panels in UEs.  We also think the orientation of the panel is important and need to be specified in the simulation. The two panels can be placed on different sides of the UE for optimizing the spherical coverage.  Element pattern also need to be captured in the simulation especially for CDL channels. The element pattern in TR38.901 can be used. from TR38.901. |  |
| **TCL** | Normal CP, Extended CP (for SCS >= 960kHz) | CDL-B and CDL-D as mandatory with 20ns to 100 ns delay spread. | Support the suggested CDL configurations. | Agree with Moderator’s suggestion. |
| **Charter** | Support NCP as mandatory and keep ECP as optional for evaluation of certain SCS | Agree with Nokia, TDL models are sufficient to evaluate the impact of PN and PA impairments and have lower simulation complexity | Fine with moderator proposal | Support 3 km/hr |
| **CATT** | Normal CP is preferred, Extended CP is optional | TDL-A (5ns, 10ns DS), both Indoor office and UMi Street-canyon scenario | For TDL model:  2x2 | 3 km/h |
| **Potevio** | Support NCP as mandatory and ECP as optional | We propose to select CDL model as mandatory for investigating the beamforming in mmWave system. | Support moderator’s proposal | Support 3km/h. |
| **OPPO** | Normal CP  Optional: Extended CP | TDL-A (5ns, 10ns DS)  CDL-D (20ns, 40ns DS) | For TDL model:  2x2  For CDL model:  (1,1,8,16,2) BS, (1,1,4,4,2) UE with (0.5 dv, 0.5 dH) | 3 Km/hr |
| **Parameter**  **Set 2** | **CP Type** | **Channel Model** | **Antenna Configuration (Mg,Ng,M,N,P)** | **Mobility** |
| **Moderator Summary/Suggestion** | Normal CP  ~~Optional:~~ Extended CP | If TDL model is used (as defined in of TR38.901 Section 7.7.2):  - TDL-A (5ns, 10ns DS) of TR38.901 Section 7.7.2  If CDL model is used (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  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).  Optional:  - TDL-A (25ns, 50ns DS)  - TDL-D (1ns, 10ns DS)  - CDL-A (10ns, 30ns DS)  - CDL-B (10ns, 30ns, 100ns DS)  - CDL-D (50ns DS) K-factor = 10 dB  [Moderator Notes: There is some divergence on whether TDL or CDL should be used for primary purposes. Note that there were slightly more companies in favor of CDL channels. Based on feedback TDL doesn’t seem to represent the delay profiles correctly, and CDL channel only represent a specific snapshot of the channel and could have beamforming calibration challenges. Either model doesn’t seem to be completely ideal. Given the situation, moderator suggests both TDL and CDL and let companies provide evaluations on either or both of them.] | 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)  [Moderator Note: there were other configurations suggested, but Moderator has selected ones that were most proposed.] | 3 km/hr |
| **NTT DOCOMO (v026)** | At least for larger SCS such as 480/960/1960 kHz, ECP should be mandatory  [Moderator comments: I’ve remove the optional for ECP. Let’s leave the two options available for companies to evaluate.] |  |  |  |
| **Ericsson** |  | As we had shown in the above, one or two TDL-A models with short DS values (5 ns, 10 ns) don’t come anywhere close to capture the true post-BF DS range and distribution. For evaluations based only on TDL-A, since it is proposed to use very small antenna arrays (i.e., 2x2, 1x2) we believe the following remedy is necessary:  If TDL model is used (as defined in of TR38.901 Section 7.7.2):  - One final BLER based on equal weighting the BLERs for TDL-A (5ns, 10ns, 20ns, 40ns, 60ns DS) of TR38.901 Section 7.7.2  [Moderator comments: I understand the concerns. There were comments from other companies stating that for evaluation of phase noise impact, more actuate representation of the delay profile that matches Indoor-office scenario might not be necessary. From what I understand, the CDL profile doesn’t capture the average statistics of the indoor-office either (as it is just one snap shot of the cluster profiles). I would suggest to leave both TDL and CDL options on the table as both models have its own imperfections. I my opinion to get better understanding of the delay spread impact to system we would need to rely on statistical information from SLS setup. Either TDL nor CDL model as defined in TR38.901 would not be accurate] |  |  |

Table 4. LLS Parameter Set 3

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter Set 3** | **PA Model** | **gNB TRP PN Model** | **UE PN Model** | **Pre-loaded Tx EVM** | **Additive Rx EVM** | **I-Q Imbalance** | **Frequency Offset** |
| **Value** | Optional:  Companies to provide modeling (in lieu of pre-loaded Tx EVM) | 3GPP TR38.803 example 2 BS  Optional:  3GPP TR38.803 example 1  Companies to provide modeling | 3GPP TR38.803 example 2 UE  Optional:  3GPP TR38.803 example 1  Companies to provide modeling | Optional:  3% at Tx  (In lieu of PA model) | Optional:  5% at Rx | Optional:  -26dBc, -31dBc | Optional:  0.1 ppm (for data channel)  10 ppm (for initial access) |
| **Huawei, HiSilicon** |  |  |  | Pre-loaded EVM is simpler than aligning the PA models and parameters (e.g. back-off value) |  |  |  |
| **Lenovo /Motorola Mobility** | We suggest adding PA model, preferably with memory effect | We suggest  PDSCH (Ex2 BS)  PUSCH (Ex2 UE) | We suggest  PDSCH (Ex2 UE)  PUSCH (Ex2 BS) |  |  | We suggest adding the I-Q imbalance option |  |
| **Ericsson** |  | In R1-2003851, we raised the need to have a phase noise modeling that is more representative of integrated RF circuit solutions more suited for low cost unlicensed band / indoor operations. Example 2 BS model, being based on GaAs, may not be widely used for such applications.  We suggest sending a LS to RAN4 to coordinate the phase noise modeling work for the SI. | In our Tdoc (R1-2003851), we also presented a new phase noise model based on recently published data on both state-of-the-art PLL and crystal oscillators that lead to an improved model representing the current technology envelope.  We suggest sending a LS to RAN4 to coordinate the phase noise modeling work for the SI. |  |  |  |  |
| **Futurewei** |  |  |  |  |  |  |  |
| **vivo** |  |  |  |  |  | We support to evaluate IQ-imbalance impact.  On the listed parameter values, we think other values should be allowed as well. For example, in TS 38.101-2-f70, the requirement on FR2 is -25/-20 dBc for UE TX IQ image depends on UE output power and power class. Based on our understanding, the requirement will be more relaxed in 60GHz due to higher RF complexity. For determining the values here, we suggest sending an LS to RAN4 to get the reasonable values to facilitate the evaluation in RAN1. |  |
| **InterDigital** | We support the moderator’s proposal | 3GPP TR38.803 example 2 | 3GPP TR38.803 example 2 |  |  |  |  |
| **ZTE** | Optional | 3GPP TR38.803 | 3GPP TR38.803 | Optional | Optional | Optional | Optional (follow the assumption in 38.802):  0.1 ppm (for data channel)  5,10,20 ppm (for initial access) |
| **Qualcomm** |  | We support Ex2 BS PN model for both DL and UL evaluation. (It would be better to change the top row to ‘BS PN model’ instead of ‘Tx PN model’) | We support Ex2 UE PN model for both DL and UL evaluation. (the top row could be changed to ‘UE PN model’) |  |  |  |  |
| **Nokia** | Optional:  Companies to provide modeling | 3GPP TR38.803 example 2 BS | 3GPP TR38.803 example 2 UE | Agree | Agree | Agree | Agree |
| **Samsung** | Support Moderator’s proposal | Didn’t see a need to consider other model than 3GPP’s | Didn’t see a need to consider other model than 3GPP’s | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | 5 ppm should be sufficient for initial access, which is same as Rel-15 assumption |
| **Apple** | Optional | 3GPP TR38.803 | 3GPP TR38.803 | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal |
| **LG** | OK with Moderator’s suggestion. | We have similar with Lenovo and Qualcomm that Ex2 BS is for DL and Ex2 UE is for UL. | We have similar with Lenovo and Qualcomm that Ex2 UE is for DL and Ex2 BS is for UL. | OK with Moderator’s suggestion. | OK with Moderator’s suggestion. | OK with Moderator’s suggestion. | OK with Moderator’s suggestion. |
| **Intel** | Prefer to use pre-loaded Tx EVM if needed since common PA model could be difficult within the SI completion period. | Regarding Mandatory PN models:  3GPP TR38.803 example 2 BS for DL, 3GPP TR38.803 example 2 UE for UL | Regarding Mandatory PN models:  3GPP TR38.803 example 2 UE for DL, 3GPP TR38.803 example 2 BS for UL |  |  |  |  |
| **MediaTek** |  | PDSCH: 3GPP TR38.803 Example 2 for BS.  PUSCH: 3GPP TR38.803 Example 2 for UE | PDSCH: 3GPP TR38.803 Example 2 for UE.  PUSCH: 3GPP TR38.803 Example 2 for BS |  |  |  |  |
| **NTT DOCOMO** | PA model or Pre-loaded Tx EVM model should be mandatory. The companies can select one of them freely.  But it is highly recommended to consider practical PA model for large bw case, i.e., 2GHz bw. | Support the moderator’s proposal | We support the moderator’s proposal. | See our comment on PA model. |  |  |  |
| **Convida Wireless** | We support the moderator’s proposal, The PA model can be further studied | 3GPP TR38.803 example 2 | 3GPP TR38.803 example 2 |  |  | We support the moderator’s proposal |  |
| **Sony** |  | We think Ex2BS model can be taken as a baseline. But we are open to examine and discuss any potential new PN models. We also share a similar view as Ericsson that the work needs to be aligned with RAN4. | We think Ex2 UE model can be taken as a baseline. But we are open to examine and discuss any potential new PN models. We also share a similar view as Ericsson that the work needs to be aligned with RAN4. |  |  |  |  |
| **TCL** | optional | 3GPP TR38.803 example 2 | 3GPP TR38.803 example 2 |  |  |  |  |
| **Charter** |  | Fine with moderator’s proposal. |  |  |  |  |  |
| **CATT** | Optional | 3GPP TR38.803 | 3GPP TR38.803 | Agree with Moderator’s proposal and optional | Agreed with Moderator’s proposal and optional | Agreed with Moderator’s proposal and optional |  |
| **Potevio** | optional | 3GPP TR38.803 example 2 | 3GPP TR38.803 example 2 |  |  |  |  |
| **OPPO** |  | 3GPP TR38.803 example 2 BS | 3GPP TR38.803 example 2 UE | Optional:  3% at Tx | Optional:  5% at Rx |  | Optional:  0.1 ppm (for data channel)  10 ppm (for initial access) |
| **Parameter Set 3** | **PA Model** | **gNB TRP PN Model** | **UE PN Model** | **Pre-loaded Tx EVM** | **Additive Rx EVM** | **I-Q Imbalance** | **Frequency Offset** |
| **Moderator Summary/Suggestion** | 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  [Moderator Note: as suggested by Ericsson and Sony, we can use the above suggestion for the time being, and send an LS to RAN4 to get further input.] | 3GPP TR38.803 example 2 UE PN profile  Optional:  - If other PN profile is used, companies to provide information on the modeling used | 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) |
| **vivo** |  | On the above Moderator Note, we actually think sending an LS to RAN4 is necessary and should cover other models (PA, UE PN, EVM, IQ-imbalance, frequency offset) as well to get RAN4’s input on modeling/ parameters, not just for gNB TRP PN model. After all, they are all practical RF impairments, which are in the scope of SID to study in RAN1 and RAN4. |  |  |  |  |  |
| **Ericsson** |  | We will prepare a draft LS to RAN4 and circulate for discussion. Hopefully this can be sent sooner rather than later so as to have a timely response to enable progress in RAN1 evaluations. |  | We want to confirm what is meant by "pre-loaded." Is it simply additive noise at the Tx side?  [Moderator comment: In my understanding it is additive noise at the Tx side] |  |  |  |

