**3GPP TSG RAN WG1 Meeting #102-e R1-20xxxxx**

**e-Meeting, August 17th – 28th, 2020**

**Source: Moderator (SoftBank)**

**Title: [102-e-NR-CovEnh-01] Summary on A.I. 8.8.1.1 baseline coverage performance using LLS for FR1**

**Agenda Item: 8.8.1.1**

**Document for: Information**

# Introduction

This paper summarizes the contributions submitted to A.I 8.8.1.1 (Study on NR coverage enhancement - Baseline coverage performance using LLS – FR1) and 8.8.3, which are relevant to simulation assumptions.

Note the header labelled at each section name means the following:

* **[H]**: high priority aiming at the discussion/approval on 8/20(Thu)
	+ These items are controversial, impact on other discussion, and/or require 2nd phase discussion
* **[M]**: Medium priority aiming at the discussion/approval on 8/26(Wed)
	+ These items are important for simulations, but have isolated impact to other topics.
* **[L]**: For last check on 8/28 (Fri)
	+ These items are binary decision, or less controversial.

Companies are encouraged to input their views to section 2 and 3 **until 12:00UTC on 8/19(Wed)**. Feature lead summary will be provided a couple of hours after this deadline.

# Open issues

## [M] Open issue No.1 - TBS for SIP invite (FR1 & FR2 common)

Open issue No.1 is the TBS for SIP invite message. We had a proposal for payload size, but no proposal was made for the corresponding TBS.

TBD: TBS for SIP invite message. Payload of 1500 bytes can be a starting point.

A detailed proposal on the TBS and number of segments was provided by [24] .

Table 1. Payload of SIP message and segmented TBS

|  |  |  |  |
| --- | --- | --- | --- |
| Example | SIP message | TB size | Segment |
| VoLTE | 2000 bytes | 56 bytes | Around 40 |

*Notes*: The TB size is captured from real network for weak coverage scenario.

* *For SIP evaluation, 56 bytes is the TB size to convey SIP message.*
* *To ensure the coverage of VoIP with acceptable VoIP delay including voice delay, ringing delay and call setup delay, 64kbps as a minimum target IP data rate of VoIP can be a starting point.*

Note that the required time period to complete the transmission is not discussed in this contribution, while R1-2003464 submitted to RAN1#101-e proposed 500ms for the worst case.

Interested companies are invited to input their views on the following aspects:

* SIP message size: 1500 bytes or 2000 bytes
* TB size: 56 bytes or any other value
* Number of segments: 40 or any other value
* Required time period: 500ms or any other value
* Requirement on PUSCH data rate for VoIP

|  |  |
| --- | --- |
| Company  | Comment |
| ZTE | Fine to consider SIP message as an optional service. The assumptions could be reported by interested companies.Regarding the data rate for VoIP, our preference is a packet size of 320 bits with 20ms data arriving interval. |
| Panasonic | We are fine with SIP invite message of 1500 bytes |
| Intel | SIP invite message can be considered as optional for link budget analysis. For VoIP, we prefer TBS of 320bits in the link level simulations.  |
| SoftBank | Considering the less number of input from the companies, we can conclude as follows:- Payload of 1500 bytes can be a starting point.- The assumptions are reported by interested companies.- Contributions R1-2003464 and R1-2005259 are taken into account for the evaluation. |
| Ericsson | * We agree that SIP is important to consider for NR coverage.
* 2000 bytes is reasonable, but TB size of 56 bytes is probably too large. With 2kB and 500ms max delay, then the data rate is 16 kbps, which is similar to the VoIP codec rate. Perhaps ~320 bits can be a starting point?
 |
| Qualcomm | SIP procedure and the SIP invite message are indeed a potential bottleneck for providing voice services. The nature of this issue is however complicated by the fact that the the SIP timers can be extended to potentially more than a second to allow for the SIP message to transmitted successfully. Nevertheless, we think the large number of segments will continue to remain an issue. Proposals to limit the number of segments will be quite helpful.We are okay with the SIP message size, but don’t want to impose a TB size. Similarly for the time period, we think extending up to 1 second can be considered, while noting that the SIP procedure has timers for the entire procedure and not just for the delivery of SIP invite message. |
| Samsung | Fine with above Softbank’s comment. |