Table 5. LLS Parameter Set 4

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter Set 4** | **Channel Estimation** | **Transmission Rank** | **PDSCH SLIV** | **DMRS Configuration** | **PTRS Configuration** | **MCS/TBS** |
| **Value** | Realistic channel estimation | Rank 1  Optional: Rank1+2 adaptive, Rank 2 | (S=2, L=12)  Optional:  (S=3, L=11), (S=0, L=14)  Note: Starting symbol, S, (indexed from 0) and length, L. | Front loaded, 1 DMRS symbol  Optional:  2 DMRS symbol at (2,11) symbol index | (K = 4, L = 1)  Optional:  (K = 2, L = 1)  Note: PTRS per K number of PRBs, and PTRS every L number of OFDM symbols | MCS 16 (16QAM), MCS 22 (64QAM)  Optional:  MCS 1 (QPSK), MCS 7 (QPSK),  MCS 23 (256QAM), MCS 27 (256QAM) |
| **Huawei, HiSilicon** |  | Do we really need the options? |  |  | Since 8 PRBs is the minimum number proposed in the evaluation assumptions, taking K=2 as mandatory would be more reasonable. | Which MCS table is used for each MCS? For example:  MCS 16 (16QAM), MCS 22 (64QAM) – MCS index table 1 for PDSCH  MCS 1 (QPSK), MCS 7 (QPSK) – MCS index table 1 for PDSCH  MCS 23 (256QAM), MCS 27 (256QAM) – MCS index table 2 for PDSCH  Why are multiple MCS needed for 256QAM and for QPSK? |
| **Lenovo /Motorola Mobility** | We agree to have realistic channel estimation | We agree to have only Rank1 as mandatory | We suggest having S=0 and L=14 as mandatory.  Optionally, we can have S=2, L=12 | We agree to have only front loaded, 1 DMRS symbol (with no data multiplexing on DM-RS symbol) | We propose to use the baseline PT-RS configuration as K=2, L=1 and K=4, L=1, depending up on RB allocation  In addition, companies should be encouraged to evaluate any new additional PT-RS configurations with relatively better performance | We suggest using 16QM, 64QM with moderate CR, e.g. from PDSCH table 1 MCS 16, MCS 22,  256QAM as an option, e.g. from PDSCH table 2 MCS27 |
| **Ericsson** |  |  |  |  | From the Moderator Summary R1-2004703, it appears that the majority of the companies evaluated using K=2 configuration. Perhaps, we can change the configuration to using K=2 to have accurate CPE estimation in most scenarios. | We assume these MCSs are for NCP. For ECP, we believe higher code rates should be used for a fair comparison to NCP. Let and denote the allocated # of OS and code rate for NCP, respectively. Assuming one DMRS OS, the code rate for ECP should be raised to . With this adjustment, a PDSCH carries the same number of info bits regardless of whether NCP or ECP is used.  For the example of , NCP MCS16 should be compared to ECP 16QAM or ECP MCS19 (64QAM). NCP MCS22 should be compared to ECP MCS25. |
| **Futurewei** | Start with ideal to calibrate,  Then add realistic channel estimation | Rank 1 | (S=2, L=12) | 2 DMRS symbol at (2,11) symbol index  Optional: Front loaded, 1 DMRS symbol | (K = 4, L = 1) | MCS 16 (16QAM), MCS 22 (64QAM) |
| **vivo** |  |  |  |  | K=2, L=1 and K=4, L=1 depending on RB number |  |
| **InterDigital** |  | Rank 1 as mandatory without optional values | We support the moderator’s proposal | We support the moderator’s proposal | We support the moderator’s proposal | MCS 16 (16QAM), MCS 22 (64QAM)  Optional:  MCS 7 (QPSK), MCS 23 (256QAM), MCS 27 (256QAM) |
| **ZTE** | Realistic channel estimation | Rank 1 | S=0, L=14, or S=2, L=12 | For DMRS evaluation purpose, it’s up to company report.  For other evaluation objectives or calibration, 2 DMRS symbols | For PTRS evaluation purpose, it’s up to company report.  For other evaluation objectives or calibration, (K = 2, L = 1) | One MCS per modulation order, e.g.,  MCS 1 (QPSK)  MCS 16 (16QAM)， MCS 22 (64QAM) |
| **Qualcomm** |  |  |  |  |  | We suggest adding at least one MCS with 256QAM as mandatory (e.g., MCS 23 in table 2). |
| **Nokia** | Agree | Rank 1  Optional:  Rank 2 | (S=2, L=12) | Front loaded, 1 DMRS symbol  Optional:  2 DMRS symbol at (2,11) symbol index | (K = 2, L = 1)  Optional:  (K = 4, L = 1).  In addition, companies should be encouraged to evaluate any new additional PT-RS configurations with better performance | Agree with proposed modulations:  MCS 16 (16QAM), MCS 22 (64QAM)  Optional:  MCS 1 (QPSK), MCS 7 (QPSK),  MCS 23 (256QAM), MCS 27 (256QAM) |
| **Samsung** | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal |
| **Apple** | Start with ideal ChEst to calibrate,  then add realistic channel estimation | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Add a QPSK modulation to study effect at low modulation orders. |
| **LG** | OK with Moderator’s suggestion. | We share the same view with other companies that only Rank 1 is sufficient. | OK with Moderator’s suggestion. | OK with Moderator’s suggestion. | We have similar view with some companies that the values of K and L would depend on BW and MCS.  Adding more (K, L) pairs or providing by each company might be better. | We are OK with Moderator’s suggestion, and agree with ZTE on one MCS per modulation order. |
| **Intel** |  | For TDL models, especially with LOS components (as mentioned above) there would be difficulties defining the channel matrices. Therefore, suggest using Rank 1.  The rank adaptation and Rank-2 transmission should be evaluated using CDL channel models. |  | Two DMRS symbols should be Mandatory and one front-loaded DMRS symbol should be Optional |  |  |
| **MediaTek** | Realistic channel Estimation | Rank 1 | S=2, L=12 | Front Loaded, 1 DMRS symbol | Support Nokia’s proposal. Specifically, companies should be encouraged to evaluate any new additional PT-RS configurations with better performance | Support moderator’s proposal |
| **NTT DOCOMO** | Support the moderator’s proposal. | Support the moderator’s proposal. | Support the moderator’s proposal. | Support the moderator’s proposal. | Support the moderator’s proposal. | Support the moderator’s proposal. |
| **Sony** | Share a similar view as Futurewei. We can start with ideal mode and then further add realistic estimation. |  |  | Agree with the moderator’s proposal.  In addition, we think it is meaningful to evaluate potential new DMRS configurations with relatively better performance. | Share a similar view as Lenovo. |  |
| **TCL** | Agree | Rank1 only |  |  |  | Support Moderator’s proposal |
| **Charter** |  | Support Moderator’s proposal. We think rank-2 evaluations will be useful for PUSCH to determine if transform precoding should support multiple layers. |  | Fine with moderator proposal | We propose to use the baseline PT-RS configuration as K=2, L=1, but companies can always evaluate additional configurations. | One MCS per modulation order to reduce simulation burden. |
| **CATT** | Realistic MMSE channel estimation | Rank 1 only | (S=2, L=12) | Front loaded DMRS | (K = 4, L = 1) |  |
| **Potevio** | Support the moderator’s proposal. | Rank1 |  |  |  | Support the moderator’s proposal. |
| **OPPO** | Realistic channel estimation | Rank 1 | (S=2, L=12) | Front loaded, 1 DMRS symbol | (K = 4, L = 1) | MCS 16 (16QAM), MCS 22 (64QAM)  MCS 23 (256QAM) |
| **Parameter Set 4** | **Channel Estimation** | **Transmission Rank** | **PDSCH SLIV** | **DMRS Configuration** | **PTRS Configuration** | **MCS/TBS** |
| **Moderator Summary/Suggestion** | Realistic channel estimation | Rank 1  Note: Companies are asked to provide information the precoding used in the evaluations. | (S=2, L=12)  Optional:(S=0, L=14)  Note: Starting symbol, S, (indexed from 0) and length, L. | 1 DMRS symbol (front loaded),  or 2 DMRS symbols at (2,11) symbol index  Note: no data multiplexing is assumed in DMRS symbols  [Moderator: few companies wish to support 2 DMRS symbol cases, moderator suggest listing two cases and have companies provide results based on either of them.] | For CP-OFDM:  (K = 4, L = 1)  or (K = 2, L = 1)  Note: PTRS per K number of PRBs, and PTRS every L number of OFDM symbols  For DFT-s-OFDM:  (Ng = 2, Ns = 2, L = 1)  (Ng = 2, Ns = 4, L = 1)  (Ng = 4, Ns = 2, L = 1)  (Ng = 4, Ns = 4, L = 1)  (Ng = 8, Ns = 4, L = 1)  Note: Ng number of PT-RS groups, Ns number of samples per PT-RS group, and PTRS every L number of DFT-s-OFDM symbols  [Moderator: Based on feedback, the suggestion is somewhat split. Moreover, it seems there could be some dependency on number of PRB or SCS. Suggest keeping both] | From MCS Table 1 (TS38.214):  - MCS 7 (QPSK) (optional),  - MCS 16 (16QAM),  - MCS 22 (64QAM),  From MCS Table 2 (TS38.214):  - MCS 27 (256QAM) (optional)  Note: If normal CP and extended CP are to be compared, companies are asked to provide information on the MCS values used that provide similar payload sizes for the comparison. |
| **Nokia** |  |  |  |  | PTRS configuration should be defined for DFTsOFDM as well. We suggest using Rel-15 PTRS configurations as mandatory (with max. PTRS overhead of about 4% as for OFDM), and companies should be encouraged to provide any enhanced PTRS configurations for both waveforms.  [Moderation comments: for now I’ve added all the PTRS configurations with L =1, so that companies can select depending on the RB allocation size to control the overall overhead] |  |

## 2.2 Evaluation Methodology for System Level Simulation

The submitted system level simulations were utilized to obtain analysis for the following purposes:

* Channel delay spread impact for various CP type/lengths
* NR-NR multi-operator coexistence analysis
* Performance analysis for PDSCH/PUSCH
* Performance impact for using various CCA levels and LBT schemes (e.g. receiver-aided LBT, omni-directional LBT, directional LBT, etc)

Table 6. Suggested harmonized system level simulation parameters as baseline for discussion

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Notes** |
| Carrier Frequency [GHz] | 60 GHz  Optional: 70 GHz |  |
| Subcarrier Spacing [kHz] | 960 kHz  Optional: 60 kHz, 120 kHz, 240 kHz, 480 kHz, 1920 kHz, 3840 kHz |  |
| Bandwidth [MHz] | 2160 MHz  Optional: 500 MHz |  |
| Number of RB | For 2160 MHz:  340 (480 kHz), 178 (960 kHz), 89 (1920 kHz), 44 (3840 kHz)  For 500 MHz:  330 (120 kHz), 165 (240 kHz), 82 (480 kHz), 41 (960 kHz), 20 (1920 kHz), 10 (3840 kHz) | Do not exceed 4k FFT size |
| Deployment Scenario | **Indoor Office:**  Scenario 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    Optional:  Scenario 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    Optional:  Scenario 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    Optional:  Scenario 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 = 40m    Optional:  Scenario 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 F) Dense Urban with 1 layer  Hexagonal grid, single layer, 3 sectors per site, 19 sites locations, BS height 10m, UE height 1.5m, ISD = 150m    Optional:  Scenario G) Dense Urban with 2 layers  Macro layer (sub 7GHz):  Hexagonal grid, single layer, 3 sectors per site, 19 sites locations  BS height 25m, UE height 1.5m, ISD = 200m, fixed BS position  Micro layer (above 52.6 GHz):  BS height 10m, UE height 1.5m, 2 operator, 1 BS per hexgrid per operator, random position within macro hexagonal grid per operator, minimum distance between TRP and UE: 10m,    **Indoor Factory Hall:**  Optional:  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 20%  Optional:  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 60% |  |
| UE distribution | Average of 10 UE per BS  For InH open office: 100% indoor UEs  For Dense urban: 100% outdoor UEs  For InF: 100% indoor UEs | UE randomly distributed over the entire deployment area |
| Channel Model | InH open office:  InH – office channel & PL model from TR38.901  Dense Urban:  UMi street canyon channel & PL model from TR38.901  Indoor factory:  InF channel & PL model from TR38.901 |  |
| Mobility | 3 Km/hr |  |
| BS Antenna Configuration (Mg,Ng,M,N,P) | (1,1,8,16,2) with (0.5 dv, 0.5 dH)  Optional:  (1,1,4,4,2), (1,1,8,4,2), (1,1,8,8,2), (1,1,16,16,2), (1,1,32,8,2) |  |
| BS Antenna Pattern | Antenna power pattern given in Table 7.3-1 of TR38.901  (with exception of antenna element gain) |  |
| BS Antenna element gain | 5 dBi |  |
| UE Antenna Configuration (Mg,Ng,M,N,P) | (1,1,2,4,2) with (0.5 dv, 0.5 dH)  Optional:  (1,1,1,2,2), (1,1,2,2,2), (1,1,4,4,2) |  |
| UE Antenna Pattern | Antenna power pattern given in Table 7.3-1 of TR38.901  (with exception of antenna element gain) |  |
| UE Antenna element gain | 0 dBi  Optional:  5dBi |  |
| BS Power Limitation | 40 dBm EIRP  Maximum TxP adjusted to meet EIRP limits |  |
| UE Power Limitation | 25 dBm EIRP with 21 dBm max TxP  Optional:  40dBm EIRP with 21 dBm max TxP |  |
| BS NF | 7 dB |  |
| UE NF | 13 dB  Optional:  10 dB |  |
| Transmission Rank | Rank adaptative transmission between Rank 1 and 2 |  |
| PDCCH Overhead | 2 Symbol per slot |  |
| DMRS Overhead | 1 Symbol per slot |  |
| CSI-RS Overhead | - |  |
| SRS Overhead | - |  |
| Other Overhead | - | This can include overhead from beam management, PRACH, RAR, SR, etc. |
| TDD DL/UL Ratio | - |  |
| CSI feedback | Ideal feedback |  |
| Additive Rx EVM | Optional:  5% at Rx | In lieu of PA model, Tx/Rx PN Model, I-Q imbalance, and other RF impairments |
| Traffic Model | FTP Model 3 (0.5MByte file)  Optional:  Full buffer,  FTP Model 1 (27Mbyte file)  FTP Model 3 (27Mbyte file) |  |
| UE Receiver | MMSE-IRC |  |
| Cell selection criteria | Random select from strongest RSRP with 1 dB HO Marginhysterisys |  |
| DL/UL Traffic Ratio | 50% DL, 50% UL  Optional:  100% DL, 0% UL,  80% DL, 20% UL  0% DL, 100% UL |  |

**Discussion Summary:**

Companies are encouraged to provide comments on

* Evaluation objectives
  + Including whether we should define a separate evaluation parameter set for a group of objective(s) separately or whether single set of evaluation parameters is sufficient.
* Comment on individual parameters, including whether anything is missing from the evaluation parameter set.
  + Including whether or not to define ‘optional’ values or whether RAN1 should just simply provide a list of parameters without providing optionality.

Table 7. SLS Parameter Set 1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter Set 1** | **Evaluation Objectives** | **Carrier Frequency [GHz]** | **Subcarrier Spacing [kHz]** | **Bandwidth [MHz]** | **Number of RB** |
| **Value** | Channel delay spread impact for various CP type/lengths  NR-NR multi-operator coexistence analysis  Performance analysis for PDSCH/PUSCH  Performance impact for using various CCA levels and LBT schemes (e.g. receiver-aided LBT, omni-directional LBT, directional LBT, etc) | 60 GHz    Optional: 70 GHz | 960 kHz    Optional: 60 kHz, 120 kHz, 240 kHz, 480 kHz, 1920 kHz, 3840 kHz | 2160 MHz    Optional: 500 MHz | For 2160 MHz:  340 (480 kHz), 178 (960 kHz), 89 (1920 kHz), 44 (3840 kHz)    For 500 MHz:  330 (120 kHz), 165 (240 kHz), 82 (480 kHz), 41 (960 kHz), 20 (1920 kHz), 10 (3840 kHz) |
| **Huawei, HiSilicon** | The objectives are generally fine, but we assume the goal is not to document values of RMS delay spread obtained by SLS since CP selection is expected to be based on LLS. SLS should rather look at the overall impact on system-level performance (throughput). So could we instead define the KPIs that are expected to be provided by the SLS? | It is not clear why evaluations at two nearby frequencies is needed. ITU-R selected 70 GHz for IMT-2020 evaluations, so we suggest 70 GHz as mandatory, and no need to provide optional values. | The SCS depends on the BW to be simulated. 120k/240Hz SCS for 500MHz and 960kHz for 2GHz | 2160MHz is not a typical 3GPP bandwidth. To align with LLS bandwidth, 2GHz can be considered. |  |
| **Lenovo /Motorola Mobility** | We agree with Huawei. We should focus on the coexistence analysis e.g. NR-NR multi-operator, and the different LBT schemes and their impact on throughput/capacity. | We agree with 60 GHz as mandatory and 70 GHz as optional | We agree with 960 kHz as mandatory and 120 kHz, 240 kHz, 480 kHz, 1920 kHz as optional | We have similar views as Huawei/HiSilicon | Similar views as for LLS |
| **Ericsson** | Traditionally, we have used system throughput to evaluate the performance. In that sense we agree with HW. F**irst and third objective should be removed**.  **Related to second and forth objective:**  At this early stay, the SI should focus on studying the interference profile that is expected to be seen in these deployments (specially the indoor scenario), to be able to decide if interference mitigation techniques are needed. We should keep in mind that for such high frequency range many single operator use cases are expected (indoor office, factory, smart Home, etc...) this scenario should not be undermined.  It is also worth noting that the multi-operator scenario is a worst-case scenario where both operators use the same channel, even though in reality the channel can be changed when interference is constantly observed. The multi-operator scenario can be justified in 5GHz, since a single channel is only 20MHz, and the assumption of operating on multiple channel to increase the capacity is reasonable. Hence, it is probable to coexist with other networks that are operating on the same channel. But the situation is different for 60GHz, where one channel can be up to 2.16 GHz. the UE device is of course power limited. The propagation loss is high, and number of available channels is also high. so in case of significant interference, the operating channel can be simply changed, so that the performance of the edge UEs can be improved. Nonetheless, we would be Ok with considering it, but only as a second stage. The focus for the first stage should be optimizing for the single operator scenario.  **Related to fourth proposal:**  Instead of jumping into solutions, we need to agree on the existence of a problem. So instead of studying enhancements for LBT, the objective should be to evaluate the interference impact on performance and coexistence between nodes. Based on the observations, the need for enhanced channel access mechanism and interference mitigation techniques can be studied (e.g. directional LBT, receiver assisted LBT) |  | 960 kHz for indoor  480 kHz for outdoor | 2000 MHz for indoor  500 MHz for outdoor | For 2000 MHz: 160 (960 kHz)  For 500 MHz: 80 (480 kHz) |
| **Futurewei** | NR-NR multi-operator coexistence analysis  Performance impact for using various CCA levels and LBT schemes (e.g. receiver-aided LBT, omni-directional LBT, directional LBT, etc). Evaluate no-LBT scheme.  Channel delay spread impact for various CP type/lengths  Performance analysis for PDSCH/PUSCH | 60 GHz,  Optional: 70 GHz | 240 kHz, 480 kHz and 960 kHz | 800 MHz  Optional: 400 MHz ,  we think that larger bandwith (2000 MHz) can be obtain via CA | 256 (240 kHz, 800MHz)  128 (480 kHz, 800 MHz)  64 (960 kHz, 800 MHz) |
| **vivo** | Our understanding is that Channel delay spread impact for various CP type/lengths on PDSCH/PUSCH performance has already been covered in LLS already. So no need to repeat here in SLS.  We propose to focus the SLS on NR-NR multi-operator coexistence study including single-operator scenario for comparison. |  |  | 2000 MHz instead of 2160 MHz to be consistent with that in LLS  Optional: 500 MHz | Consistent with that in LLS |
| **InterDigital** | We also agree with Huawei that the overall impact of system performance should be studied for SLS. | 60 GHz,  Optional: 70 GHz | We support the moderator’s proposal | 2 GHz  Optional: 400 MHz | For 2000 MHz:  320 (480 kHz), 160 (960 kHz), 80 (1920 kHz), 40 (3840 kHz)    For 400 MHz:  256 (120 kHz), 128 (240 kHz), 64 (480 kHz), 32 (960 kHz), 16 (1920 kHz), 8 (3840 kHz) |
| **ZTE** | CP length should be evaluated in LLS  PDSCH/PUSCH performance shouldn’t be regarded as an SLS objective, it could be used for the performance metrics of coexistence analysis and LBT types analysis.  It’s good to prioritize the following 2 objectives:  NRU-NRU multi-operator coexistence analysis  Performance impact for using various CCA levels and LBT schemes(Omni-directional LBT could be set as a baseline, evaluate different CCA levels and other LBT schemes) | 60 GHz | Depending on the output of SCS evaluation from LLS | Align with LLS | Align with LLS |
| **Qualcomm** | We propose that objective 1 be deprioritized. Objective 3 could be studies as part of KPIs used for evaluating objectives 3 and 4.  As part of objective 2 we propose that Multi-Operator coexistence as well as Single-Operator deployments should be studied.  As part of objective 4, the study should not restrict to LBT but also include other interference management techniques, including ATPC, LBT and variants of longer term determination/mitigation of interference conditions.  In investigations in the study item with its limited time opportunity could be concurrently focused on identifying the severity and prevalence as well as on possible paths forward to solve the foreseen issues. It may be desirable for RAN1 to have studied and settled question rather than leave them unevaluated - especially in the context of potential discussions in regards to technologies outside the purview of NR/3GPP. | 60 GHz,  Optional: 70 GHz | 960 kHz, 120KHz    Optional: 480 kHz, 1920 kHz, 3840 kHz | 400MHz, which is the largest bandwidth supported with 120kHz SCS in FR2, should be the baseline and mandated, Keeping 400MHz and 2000MHz as mandatory will be desirable. | Consistent with the SCS under the requirement of FFT size <=4k. |
| **Nokia** | We share the view of HW and Ericsson that traditional SLS KPIs should be used on the 1st and 3rd objectives. Single operator scenario should be in the focus of the studies and, hence, we see the value of 3rd objective with traditional KPIs.  Once moving to the coexistence analysis, we share Ericsson’s view that first the focus should be on investigation of the interference distributions as well as on interference impact on throughput and latency. This is obviously target of objective 2, NR-NR multi-operator coexistence analysis.  Necessary coexistence mechanisms (on channel access and interference mitigation) should be determined based on this analysis. In that perspective, determination of the 4th objective on LBT is premature. | 60 GHz    Optional: 70 GHz | Agree on mandatory but should reduce the optional set:  960 kHz mandatory  Optional: 120 kHz, 3840 kHz | 2.16 GHz  Optional: 400 MHz | For 2.16 GHz we propose the following:   * 180 (SCS ≤ 960 kHz) * 45 for 3840 kHz SCS |
| **Samsung** | Support Moderator’s proposal | 60 GHz is sufficient. | No need for SCS larger than 960 kHz | 400 MHz instead of 500 MHz for study | 400 MHz instead of 500 MHz for study |
| **Apple** | Focus on the second and fourth objectives. 1st and 3rd objectives can be investigated using LLS. | Support Moderator’s proposal | choices should depend on outcome of LLS | Add 400 MHz. 2.16 GHz should be 2 GHz | 2 GHz and 400 MHz (with appropriately scaled number of RBs) |
| **LG** | We share the same with other companies that the 2nd objective (coexistence analysis) and the 4th objective (LBT scheme performance) are to be studied in this SLS scope.  Other objectives related to channel delay spread or data channel performance are to be studied in LLS. | Same as LLS.  60 GHz should be sufficient. | Same as LLS.  The values of 240/480/960 kHz are to be baseline. | Same as LLS.  - 400/800 MHz should be baseline.  - 1600 MHz or larger bandwidth can be considered as optional. | Same as LLS.  - For 400 MHz:  128 (240 kHz), 64 (480 kHz), 32 (960 kHz)  - For 800 MHz:  256 (240 kHz), 128 (480 kHz), 64 (960 kHz) |
| **Intel** | Support Moderator’s proposal.  Objective 1 should be kept.  We only partially agree that the CP length should be evaluated in LLS.  First, the SLS is used as the main source of expected channel delay spread values for further LLS evaluations. Only SLS provides thorough ensembles of channel realizations with different cluster arrangements (i.e., not only one as, e.g., in CDL models for LLS) taking into account Tx-Rx beamforming at the same time.  Second, only SLS unveils an impact of inter-symbol interference (ISI) onto CP-OFDM/DFT-s-OFDM waveforms which may be critical for CP selection. |  | 960 kHz    Optional: 120 kHz, 240 kHz, 480 kHz, 1920 kHz, 3840 kHz  SCS=60 kHz is too small and should be excluded | Optional bandwidth of 500 MHz or smaller is unclear to us.  We should focus on additional larger BW values, i.e., 800 MHz, as smaller BW values can be anyway supported by appropriate frequency resource allocation | For 800 MHz:  264 (240 kHz), 132 (480 kHz), 66 (960 kHz), 32 (1920 kHz), 16 (3840 kHz) |
| **MediaTek** | We are fine with the 4 objectives in general. Regarding to the first objective: “Channel delay spread impact for various CP type/lengths,” we believe it’s beneficial for the SLS to provide the insights into the statistics of the delay spread after beam-forming under the agreed deployment scenarios. | 60 GHz | 960  Regarding numerology, we are fine with 960 kHz sub-carrier spacing and 2160 MHz channel bandwidth as baseline. However, the choice of numerology depends heavily on LLS study. The number should be revisited after the LLS study reaches a conclusion. | 2160 MHz    Optional: 500 MHz | Maintain a maximum FFT size of 4096. |
| **NTT DOCOMO** | We agree to deprioritize the objective 1 on CP as it would be covered in LLS.  On the coexistence analysis, we share Ericsson’s view that first the focus should be on investigation of the interference distribution and its impact on throughput/latency.  The 3rd objective is ok for us.  On the 4th objective, coexistence mechanism in 60 GHz should be studied based on the 2nd objective in our view, as mentioned by Ericsson already. | Support moderator’s proposal. | In addition to 960 kHz, at least 120 and 1920 kHz should also be studied. | We support 2.16 GHz. 2 GHz instead of 2.16 GHz is also fine.  400 or 500 MHz should also be studied. | Same view as for LLS. |
| **Sony** | We think it is important to study different LBT schemes in system level simulation. |  |  |  |  |
| **TCL** | Focus on NR-NR multi-operator coexistence analysis  Performance impact for using various LBT schemes (e.g. omni-directional LBT, directional LBT, no-LBT etc). |  | SCS depends on BW to be simulated: 480kHz up to 1000MHz BW and 960kHz SCS above 1000MHz | 2GHz instead of 2.16 GHz | For 400 MHz:  64 (480 kHz)  For 2000 MHz  320 (480 kHz), 160 (960 kHz |
| **Charter** | Agree to deprioritize the objective 1 on CP as it would be covered in LLS. In other words, numerology design should be guided.by LLS. Objectives 2 and 4 could be combined as pointed out by others. | Same as LLS |  |  |  |
| **CATT** | Performance analysis for PDSCH/PUSCH/PRACH  Performance impact with/without interference management and collision avoidance with narrow beamwidth operation (with or without LBT) | 60 GHz,  Optional: 70 GH | 240 kHz, 480 kHz and 960 kHz | 1 GHz and 400 MHz | For 400 MHz:  256 (120 kHz), 128 (240 kHz), 64 (480 kHz), 32 (960 kHz), 16 (1920 kHz), 8 (3840 kHz) |
| **Potevio** | We support moderator’s proposal, and also suggest study performance impact for using various CCA levels and LBT schemes, especially for directional LBT |  |  |  |  |
| **OPPO** | We think one main objective of SLS is to evaluate the fair coexistence of different systems on shared spectrum. |  |  |  |  |
| **Parameter Set 1** | **Evaluation Objectives** | **Carrier Frequency [GHz]** | **Subcarrier Spacing [kHz]** | **Bandwidth [MHz]** | **Number of RB** |
| **Moderator Summary/Suggestion** | 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  [Moderator Notes: majority of the companies seem to prefer 60GHz as the baseline frequency. Let’s keep 70GHz as optional] | 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  ~~Optional:~~ 400 MHz  Note: Channel bandwidth evaluated may be revisited after further investigation. | For 2000 MHz:  - N/A (120 kHz),  - N/A (240 kHz),  - 320 (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 encourage to utilize linearly scaled PRB sizes for a given bandwidth based on above. |
| **Lenovo/ Motorola Mobility** |  |  |  |  | Same comment as for link level: for 2000 MHz BW, 480 kHz SCS should be N/A as well in terms of number of RBs |
| **NTT DOCOMO (v026)** |  |  |  | 400 MHz (or something smaller value) should be mandated as well to obtain interference model considering EIRP constraint  [Moderator comment: updated] | [Moderator comments: I think we can discuss later whether RB size beyond 275 should be valid or not. For the evaluation purposes, I think it ok to leave it as is. The purpose of the evaluation to get insights on phase noise impact and not trying to agree to specific RB sizes anyway. I would suggest leaving the value as they are for now] |
| **Futurewei** |  |  |  | 400 MHz should be mandated as well  [Moderator comment: updated] |  |
| **Nokia** |  |  |  | 2000 GHz should be 2000 MHz  [Moderator comment: corrected] |  |