## [H] Open issue No.2 – CDL for link level simulation (FR1 only)

Open issue No.2 is the use of CDL for link level simulation, which has not been agreed yet.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Channel model for link-level simulation | TDL-C for NLOS, TDL-D for LOS.[CDL] |
|  |  |

There are not many contributions discussing about this issue, especially for the support on CDL. Therefore, in order to reduce the companies’ efforts on simulation campaign, the following proposal is made.

**Moderator’s proposal**

* Remove CDL from the channel model for link-level simulation.
	+ This does not preclude companies from performing the link-level simulations using CDL

Companies are invited to input the views on the moderator’s proposal.

|  |  |
| --- | --- |
| Company  | Comment |
| OPPO | Support removing CDL from the channel model for link-level simulation.Antenna gain and beamforming gain can be included in the link budget template when using TDL model, there is no need to use CDL for link-level simulation. |
| CATT | Support FL’s proposal |
| ZTE | Fine with the proposal.  |
| Panasonic | We support the moderator’s proposal. |
| Nokia/NSB | Ok. |
| Intel | We are fine with FL’s proposal.  |
| NTT DOCOMO | We support FL proposal. |
| Ericsson | While we don’t have a strong view, we are fine with reporting TDL based results in the link budget templates. However, we don’t yet see why we need to remove the channel model from link level simulations. For example, we may wish to capture CDL based results in the TR to explain e.g. how antenna gain values are compensated for effects such as channel estimation and angle spread in the link budget templates. Would it be more clear to phrase the proposal as follows?* TDL models are used to generate results in the link budget templates
 |
| Qualcomm | We were the primary proponents of using CDL, which we thought was essential to evaluate MMIMO systems. But considering the general lack of support in running accurate simulations, and to better align our results with other companies, we have switched to using TDL in our simulations. While we know this is unlikely to accurately reflect absolute coverage performance, this may be good enough for relative comparisons.We reluctantly agree to drop CDL. |
| InterDigital | We support the proposal from FL |
| vivo | We agree with the proposal for FR1.CDL model can be considered in FR2. |
| Samsung | Support moderator’s proposal. |
| Sharp | We are OK with FL proposal. |
| Apple | We support the FL’s proposal |
| SONY | OK with FL proposal |

## [H] Open issue No.3 – link budget template (FR1 & FR2 common)

This issue is to choose the link budget template:

* *Down selection on the following options for the link budget template for FR1 in next meeting.*
	+ *Option 1: Adopt single link budget template based on IMT-2020 self-evaluation with necessary revisions, including adding/removing/revising some parameters.*
		- *FFS: The template provided by FL in Tdoc R1-2005005.*
	+ *Option 2: Adopt both templates, i.e. link budget template in IMT-2020 self-evaluation and link budget template in TR 36.824.*
	+ *Option 3: Adopt single link budget template in TR 36.824 with necessary revisions, including adding/revising some parameters.*

Additionally, [7] and some other contributions have proposed to add some rows to show MCL/MIL in IMT-2020 table (hereafter this is called as option 1’) as a compromise. Note that, as discussed in section 3.1, the definition of MCL, MIL is not clear. So, this point is intentionally left ambiguous at this moment.

In summary we now have four options for discussions.