Table 8. SLS Parameter Set 2

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter Set 2** | **Deployment Scenario** | **UE distribution** | **Channel Model** |
| **Value** | **Indoor Office:**  Scenario 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    Optional:  Scenario 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    Optional:  Scenario 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    Optional:  Scenario 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 = 40m    Optional:  Scenario 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 F) Dense Urban with 1 layer  Hexagonal grid, single layer, 3 sectors per site, 19 sites locations, BS height 10m, UE height 1.5m, ISD = 150m    Optional:  Scenario G) Dense Urban with 2 layers  Macro layer (sub 7GHz):  Hexagonal grid, single layer, 3 sectors per site, 19 sites locations  BS height 25m, UE height 1.5m, ISD = 200m, fixed BS position  Micro layer (above 52.6 GHz):  BS height 10m, UE height 1.5m, 2 operator, 1 BS per hexgrid per operator, random position within macro hexagonal grid per operator, minimum distance between TRP and UE: 10m,    **Indoor Factory Hall:**  Optional:  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 20%  Optional:  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 60% | Average of 10 UE per BS    For InH open office: 100% indoor UEs  For Dense urban: 100% outdoor UEs  For InF: 100% indoor UEs | InH open office:  InH – office channel & PL model from TR38.901    Dense Urban:  UMi street canyon channel & PL model from TR38.901    Indoor factor:  InF channel & PL model from TR38.901 |
| **Huawei, HiSilicon** | We suggest to shorten the office box size to 50\*50 with four office boxes, to reduce the simulation burden. For outdoor scenario, 7 sites could be sufficient (instead of 19) considering the higher pathloss  We would like to prioritize the indoor scenario. The ISD for outdoor scenario should be checked considering the transmit power and pathloss in the frequency band. . |  |  |
| **Lenovo /Motorola Mobility** | We prioritize indoor scenario, Scenario (A) | We suggest an average of 20 UEs/BS | InH – office channel & PL model from TR38.901  InF channel & PL model from TR38.901 |
| **Ericsson** | We prefer to focus on a single indoor and single outdoor scenario and remove all the optionality that will only cause confusions.  It is important that the indoor scenario has two setups, one with single operator (used in first stage), and 2 operators (used in the second stage).  Stage 1: can be a smaller version of the 3rd layout that we proposed (50x60, with 6 gNBs)  Stage 2: an extension of the same scenario but with 2 operators deployed similar to the 1st layout here.  Outdoor scenario should be optional, and with much fewer number of gNBs as compared to scenario F. | Baseline 5 UEs/gNB.  Optional 10 UEs |  |
| **Futurewei** | Indoor Office Scenario A, Dense Urban Scenario G (one of each indoor/outdoor scenarios) | 10 UE per gNB, 100% indoor, 100% outdoor | InH open office:  InH – office channel & PL model from TR38.901    Dense Urban:  UMi street canyon channel & PL model from TR38.901 |
| **vivo** | Propose to prioritize indoor scenario for SLS  For Indoor Office, prefer Scenario A  For Dense Urban, prefer Scenario G. Note that our proposal in R1-2003425 has a scale factor to ISD which is not reflected in scenario G option. |  |  |
| **InterDigital** | Indoor Office Scenario A, Dense Urban Scenario G | 10 UEs/gNB  For InH open office: 100% indoor UEs  For Dense urban: 100% outdoor UEs | InH open office:  InH – office channel & PL model from TR38.901    Dense Urban:  UMi street canyon channel & PL model from TR38.901 |
| **ZTE** | We suggest to prioritize indoor open office scenario.  We prefer to have Scenario D as mandatory, Scenario A as optional. |  |  |
| **Qualcomm** | Qualcomm is aligned with evaluation under indoor scenario A. The use case of inter-operator coexistence is sufficiently highlighted in scenario A. A single operator scenario can be studied by turning off nodes of one of the operators.  As part of optional scenarios, simplified scenario B may be useful for highlighting specific features of algorithms such as directional sensing.  For outdoor scenarios, single and two operator dense urban layout (e.g. Scenario G) with Macro-layer ISD 100m or smaller is recommended.  Optional Scenario F and both indoor factory hall scenarios are useful for single operator/licensed operation. | User densities important to study are 1 and 2 users per cell. These type of user densities represent cases with lower levels of interference diversity and can better reveal the rarity as well as the severity of beamformed interference.  Baseline: 5 UE/gNB,  Optional 1UE/Cell, 2 UE/Cell | InH open office:  InH – office channel & PL model from TR38.901    Dense Urban:  UMi street canyon channel & PL model from TR38.901  InF scenarios: TR38.901 |
| **Nokia** | The mandatory indoor scenario should support both single operator and 2 operator deployments, as the single operator case will be in the focus of system design.  In coexistence analysis, simplicity of scenario is the key issue in facilitating fast simulations, allowing for use of simulation analysis in the design. Hence, we see that a simple scenario as scenario B should be supported at least as optional.  Optional outdoor scenario should also be supported, but as also Ericsson said, with much reduced number of BS sites than in scenario F or G to facilitate reasonable simulation times. Further, due to high propagation loss, significantly reduced number of cells provides sufficient modelling accuracy.  For example, it may be sufficient to model only 3 sectors per operator per simulation with moderate number of UEs per sector. This ensures that there are at least some border users that experience inter-cell interference situations, if such exist.    Both single operator and 2-operator cases should be supported on the optional outdoor scenario.  For performance scenarios, non-coexistence cases, larger number of cell sizes may be supported as the overall complexity is reduced in these cases. | 5 UEs per BS  Optional: 10 UEs per BS | Agree with first two scenarios only:  InH open office:  InH – office channel & PL model from TR38.901    Dense Urban:  UMi street canyon channel & PL model from TR38.901. |
| **Samsung** | Prioritize indoor scenario | Support Moderator’s proposal | Support Moderator’s proposal |
| **Apple** | 1 indoor scenario and 1 outdoor scenario should be studied. For indoor, Scenario C can be used as baseline and Scenario D for actual testing. For outdoor, scenario F can be usedas baseline with scenario G for actual testing. For the outdoor scenarios, we suggest using a 7 cell system rather than 19 for simplicity. | 5 UEs per BS | Support Moderator’s proposal |
| **LG** | We prefer Scenario D for indoor and Scenario G for outdoor. | We share the same view with Ericsson and Qualcomm and Nokia that 5 UEs per BS should be baseline. | OK with Moderator’s suggestion. |
| **Intel** | **Indoor Office:**  In scenario D, should be ISD = 20 m. Also, Scenario D should be mandatory as it was used during NR-U SI. The densification and distances could be further adjusted if needed.  In scenario E, the ISD is 40 m which seems large. Some further densification is needed for this scenario. Otherwise, the scenario may be excluded.  **Dense Urban:**  Should be 7 sites instead of 19 (all scenarios)  **Indoor Factory Hall:**  InF-DL the clutter density should be 60% and in InF-SH the clutter density should be 20% |  |  |
| **MediaTek** | We agree with many companies above that indoor scenario should be prioritized. Specifically, scenario A can better reflect interference situation among uncoordinated beam-forming devices. Outdoor scenario (Dense Urban) should be either removed or made optional. If outdoor scenario is to be simulated, the number of sites should be reduced to 7 or less. |  |  |
| **NTT DOCOMO** | For indoor scenario, 1-operator case should also be studied. | Support moderator’s proposal | Support moderator’s proposal |
| **TCL** |  | Support Moderator’s proposal | Support Moderator’s proposal |
| **Charter** | **Indoor Office** Scenario A) for both single operator and multi-operator. Consolidate the number of scenario options to simplify drawing a meaningful conclusion for the SI. | Support Moderator’s proposal | Support Moderator’s proposal |
| **CATT** | One indoor scenario and one outdoor scenario would be sufficient  Indoor: InH open office  Outdoor: dense urban with 1 layer. | 5 UE per BS is the baseline | InH open office:  InH – office channel & PL model from TR38.901    Dense Urban:  UMi street canyon channel & PL model from TR38.901 |
| **Potevio** |  | Support Moderator’s proposal | Support Moderator’s proposal |
| **Parameter Set 2** | **Deployment Scenario** | **UE distribution** | **Channel Model** |
| **Moderator Summary/Suggestion** | **Prioritized scenarios:**  - Scenario (indoor-A or indoor-D), (outdoor-A or outdoor-C)  **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    **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    **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    **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    **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    **Scenario Outdoor-B)** Dense Urban with 2 layers  Macro layer (sub 7GHz – not necessary 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 = 200m, 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,    **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. |
| **Futurewei** | What is the value of having two indoor office scenarios prioritized? We think that one indoor and one outdoor scenario should be enough. If companies want a third scenario maybe an Indoor factory would be more valuable.  [Moderator comments: companies view on which one should be prioritized was diverse. I suggest to resolve the selection between A and D during GTW meeting] |  |  |
| **Apple** | Just need to fix a reference typo: outdoor G is from the original table. I assume you mean Outdoor-B.  [Moderator comments: G was a typo. It should have been outdoor-A] |  |  |
| **Ericsson** | As many companies already indicated, it is preferred to focus on one indoor scenario. And one outdoor scenario as optional. There is no need to include scenario D in the prioritized list, given the small variation as compared with scenario A.  Also, it should be emphasized that single operator scenario is prioritized. (scenario A + switching off nodes of one of the operators)  We suggest that for scenario A, only 6 APs/operator is enough (i.e. scaling the dimension to 60\*50 m). This has been iterated by other companies as well. Given the high path loss, we do not expect that more deploying more gNB using the proposed distribution will not change anything about the expected observations.  [Moderator comments: companies view on which one should be prioritized was diverse. I suggest to resolve the selection between A and D during GTW meeting]  The list in the moderator’s summary does not include outdoor-G. we assume what is meant is scenario outdoor-B with only 7 sites from the summary. If yes, we still think that 7 sites is also not needed here, 3 sites would be enough.  [Moderator comments: G was a typo. It should have been outdoor-A] |  |  |
| **Nokia** | Nokia agrees that an outdoor scenario should be included in the evaluation. However, Nokia has concerns with outdoor scenario G as being underspecified. Our concerns are captured below. Nokia strongly recommends that either scenario F be selected as the outdoor scenario or the issues itemized below be addressed to improve scenario G.  [Moderator comments: G was a typo. It should have been outdoor-A]  The macro layer in scenario G remains underspecified. For example, the operating bandwidth and carrier frequency for sub 7 GHz layer are not specified. A sub 7GHz macro layer configured as having a 400 MHz BW at 3.5 GHz will behave much differently than a macro layer having 20 MHz bandwidth at 1.8 GHz. The benefit of offloading to the 60 GHz micro layer will be very different in the two described configurations.  [Moderator comments: Understood. Given that we are studying the impact for the 60 GHz, I assumed companies would only need to simulate the micro layer. I’ve updated to clarify this further.]  Furthermore, the micro layer in scenario G requires further definition for about 52.6 GHz. As micro TRPs at 60 GHz will not be omnidirectional, A single panel micro TRP will not provide coverage to its backside and be largely ineffective as micro-layer. At least three panels need to be defined or preferably 3 sectors (I.e. cells) per micro site. Furthermore, 1 microsite in a macro cell with a 200m ISD is probably too few. We would recommend at least 2 microsites each with 3 sectors to provide the omnidirectional coverage.  [Moderator comments: I understood outdoor-B as not trying to provide full coverage using the micro layer as coverage is provided by the micro layer. With this said outdoor-B has been updated as suggested. Antenna configuration has been clarified in the antenna configuration field] |  |  |

Table 9. SLS Parameter Set 3

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter Set 3** | **Mobility** | **BS Antenna Configuration (Mg,Ng,M,N,P)** | **BS Antenna Pattern** | **BS Antenna element gain** | **UE Antenna Configuration (Mg,Ng,M,N,P)** | **UE Antenna Pattern** | **UE Antenna element gain** |
| **Value** | 3 Km/hr | (1,1,8,16,2) with (0.5 dv, 0.5 dH)    Optional:  (1,1,4,4,2), (1,1,8,4,2), (1,1,8,8,2), (1,1,16,16,2), (1,1,32,8,2) | Antenna power pattern given in Table 7.3-1 of TR38.901  (with exception of antenna element gain) | 5 dBi | (1,1,2,4,2) with (0.5 dv, 0.5 dH)    Optional:  (1,1,1,2,2), (1,1,2,2,2), (1,1,4,4,2) | Antenna power pattern given in Table 7.3-1 of TR38.901  (with exception of antenna element gain) | 0 dBi    Optional:  5dBi |
| **Huawei, HiSilicon** |  | We would prefer reducing the number of optional configurations, e.g. to (1,1,4,4,2), or to have both (1,1,8,16,2) and (1,1,4,4,2) as mandatory, and leave the other configurations as optional. |  |  |  |  |  |
| **Lenovo /Motorola Mobility** | We agree with 3Km/hr | Similar configuration as for LLS |  |  | Similar configuration as for LLS |  |  |
| **Ericsson** |  | (1,1,8,16,2) for outdoor  (1,1,4,8,2) for the indoor office | According to 38.802, the 3db = 65 is suitable for single sector and 3-sector indoor deployment. Instead, for the Ceiling-mount 3db = 135 is used. [see 38.802 Table A.2.1-7: Indoor BS antenna radiation pattern for above 6GHz] , |  | (1,1,4,4,2) for outdoor  (1,1,2,2,2) for the indoor office | For 0 dBi UE AE gain, use omni-directional pattern.  For >0 dBi UE AE gains, 38.802 proposes a UE antenna radiation pattern in Table A.2.1-8, so no need to use the one specified for the BS in 38.901. |  |
| **Futurewei** |  | (1,1,8,16,2) with (0.5 dv, 0.5 dH) |  |  | (1,1,4,4,2) with (0.5 dv, 0.5 dH) Optional: (1,1,2,2,2) |  |  |
| **vivo** |  |  |  |  | (1,1,4,4,2) with (0.5 dv, 0.5 dH) |  |  |
| **InterDigital** | We support the moderator’s proposal | Aligned configuration with LLS |  |  | Aligned configuration with LLS |  |  |
| **ZTE** | 3 Km/h | (1,1,8,16,2) with (0.5 dv, 0.5 dH)  Optional:  (1,1,4,4,2) | Antenna power pattern given in Table 7.3-1 of TR38.901 | 5 dBi | (1,1,4,4,2) with (0.5 dv, 0.5 dH)  Optional:  (1,1,1,2,2), (1,1,2,2,2), (1,1,2,4,2) | Antenna power pattern given in Table 7.3-1 of TR38.901 | 0 dBi |
| **Qualcomm** | 3 Km/hr | We propose to have (1,1,8,16,2) and (1,1,4,8,2) configurations as mandatory and others as optional. | We agree with Ericsson’s comment above for ceiling mounted indoor gNBs and propose θ3dB = 130 for indoor single sector ceiling mounted configuration. | 5dBi | (1,1,2.4. 2) with (0.5 dv, 0.5 dH)    Optional:  (1,1,2,2,2), (1,1,4,4,2) | We agree with Ericsson’s comment. We propose to use UE antenna element pattern with 5dBi gain as captured in 38.802 Table A.2.1-8. | 5dBi |
| **Nokia** | We agree with 3 Km/hr. | Same as LLS  (1,1,8,16,2)  Optional:  square pattern may be used for ceiling mounted inH gNB (1,1,4,4,2), (1,1,8,8,2).  Outdoor may consider (1,1,8,32,2), (1,1,16, 16,2) | Agree with proposed power pattern in TR 38.901 | agree | Same as LLS:  (1,1,4,4,2) UE with (0.5 dv, 0.5 dH)  Should consider multi-panel UE with 2 panels back-to-back with selection done at the receiver. | Agree with proposed power pattern in TR 38.901 | 5 dBi  For this frequency range omnidirectional radiator with 0 dBi is unrealistic nor is it consistent with a multi-element array |
| **Samsung** | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal |
| **Apple** | Support Moderator’s proposal | Aligned with LLS | Support Moderator’s proposal | Support Moderator’s proposal | Aligned with LLS | Support Moderator’s proposal | 5 dBi |
| **LG** | OK with Moderator’s suggestion. | Same as LLS.  (1,1,4,8,2) needs to be evaluated. | OK with Moderator’s suggestion. | OK with Moderator’s suggestion. | Same as LLS.  (1,1,2,2,2) needs to be evaluated. | OK with Moderator’s suggestion. | OK with Moderator’s suggestion. |
| **Intel** |  | Should consider possibility of having a list of different useful antenna configurations intended for different deployment scenarios instead of only one Mandatory configuration and many Optional. |  |  |  |  |  |
| **MediaTek** | We agree with 3 Km/hr. |  |  |  | (1,1,2,4,2) with (0.5 dv, 0.5 dH). In addition, an optional configuration of (1,1,4,4,1) with (0.5 dv, 0.5 dH) for devices with only 1 RX chain. |  |  |
| **NTT DOCOMO** | Support moderator’s proposal | Support moderator’s proposal | Support moderator’s proposal | Support moderator’s proposal | Support moderator’s proposal | Support moderator’s proposal | Support moderator’s proposal |
| **Sony** |  |  |  |  | Optional: study (1,2,2,4,2) with (0.5 dv, 0.5 dH), which can show the effect from multiple panels in UEs.  We assume the baseline is single beam operation with 1 TxRU for both DL and UL. |  |  |
| **TCL** | Agree with 3Km/h | Aligned with LLS |  |  | Aligned with LLS |  |  |
| **Charter** | Should align these with LLS |  |  |  |  |  |  |
| **CATT** | 3 km/h | (1,1,8,16,2) for outdoor  (1,1,4,8,2) for the indoor office | Agreed with Moderator’s proposal | Agreed with Moderator’s proposal | (1,1,2,4,2) with (0.5 dv, 0.5 dH) | Agreed with Moderator’s proposal | 0 dBi |
| **Potevio** | Support Moderator’s proposal |  | Support Moderator’s proposal |  |  |  |  |
| **Parameter Set 3** | **Mobility** | **BS Antenna Configuration (Mg,Ng,M,N,P)** | **BS Antenna Pattern** | **BS Antenna element gain** | **UE Antenna Configuration (Mg,Ng,M,N,P)** | **UE Antenna Pattern** | **UE Antenna element gain** |
| **Moderator Summary/Suggestion** | 3 km/hr | For outdoor macro/sectorized scenarios:  (Mg,Ng,M,N,P) = (1,1,8,16,2)  with (0.5 dv, 0.5 dH)  For outdoor micro-layer scenarios:  (Mg,Ng,M,N,P) = (1,3,8,16,2)  with (0.5 dv, 0.5 dH)  Note: 3 horizonal panels are 120 degree sectorized  For indoor scenarios:  (Mg,Ng,M,N,P) = (1,1,4,8,2)  with (0.5 dv, 0.5 dH) | For outdoor scenarios:  - Antenna power pattern given in Table 7.3-1 of TR38.901  (with exception of antenna element gain)  For indoor/factory scenarios:  - Antenna power pattern given in Table A.2.1-7 of TR38.802 for ceiling mount  (with exception of antenna element gain) | 5 dBi | ~~For outdoor scenarios:~~  (Mg,Ng,M,N,P) = (1,2,4,4,2)  with (0.5 dv, 0.5 dH)  ~~For indoor scenarios:~~  (Mg,Ng,M,N,P) = (1,2,2,2,2)  with (0.5 dv, 0.5 dH)  Note: The 2 panels are back-to-back with panel selection done the at receiver. The UE will only utilize 1 panel at a given moment. | For >0 dBi UE AE gains:  - Antenna power pattern given in Table A.2.1-8 of TR38.802  For 0 dBi UE AE gain:  - use omni-directional pattern. | 5 dBi    Optional:  0 dBi |
| **Ericsson** |  |  |  |  | The note is irrelevant and contradicts with the proposed configuration (Mg and Ng equal to 1)  [Moderator comment: it was specified as 1 as the UE will only utilize 1 panel at a given moment. Therefore, the number of panel isn’t strictly 2. With this said I’ve updated the number of panels and made updates to the note] |  | Majority of the companies proposed 0dBi (explicitly mentioned or did not object to the original moderator’s proposal of 0dBi). It should be the baseline and 5dBi can be optional.  [Moderator comment: I’ve counted 5 companies preferring 0dB, and 3 companies preferring 5dB. While it is correct it is the majority among input provided in the strict sense I would not necessary state this is majority from RAN1 perspective. Just a clarification if 0dBi is mandatory, does this mean UE would have omni-direction antenna aray?] |
| **Nokia** |  | The configuration of the micro TRP in scenario G is ambiguous. As defined, it is only 1 sector. For 1 sector, the orientation of the panel is not specified. Arguably 1 sector insufficient for outdoor.  Recommend for outdoor scenarios that gNB site be 3 sector (i.e.cell).  [Moderator comment: updated] |  |  | Disagree. No reason to have different outdoor and indoor UE configurations for mobile. The only reason to have different configuration if we are modelling outdoor CPEs.  Recommend that the same configuration be used for both outdoor and indoor:  (Mg,Ng,M,N,P) = (1,1,2,2,2)  with (0.5 dv, 0.5 dH)  [Moderator comment: deleted the outdoor and indoor differentiation for the UE. Left the two options on the table] |  |  |