* Option 1:
	+ Adopt single link budget template based on IMT-2020 self-evaluation with necessary revisions, including adding/removing/revising some parameters.
		- FFS: The template provided by FL in Tdoc R1-2005005.
* Option 1’:
	+ Adopt single link budget template based on IMT-2020 self-evaluation with row(s) for MCL (and/or MIL) and necessary revisions, including adding/removing/revising some parameters.
* Option 2:
	+ Adopt both templates, i.e. link budget template in IMT-2020 self-evaluation and link budget template in TR 36.824.
* Option 3:
	+ Adopt single link budget template in TR 36.824 with necessary revisions, including adding/revising some parameters.

We didn’t see clear majority for each option as well as a crucial argument to choose one from the above options. Hence, the moderator would like to propose to adopt a compromise solution (i.e. option 1’ or 2) to accelerate the discussion.

**Moderator’s proposal**

* Adopt option 1’ or 2
* The detailed discussion on link budget table will be taken place at the 2nd phase email discussion of RAN1#102-e.

Companies are invited to share the views on the moderator proposal:

|  |  |  |
| --- | --- | --- |
| Company | Preferred option | Comments |
| China Telecom | Option 1’ | We prefer option 1’. From our view, we care more about what NR can achieve in term of coverage performance at present, as well as the gap between the baseline performance and target performance. Hence, we prefer to use IMT-2020 link budget template, which has the following advantages:1) Companies have experience in the simulation for IMT-2020 submission, and have submitted results based on IMT-2020 template to ITU. 2) IMT-2020 template provides comprehensive parameters, which contains all the parameters in 36.824 link budget template. Then the results based on IMT-2020 template are more accurate than 36.824 link budget template.3) Target MPL or MCL can be derived from ISD, while ISD can be provided based on operators’ practical deployment. Operators can better understand the gap between the baseline performance and the target. |
| OPPO | option 1’ | * The link budget template based on IMT-2020 self-evaluation has been well discussed in ITU self-evaluation, and it has more detailed factors (including antenna gains, shadowing, penetration loss and so on).
* The MPL based IMT-2020 may provide more intuitive and precise assessment. Meanwhile, MCL can also calculate based IMT-2020 if it’s needed for some companies.

Modification ontop of MCL could be one way forward. |
| CATT | Option 1’ | The link budget template used in IMT-2020 self-evaluation has been developed very well during evaluate the coverage of NR system. It is a straightforward and rational way to go with Option 1’.Furthermore, the more practical parameters included in the IMT-2020 template provide more room to help people balance the simulation load and accuracy of the evaluation results. |
| ZTE | Option 1’ | Our first preference is Option1 while would be fine with Option 1’s for progress. But, as for MIL, clarification is needed. It’s better the proponent to clarify what’s the exact definition of MIL. If it is the definition as provided in section 3.1, isn’t it the hardware link budget in the row 23(a) or (23b) in the ITU link budget template? |
| Panasonic | Option 1’ | Option 1’ seems good compromise between Option 1 and Option 3. |
| Nokia/NSB | Option 1 or Option 1’ | From our perspective, IMT-2020 LB template offers the flexibility to compute several metrics of interest explicitly (MCL and MPL). If MIL is considered a metric of interest by the majority, to be calculated explicitly, this is also fine by us. In this sense, both Option 1 and Option 1’ are good choices. |
| Intel | Option 1’ | In our view, as link budget template based on MPL is well defined at least for FR1, it is preferable to adopt MPL as performance metric and reuse the parameters in link budget template for various deployment scenarios. Further, given that MCL can be straightforwardly calculated based on the link budget template, e.g., adding two rows for MCL calculation for data and control channels, we are also fine to consider MCL as performance metric for link budget analysis. Hence, we can consider both MPL and MCL based performance metric.  |
| NTT DOCOMO | Option 1’ | The link budget table may be revised for the target metric (MCL/MIL/MPL) which will be defined. Therefore, the table may be defined once the metric will be defined, and Option 1’ can be used for the target metrics. |
| SoftBank | Either option is OK | If the necessary information is shown in the link budget table, either option is acceptable to us.  |
| Ericsson | Option 3 with MIL (first choice) or Option 1’ (second choice) | The drawback of the IMT-2020 is its complexity: aligning views on all the parameters may be difficult. Given MIL and MCL, it is hard to see what the benefit of calculating available path loss is in the context of the study, since the bottlenecks are already known. Adding antenna gain to calculate MIL in an updated 36.824 template seems like it should be much more efficient and allow better alignment of results. On the other hand, as long as there is some flexibility in the IMT2020 template, it is certainly feasible. |
| Qualcomm | Option 3  | Similar views as Ericsson. IMT-2020 is unnecessarily complex and doesn’t yield any new insight. We also have not agreed to any of the parameters necessary for using IMT-2020 table. |
| InterDigital | Option 1’ or Option 3 | Prefer Option 3 to modify the template in TR 36.824 to add necessary parameters but for progress we can support Option 1’. |
| vivo | Option 1 | Considering evaluation methodologies have been well discussed in ITU self-evaluation, using IMT-2020 self-evaluation template may be an adoptable choice. |
| Samsung | Option 1’ | Our 1st preference is option 1 with the same reasoning provided by China Telecom. We can accept option 1’  |
| Sharp | Option 1’ | Single template is preferred. |
| Apple | Option 1 | Option 1 is clear, the MPL will be used as the target performance metric. For Option1’, does it mean either MPL or MCL or both could be used as target performance metric?  |
| SONY | Option 1’ | Our preference is to use the IMT-2020 methodology as companies have experience with this and it already contains some parameters that are lacking from the 36.824 template (like the antenna gains / array gains) and are different between NR channels. Our preference is to consider the hardware link budget (in items 23a / 23b), since calculating the pathloss (29a / 29b) is very dependent on scenario assumptions (penetration loss) etc and doesn’t provide new information.  |