Table 10. SLS Parameter Set 4

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter Set 4** | **BS Power Limitation** | **UE Power Limitation** | **BS NF** | **UE NF** | **Transmission Rank** |
| **Value** | 40 dBm EIRP  Maximum TxP adjusted to meet EIRP limits | 25 dBm EIRP with 21 dBm max TxP    Optional:  40dBm EIRP with 21 dBm max TxP | 7 dB | 13 dB    Optional:  10 dB | Rank adaptative transmission between Rank 1 and 2 |
| **Huawei, HiSilicon** |  |  |  |  |  |
| **Lenovo /Motorola Mobility** | Maximum TxP adjusted to meet EIRP limits |  |  |  | Agree |
| **Ericsson** |  |  |  |  |  |
| **Futurewei** | 40 dBm EIRP |  |  | 10 dB (consistent with RAN4 param for FR2) | Rank 1 |
| **vivo** |  |  |  |  |  |
| **InterDigital** |  |  |  |  | We support the moderator’s proposal |
| **ZTE** | 40 dBm EIRP  Maximum TxP adjusted to meet EIRP limits |  |  |  |  |
| **Qualcomm** | Agee | Agree | Agree | 10 dB | Agree |
| **Nokia** | 40 dBm EIRP. May consider higher 60 dBm EIRP for licensed scenario. Agree. Maximum TxP adjusted to meet respective EIRP limits | agree | Agree. 7 dB as ITU-R M.2412) | 10 dB (as ITU-R M.2412) | Agree: Rank adaptative transmission between Rank 1 and 2. |
| **Samsung** | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | 10 dB | Support Moderator’s proposal |
| **Apple** | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal |  | Rank 1 |
| **LG** | OK with Moderator’s suggestion. | OK with Moderator’s suggestion. | OK with Moderator’s suggestion. |  | OK with Moderator’s suggestion and Rank 1 is also fine. |
| **Intel** | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | 10 dB | Support Moderator’s proposal |
| **MediaTek** | 40 dBm EIRP seems to be a universally accepted maximum in most regions. |  |  |  |  |
| **NTT DOCOMO** | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal |
| **TCL** | Agree | Agree | Agree | Agree | Rank 1 |
| **Charter** | Support moderator’s proposals | Support moderator’s proposals | Support moderator’s proposals | Support moderator’s proposals | Support moderator’s proposals |
| **CATT** | 40 dBm EIRP | Agreed with Moderator’s proposal | 7 dB | 13 dB | Rank 1 |
| **Potevio** | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal |  | Support Moderator’s proposal |
| **Parameter Set 4** | **BS Power Limitation** | **UE Power Limitation** | **BS NF** | **UE NF** | **Transmission Rank** |
| **Moderator Summary/Suggestion** | 40 dBm EIRP  Optional: 60 dBm EIRP  Maximum TxP adjusted to meet EIRP limits | 25 dBm EIRP with 21 dBm max TxP    Optional: 40dBm EIRP with 21 dBm max TxP | 7 dB | 10 dB  Optional: 13dB | Rank adaptative transmission between Rank 1 and 2 |
| **Nokia** | Both licensed and unlicensed spectrum between 57 GHz and 71 GHz were discussed in the SI, RP-193259. Considering this, 60 dBm EIRP should be included as an optional for outdoor scenarios.  [Moderator comments: added] |  |  |  |  |

Table 11. SLS Parameter Set 5

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter Set 5** | **PDCCH Overhead** | **DMRS Overhead** | **CSI-RS Overhead** | **SRS Overhead** | **Other Overhead** |
| **Value** | 2 Symbol per slot | 1 Symbol per slot | - | - | - |
| **Huawei, HiSilicon** |  |  |  |  |  |
| **Lenovo/**  **MotorolaMobility** | We agree to consider 2 symbols/slot as PDCCH overhead | We agree to consider 1symbols/slot as PDCCH overhead (with no data multiplexing on DM-RS symbol) |  |  |  |
| **Ericsson** |  |  |  |  |  |
| **Futurewei** |  |  |  |  |  |
| **vivo** |  |  |  |  |  |
| **InterDigital** | We support the moderator’s proposal | We support the moderator’s proposal |  |  |  |
| **ZTE** | 2 Symbol per slot | 1 Symbol per slot |  |  |  |
| **Qualcomm** | 2 symbols/slot | 1 Symbol/Slot | Specify with the Simulation assumptions | Specify with the Simulation assumptions | PUCCH, Specify with the simulation assumptions |
| **Nokia** | Perhaps use a fixed overhead matching ITU IMT-2020 proposal for FR2 |  |  |  |  |
| **Samsung** | Support Moderator’s proposal | Support Moderator’s proposal |  |  |  |
| **Apple** | Support Moderator’s proposal | Support Moderator’s proposal |  |  |  |
| **LG** | OK with Moderator’s suggestion. | OK with Moderator’s suggestion. |  |  |  |
| **Intel** | Support Moderator’s proposal | Support Moderator’s proposal |  |  |  |
| **NTT DOCOMO** | Support Moderator’s proposal | Support Moderator’s proposal |  |  |  |
| **TCL** |  |  |  |  |  |
| **Charter** | Left to company choice but should be clearly specified along with the results | Left to company choice but should be clearly specified along with the results | Left to company choice but should be clearly specified along with the results | Left to company choice but should be clearly specified along with the results | Left to company choice but should be clearly specified along with the results |
| **CATT** | 2 symbols/slot | 1 symbol/slot |  |  |  |
| **Potevio** | Support Moderator’s proposal | Support Moderator’s proposal |  |  |  |
| **Parameter Set 5** | **PDCCH Overhead** | **DMRS Overhead** | **CSI-RS Overhead** | **SRS Overhead** | **Other Overhead** |
| **Moderator Summary/Suggestion** | 2 symbol per slot | 1 symbol per slot | Companies to provide information | Companies to provide information | Companies to provide information |

Table 12. SLS Parameter Set 6

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter Set 6** | **TDD DL/UL Ratio** | **CSI feedback** | **Additive Rx EVM** | **Traffic Model** | **UE Receiver** | **Cell selection criteria** | **DL/UL Traffic Ratio** |
| **Value** | - | Ideal feedback | - | FTP Model 3 (0.5Mbyte file)    Optional:  Full buffer,  FTP Model 1 (27Mbyte file)  FTP Model 3 (27Mbyte file) | MMSE-IRC | Random select from strongest RSRP with 1 dB HO Margin | 50% DL, 50% UL    Optional:  100% DL, 0% UL,  80% DL, 20% UL  0% DL, 100% UL |
| **Huawei, HiSilicon** | Irrelevant for unlicensed operation coexistence study |  |  |  |  |  |  |
| **Lenovo/**  **Motorola Mobility** |  | Agree |  | Agree | Agree |  | Agree |
| **Ericsson** |  |  |  | Full buffer should be removed. |  | A lower limit on the received Power should be set. | The UE processing delays for 960KHz SCS are not specified. How should that be considered if UL is to be included at this early stage ? |
| **Futurewei** |  | Ideal feedback |  | We prefer large files. FTP Model 1 (27 MB) |  |  | 80% DL, 20%UL  Optional: 50% DL 50% UL |
| **vivo** |  |  |  |  |  |  |  |
| **InterDigital** |  |  |  | We support the moderator’s proposal | We support the moderator’s proposal |  |  |
| **ZTE** | 5:5 DL/UL  Optional:  10:0 DL/UL  8:2 DL/UL  0:10 DL/UL | Ideal feedback |  | FTP Model 3  (0.5, 8 Mbyte file)  Optional:  2, 16 Mbyte file | MMSE-IRC | Random select from strongest RSRP with 1 dB HO Margin | 50% DL, 50% UL    Optional:  100% DL, 0% UL,  80% DL, 20% UL  0% DL, 100% UL |
| **Qualcomm** | Specify with the Simulation assumptions | What does ideal feedback entail? It is preferred to specify with simulation assumptions. |  | We prefer the use of FTP Model 3 for simulations. Further, we consider 0.5Mbyte file size would be small for wider bandwidth investigations. We propose to make 27Mbyte as the non-optional file size. | Agree | Agree | Agree. Any assumptions related to UE timing could be specified with simulation assumptions. 120KHz timelines could be the starting point. |
| **Nokia** | Declared. May be adjusted to match traffic ratio or dynamic. | Agree ideal feedback |  | Agree with proposed models. Perhaps consider scaling the file size now that we are using 2.16 GHz bandwidths | Agree | Based on RSRP | 50% DL, 50% UL |
| **Samsung** |  | Support Moderator’s proposal |  | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal |
| **Apple** | Needs to be specified | Definition of ideal feedback is needed e.g. no error, no delay |  | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal |
| **LG** |  | OK with Moderator’s suggestion. |  | We share the same view with Ericsson that Full buffer case should be removed. | OK with Moderator’s suggestion. | We share the same view with Ericsson that a lower limit on the received power needs to be set. | OK with Moderator’s suggestion. |
| **Intel** |  |  | Optional Rx EVM should depend on SCS, i.e., smaller SCS has larger additive Rx EVM |  |  |  |  |
| **MediaTek** |  |  | Optional for the time being. Pending outcomes from LLS study. | FTP Model 3 (27 MB) |  |  |  |
| **NTT DOCOMO** |  |  |  |  |  |  |  |
| **TCL** |  |  |  | Agree | Agree | Agree |  |
| **Charter** | Specify in assumptions | OK assuming this means instantaneous feedback |  |  |  |  |  |
| **CATT** | Specified in the simulation assumption | Ideal |  | FTP-3 (27 MB) | MMSE | RSRP-based | 50% DL, 50% UL |
| **Potevio** |  |  |  | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal | Support Moderator’s proposal |
| **Parameter Set 6** | **TDD DL/UL Ratio** | **CSI feedback** | **Additive Rx EVM** | **Traffic Model** | **UE Receiver** | **Cell selection criteria** | **DL/UL Traffic Ratio** |
| **Moderator Summary/Suggestion** | 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  [Moderator note: Moderator has a question on placing a minimum RSRP threshold for the UE selection. What would happen to UEs that are below threshold? Are those UEs re-dropped to new location until suitable serving cell is found or left out of the evaluation or something else?. If this is something that requires debate, moderator suggest to keep the above for now and further discuss about additional restrictions to cell selection in the next meeting] | 50% DL, 50% UL    Optional:  100% DL, 0% UL,  80% DL, 20% UL  0% DL, 100% UL  Note: For evaluation purposes, UE processing timeline in microseconds are assumed to be same as 120 kHz SCS. |
| **Ericsson** |  |  |  |  |  | To answer moderator’s question, below is the procedure that was followed for LAA evaluations [copied from TR 36.889]  “All UEs should be randomly dropped and be within coverage of the small cell in the unlicensed band.  Example of a dropping method to achieve this with N=10 UEs:   * Drop a large enough number of UEs, so that at least 10 UEs are covered by the small cell in the unlicensed band.   Randomly select 10 UEs from the UEs that have coverage.”  [Moderator note: understood. What is the threshold level that is being proposed? We would still need this] | Related to the note, it is not clear if we are reusing the processing timeline values in microsecond or slots.  Is it correct to assume N1 would be about 178.4 us, and N2 would be about 321.12 us ?  [Moderator note: clarified that this would be in absolute time/microseconds. However, we may need to check during GTW] |

Suggested note to be added to the evaluation parameters:

* Companies to report details of LBT procedure and parameters (e.g. ED, CWmax, COT, etc.) if LBT procedure is used in the evaluations.

## 2.3 High-level Issues for Supporting NR from 52.6 GHz to 71 GHz SI

Based on submitted contributions, we provide a summary of high-level abstracted issues for supporting NR from 52.6 GHz to 71 GHz. Please note the summary is not an exhaustive list.

1. Candidate numerology (SCS, and CP length) to be supported by RAN1 specification.
   * Discussions may include how RAN1 should conclude on determination of the candidate numerologies
   * Discussion may also include identification of any coupling with other system parameters, such as bandwidth (number of PRB), FFT size, etc
2. Candidate bandwidths (or range of bandwidth) to be supported by RAN1 specification and related considerations (e.g. maximum FFT size)
   * Discussions may include how RAN1 should conclude on determination of the candidate bandwidths
3. Identification of regulatory aspects to consider in channel access (and interference mitigation techniques) for 60GHz unlicensed NR operation
   * Some examples could be CCA sensitivity levels, time unit for measurement and back-off counters, access categories, channel bandwidth occupancy, etc.
4. Supported LBT modes of operation (e.g. omni-directional LBT, directional LBT, receiver-aided LBT, no-LBT, etc)
   * Discussion may include how RAN1 should conclude on LBT mode of operations and identification of various consideration aspects (in the decision-making process)
   * Discussions may also include whether to always mandate LBT operations or not

Other issues discussed in submitted contributions are (not an exhaustive list):

* Investigation of directional LBT
* Investigation of receiver-aided LBT
* Shared COT mechanisms
* Beam sweeping issues for SS/PBCH blocks
* Beam failure detection issues
* Potential enhancements to increase the channel access opportunities
* Energy detection threshold calculation to account for instance for the directivity of LBT, or LBT channel bandwidth
* OCB constraints and related specification impact
* FBE operations
* SSB and CORESET#0 multiplexing

**Discussion Summary:**

Companies are encouraged to provide comments on

* Identification of high-level issues/considerations
  + Including whether the above listed 4 issues above is ok
  + Including any changes and modifications to the high-level issue description
* For each high-level issue/consideration provide further comment on what RAN1 should make conclusions and agreements on.

|  |  |
| --- | --- |
| **Company Name** | **Comments/Views** |
| **Huawei, HiSilicon** | We suggest completing the list of other issues or considerations in making decisions on numerology and in assessing impact on channel design, to make it an exhaustive list. We noted at least the following points should be added:   * Investigation of directional LBT * Investigation of receiver-aided LBT * Shared COT mechanisms * Beam sweeping issues for SS/PBCH blocks (including beam switching time) * Beam failure detection issues * Potential enhancements to increase the channel access opportunities * Energy detection threshold calculation to account for instance for the directivity of LBT, or LBT channel bandwidth * OCB constraints and related specification impact * PSD constraints and related specification impact * FBE operations * SSB and CORESET#0 multiplexing * Constraints related to UE processing times and PDCCH monitoring capabilities * Coverage requirements for IAB and for short physical channels |
| **Lenovo/**  **Motorola Mobility** | In addition to the key objectives listed in simulation assumptions i.e. **higher numerology with different CP lengths and new PT-RS configurations**, at least following issues should be considered and studied in this study item:   * **For unlicensed access:**   + Investigation of directional LBT (including received assisted LBT)   + Shared COT mechanisms   + UL interlacing enhancements   + Initial access enhancements * **For licensed as well as unlicensed access:**   + CSI processing timeline and CSI processing unit availability for different SCS   + PDCCH monitoring enhancements   + Scheduling enhancements for high SCS   + Beam managements enhancements, if needed   + New DM-RS design |
| **Ericsson** | The fourth proposal needs to be modified. It assumes that operation based on LBT as a channel access/interference mitigation technique is the baseline, when the SI description does not explicitly mention LBT. Ofcourse based on some regulations, it has to be there, but that discussion can be taken as part of the third proposal in the list.  We propose to reword the fourth proposal to say supported channel access/interference mitigation techniques (e.g. ATPC, LBT, etc.. ) instead of LBT supported modes. |
| **Futurewei** | We agree with high level issues 1) to 4), in addition we propose to investigate LBT specific beam management enhancements (for instance beam management for LBT failure) |
| **vivo** | Support these 4 bullets as high level issues in principle.  We have a similar view as Ericsson and also propose to reword the 4th main bullet into “Supported channel access/interference mitigation techniques (e.g. omni-directional LBT, directional LBT, receiver-aided LBT, no-LBT, etc.)”.  Furthermore, we suggest to reword the 1st sub-bullet of the 4th bullet as well into “Discussion may include how RAN1 should conclude on channel access schemes and identification of various consideration aspects (in the decision-making process)” |
| **InterDigital** | We support 4 issues from the moderator. In addition, at least following issues should be studied:   * Investigation of directional LBT * Investigation of receiver-aided LBT * Required processing time lines for candidate numerologies * DMRS enhancement |
| **ZTE** | Support these 4 bullets as high level issues in principle. For the 4th main bullet, we prefer to keep it as it is. Omni-directional LBT can be served as the baseline, and we can evaluate the other LBT schemes including no LBT. |
| **Qualcomm** | We agree with the high-level description and the accompanying list of issues. We also support the proposal to reword 4the main bullet with a language similar to that proposed by Ericsson and Vivo. “Supported channel access/interference mitigation techniques including variants based on sensing mechanisms such as LBT, directional LBT, receiver-aided LBT, and other classes of mechanisms such as No-LBT, ATPC, etc.” Further “Discussion may include how RAN1 should conclude on channel access mechanisms and identification of various considerations in the decision-making process” |
| **Nokia** | 1. This is a valid issue.   Link performance under conditions of phase noise should be used as one criterion when comparing different candidate numerologies (the others are listed under issue #2)   * Both CP-OFDM and DFT-S-OFDM need to be studied * Both normal and extended CP lengths need to be studied * Both existing and improved PTRS configurations need to be studied * Separate studies are needed for data/control channels, as well as for initial access signals/channels (SSB, PRACH)   The results shown in our Tdoc (R1-2003811) show that with CP-OFDM, higher order modulations such as 64-QAM require at least 960 kHz SCS. Block-PTRS can enable efficient PN compensation with lower PTRS overhead and enable using 120kHz SCS for up to 256-QAM. SC-FDMA is more robust under phase noise than OFDM. New PTRS configurations for SC-FDMA can enable the use of current numerologies with all MCSs.  There are connections between SCS and other system parameters, e.g.   * With given number of PRBs, the SCS defines the maximum achievable BW * The performance depends not only on the SCS and waveform, but also on the PTRS configuration.   We propose to decide the maximum FFT size first. Based on the company Tdocs, there seems to be wide consensus not to increase the FFT size.  Based on the discussion above, we propose the following:   * Maintain the maximum number of RBs supported by NR specification also for above 52.6 GHz * Support the existing subcarrier spacings also for above 52.6 GHz * Extend the numerology scaling framework defined in NR Rel-15 to higher numerologies with at least one new value for μ. * Study the need for ECP length for the high SCSs * Study PTRS enhancements for NR scenario above 52.6 GHz.  1. This is a valid issue.   Related to candidate bandwidths (& SCSs), there are many aspects RAN1 should consider:   * **Performance** under conditions of phase noise (discussed under issue #1) * **Coexistence:** In order to maximize the coexistence between WiGig, it makes sense to consider 2.16 GHz as the baseline channelization for NR above 52.6 GHz. Based on the company Tdocs, there seems to be wide support for operation with CBW=2.16 GHz. * **Coverage & UE capability/cost:** One of the basic features of NR is variable bandwidth operation. We think that narrowband operation within a 2.16 GHz channel should be enabled. A natural starting point based on NR defined for FR2 would be to support 400 MHz transmission bandwidth as a bandwidth option for 60 GHz scenario (support for BW < 400 MHz is FFS). We think that sub-channelization needs to be considered in order to facilitate efficient interference management for narrowband operation. * **Maximum achievable bandwidth:** Increasing the subcarrier spacing will allow an increase in the transmission bandwidth. Further transmission bandwidth increases may be achieved by bonding multiple 2.16 GHz channels. Another solution is to increase the transmission bandwidth with carrier aggregation. We think that both options need to be supported.   Based on the discussion above, we propose the following bandwidth -related aspects:   * Support operation with CBW=2.16 GHz * Support both channel bonding and CA between 2.16 GHz channels * Consider n x 400 MHz, n=[1, 2, 3, 4] as supported channel BW options for operation within a 2.16 GHz channel (Support for BW <400 MHz is FFS) * Support also CA within 2.16 GHz channels * Consider sub-channelization for 2.16 GHz channels to enable narrowband operation.   3) This is a valid issue  The considered regulatory aspects should include also power spectral density.  The considered aspects should contain also identification of regional differences in the regulatory aspects as well as differences between regulatory requirements and ETSI harmonized standards. For example, the given list of LBT aspects (CCA sensitivity levels, etc) seem to relate more to ETSI standard than regulatory requirements.  4) This is a valid issue  However, we share the view of Ericsson and Qualcomm. The issue should be about supported channel access modes/mechanisms instead of LBT modes of operation. Further, the issue should include also   * discussion of candidate channel access or coexistence mechanisms as LBT is not required by any regulation on 60 GHz band. * discussion of channel access channelization. E.g. channelization based on 2.16 GHz BW seem to be considered in several Tdocs due to coexistence with WiGig, while operation also with narrower BW should be considered. * identification of LBT modes. Ambiguity in LBT modes would easily cause confusion in consecutive discussions. E.g. no-LBT could mean no-LBT deployment based on region, no-LBT of responding device in shared channel access, or no-LBT for certain short control signals. There should be also discussion of LBT categories (e.g. between Cat-3 and Cat-4 LBT) as well as whether FBE or LBE is assumed.   Related to the issue 4, we propose to target agreement on channel access channelization BW:   * Channel access channelization based on 2.16 GHz is assumed as a starting point in the studies. * Transmissions with a bandwidth smaller than 2.16 GHz, such as 400 MHz, are also considered in the channel access studies.   Related to other issued listed, there seem to be a few topics missing. Those are related mainly to operation with high SCSs:   * Processing timelines for high SCSs * BD/CCE limits for high SCSs * Scheduling operation, including minimum scheduling/PDCCH monitoring unit for high SCSs * Maintaining cell coverage/link budget for high SCSs * Supporting rank-2 SU-MIMO for DFT-s-OFDM * PRACH sequence lengths to achieve max allowed EIRP. |
| **Samsung** | We are OK with the high-level issues/considerations with one more added issue on identification of the potential impact and discussion on how to address it if any, we think with the discussion on numerology and bandwidth, there might be a chance to adopt new ones so that some issues might be identified and some potential enhancement should be considered as already commented by many companies, which we think is also aligned with SID.  Moreover, we are thinking whether the development scenarios and use cases for 52.6 GHz to 71 GHz need to be clarified. We understand that a study according to this direction has been performed in a RAN SI, and captured in TR 38.807, but that study is for a wider scope of carrier frequency range up to 100 GHz. Technically, the development scenarios and use cases for 52.6 GHz to 71 GHz could be a subset from the ones identified in TR 38.807, and it should be clarified since they give importance guidance on the selection of numerology and bandwidth for this study item. Even the same development scenarios and use cases are used, it would be good to capture this point (e.g. a reference to TR 38.807) in the TR for this SI. |
| **Apple** | We support the 4 main issues raised with the caveat that the main bullet of the fourth issue is modified to discuss the applicability of LBT AND the supported LBT modes if applicable even though we concede that this interpretation can be implied in the sub-bullets.  We also want to ensure that in cases where there are devices with bandwidths smaller than the BW of existing RATs, we have LBT schemes that account for this. |
| **LG** | We are generally fine with the summary of high-level abstracted issues provided by Moderator, and would suggest inclusion of the following aspects as the consideration points which should be studied in this SI.   * SSB structure with beam sweeping for licensed band and unlicensed band * Multiplexing between SSB and CORESET#0 with same/different SCSs * Handling of beam switching time for control/data channel transmission * Handling of control/data channel coverage by OFDM symbol shortening * LBT procedure with respect to {carrier BW, maximum power, ED threshold} * Multi-carrier based operation for multi-RAT coexistence in unlicensed band |
| **Intel** | Support Moderator’s proposal on the list of issues which could be extended by following:  Performance verification of existing RS, e.g., DMRS & PTRS, may be needed to cross-check whether channel estimation/phase tracking is sufficient or not. |
| **Mediatek** | We have concerns over the regulatory framework mismatch between gNB and UE adhering to different regulations ETSI EN 302 567 (indoor low power, fixed outdoor explicitly disallowed) and ETSI EN 303 722 (outdoor fixed only), especially around power level mismatch and channel access mechanism mismatch.  We have concerns about the maturity of ETSI EN 303 722 relative to the timeline of Release-17 where this Release-17 study item will likely end before ETSI EN 302 722 is finalized. For this reason we think outdoor scenarios should be either low priority optional or removed from this study. We also have concerns on the maturity of EN 302 567, given that significant parameter changes were made to channel access (COT length and observation slot counts) even at the last ETSI BRAN meeting, even as this specification is nearing submission to the EU Commission.  Given some early simulations from other companies are calling into question the utility of LBT as a channel access mechanism at >57GHz we propose first to study the different proposed access mechanisms BEFORE we start a study on directional LBT or receiver assisted LBT, LBT BW handling, i.e. first establish if LBT is a candidate before expending simulation effort on advanced LBT techniques. |
| **NTT DOCOMO** | We support the listed 4 issues above from the moderator.  For other case, following should be studied:   * Investigation of directional LBT * Beam sweeping issues for SS/PBCH blocks * OCB constraints and related specification impact * FBE operations * SSB and CORESET#0 multiplexing   In addition to above, timeline aspects should also be included in the scope of this SI, assuming the use of extended SCS |
| **Convida Wireless** | The first four issues from the moderator are valid, in our view. We prefer to keep 4) as it is.  The issues in the 10 bullets are also valid, in our view. However, the 4th issue could be revised to “Issues for SS/PBCH blocks”, since it’s not clear what “beam sweeping issues” are.  We suggest to study if there are any other issues with initial access. Additionally, RAN1 should study if enhancements to PT-RS are needed. |
| **Sony** | We support 4 bullets as high-level issues (Candidate numerology, Candidate bandwidths, Identification of regulatory aspects, and Supported LBT modes of operation ). In addition, the following issues should be studied in study item phase.   * Investigation of directional LBT * Investigation of receiver-aided LBT * Shared COT mechanisms * Beam sweeping issues for SS/PBCH blocks * Potential enhancements to increase the channel access opportunities * Energy detection threshold calculation to account, for example, for the directivity of LBT, or LBT channel bandwidth   SSB and CORESET#0 multiplexing |
| **TCL** | We support 4 issues from the moderator. In addition, at least following issues should be studied:   * Investigation of directional LBT * Investigation of receiver-aided LBT * Shared COT mechanisms * Energy detection threshold calculation * OCB constraints and related specification impact (e.g. wideband PUCCH) |
| **Mitsubishi** | Support the 4 items from the moderator. In addition, at least PT-RS and DM-RS design enhancements should be investigated for both waveforms. |
| **Charter** | Support these 4 bullets as high level issues to be studied in principle |
| **CATT** | Agree with 4 listed issues proposed by Moderator with additional issues to study   * Interference management technique with/without LBT * Broadcast/control channel beam sweeping * DL/UL beam correspondence in licensed/unlicensed spectrum   Directional RACH access |

**Moderator suggestion for conclusion:**

* Companies are encouraged to provide inputs and considerations for the following identified physical layer aspects:
  + Candidate numerology (SCS, and CP length) to be supported by RAN1 specification.
    - Discussions may include how RAN1 should conclude on determination of the candidate numerologies
    - Discussion may also include identification of any coupling with other system parameters, such as bandwidth (number of PRB), FFT size, etc
  + Candidate bandwidths (or range of bandwidth) to be supported by RAN1 specification and related considerations (e.g. maximum FFT size)
    - Discussions may include how RAN1 should conclude on determination of the candidate bandwidths
  + Identification of regulatory aspects to consider in channel access (and interference mitigation techniques) for 60GHz unlicensed NR operation
    - Note: some examples of consideration aspects could be CCA sensitivity levels, time unit for measurement and back-off counters, access categories, channel bandwidth occupancy, etc.
  + Supported channel access and interference mitigation techniques
    - Discussion may include how RAN1 should conclude on channel access schemes and/or interference mitigation techniques (e.g. omni-directional LBT, directional LBT, receiver-aided LBT, no-LBT, ATPC, etc) and identification of various consideration aspects (in the decision-making process)
    - Discussions may also include whether to always mandate LBT operations or not
* In addition to the above considerations, the following physical layer aspects have been additionally ~~identified~~ mentioned in RAN1#101-e:
  + Investigation of directional LBT
  + Investigation of receiver-aided LBT
  + Required processing timelines for candidate numerologies
  + Performance verification of existing and improved RS, e.g., DMRS & PTRS
  + Investigation of UL interlace transmissions
  + Shared COT mechanisms
  + Investigation of transmissions of SS/PBCH blocks (including beam switching time)
  + Beam failure detection issues
  + Potential enhancements to increase the channel access opportunities
  + Energy detection threshold calculation to account for instance for the directivity of LBT, or LBT channel bandwidth
  + OCB constraints and related specification impact
  + PSD constraints and related specification impact
  + FBE operations
  + SSB and CORESET#0 multiplexing
  + Constraints related to UE processing times and PDCCH monitoring capabilities
  + Coverage requirements for IAB and for short physical channels
  + CSI processing timeline and CSI processing unit availability for different SCS
  + BD/CCE limits for high SCSs
  + Scheduling operation, including minimum scheduling/PDCCH monitoring unit for high SCSs
  + Maintaining cell coverage/link budget for high SCSs
  + Supporting rank-2 SU-MIMO for DFT-s-OFDM
  + PRACH sequence lengths to achieve max allowed EIRP
  + SSB structure with beam sweeping for licensed band and unlicensed band
  + Multiplexing between SSB and CORESET#0 with same/different SCSs
  + Handling of beam switching time for control/data channel transmission
  + Handling of control/data channel coverage by OFDM symbol shortening
  + LBT procedure with respect to {carrier BW, maximum power, ED threshold}
  + Multi-carrier based operation for multi-RAT coexistence in unlicensed band
  + DL/UL beam correspondence in licensed/unlicensed spectrum
* Note that issues or considerations listed above does not necessarily mean RAN1 will automatically support the related features.

|  |  |
| --- | --- |
| **Company Name** | **Comments/Views** |
| **Ericsson** | We propose the following rewording:  ….   * + Supported channel access and interference mitigation techniques     - Discussion may include how RAN1 should conclude on channel access schemes and/or interference mitigation techniques (e.g. omni-directional LBT, directional LBT, receiver-aided LBT, no-LBT, ATPC, etc) and identification of various consideration aspects (in the decision-making process)     - Discussions may also include whether to always mandate LBT operations or not   …..  [Moderator comment: updated]  The list for the additional aspects is quite large and there was no discussions or agreement on the validity of those aspects, so we do not feel comfortable committing to this list at this point, unlike the first 4 main bullets which was brought up by many companies. So we propose rewording the top level description of the list :   * In addition to the above considerations, the following physical layer aspects have been additionally ~~identified~~ mentioned in RAN1#101-e:   [Moderator comment: Honestly, I don’t know if there is a difference. Identification is something that has been used commonly in other WI/SI. With this said, I’ve updated text. We can review this during GTW.]  The following ten aspects are already covered within the scope of the regulatory, channel access and interference mitigation considerations. These duplicates should be removed from the additionally identified aspect list.   * + Investigation of directional LBT   + Investigation of receiver-aided LBT   + Shared COT mechanisms   + Potential enhancements to increase the channel access opportunities   + Energy detection threshold calculation to account for instance for the directivity of LBT, or LBT channel bandwidth   + FBE operations   + LBT procedure with respect to {carrier BW, maximum power, ED threshold}   + Multi-carrier based operation for multi-RAT coexistence in unlicensed band   + OCB constraints and related specification impact   + PSD constraints and related specification impact   [Moderator comment: Given that now the section simply states that it was “mentioned” sub-selection might not be worth our effort. I my opinion, the list would be used a food for thought for companies to bring proposals/analysis/considerations in the next meeting and does not really have any binding power. With this said, let’s discuss this during GTW] |
| **Samsung** | We are thinking whether the development scenarios and use cases for 52.6 GHz to 71 GHz need to be clarified. We understand that a study according to this direction has been performed in a RAN SI, and captured in TR 38.807, but that study is for a wider scope of carrier frequency range up to 100 GHz. Technically, the development scenarios and use cases for 52.6 GHz to 71 GHz could be a subset from the ones identified in TR 38.807, and it should be clarified since they give importance guidance on the selection of numerology and bandwidth for this study item. Even the same development scenarios and use cases are used, it would be good to capture this point (e.g. a reference to TR 38.807) in the TR for this SI. |
| **Nokia** | "Performance verification of existing and improved RS, e.g., DMRS & PTRS." We should also consider any improved PTRS configurations to improve the performance.  [Moderator comment: updated] |
| **InterDigital** | We think that “Required processing timelines for candidate numerologies” overlaps with other bullets such as  “Constraints related to UE processing times and PDCCH monitoring capabilities”,  “CSI processing timeline and CSI processing unit availability for different SCS”,  “Scheduling operation, including minimum scheduling/PDCCH monitoring unit for high SCSs”,  “Handling of beam switching timing for control/data channel transmission” and  “Handling of control/data channel coverage by OFDM symbol shortening”.  We think that it is better to remove “Required processing timelines for candidate numerologies”.  [Moderator comment: Same comment as provided to Ericsson. Given that now the section simply states that it was “mentioned” sub-selection might not be worth our effort. I my opinion, the list would be used a food for thought for companies to bring proposals/analysis/considerations in the next meeting and does not really have any binding power. With this said, let’s discuss this during GTW] |

# Conclusion of the Email Discussion [101-e-NR-52\_71\_GHz]

**Summary of email discussion outcome:**

* xxx

# Reference

1. R1-2004703, “Summary of discussions on supporting NR from 52.6 GHz to 71 GHz,” Moderator (Intel Corporation)