## [H] Open issue No.4 - antenna array gain (FR1 & FR2 common)

Open issue No.4 is the definition of antenna array gain.

Down selection on the following options for antenna array gain for LLS based methodology for FR1 in next meeting.

Option 1: Antenna array gain is included in the link budget template.

- FFS: array gain = 10 \* 1og10 (number of antenna elements/number of TxRUs)

- FFS: For TDL channel model

- FFS: Values reflective of realistic implementation and network operation.

Option 2: Antenna array gain is included in LLS.

- FFS: For CDL channel model

According to the contributions submitted to this e-meeting, clear majority of companies support option 1 (even though some more discussion for FFS is necessary).

**Moderator’s proposal**

* Adopt option 1, i.e. Antenna array gain is included in the link budget template
	+ Note: details of array gain formula is discussed under section 3.3

Companies are invited to share the views on the moderator proposal.

|  |  |  |
| --- | --- | --- |
| Company | Preferred option | Comments |
| China Telecom |  | Whether the antenna gain is included in the link budget template or in LLS depends on the antenna structure.* For TDL option 1, 2 or 4 gNB receive chains in LLS.
	+ Antenna component 1 is included in LLS and reflected in the required SNR.
	+ Antenna component 2/3/4 is are included in link budget template.

 |
| OPPO | option 1 | The LLS complexity is low, and a more realistic antenna array gain can be obtained by the array gain formula with considering of the antenna gain loss. The loss could be a fixed value. |
| CATT |  | Support FL’s proposal |
| ZTE | Option 1 |  |
| Panasonic | Option 1 | Option 1 could be beneficial to simplify the link level evaluation than Option 2. |
| Nokia/NSB | Option 1 | Option 1 should be preferred. We see two possible approaches to model antenna array gain:* Hybrid simulation approach. Open-loop 10% BLER SINR is simulated in LLS and antenna gain components 1 to 3 in the diagram shared by China Telecom are calculated using SLS. Antenna gain component 4 is a static parameter, whose value needs to be agreed upon (IMT-2020 value is fine for us). Finally, and using field numbers as per IMT-2020 LB template for simplicity:
* SINR value is used for field (19a)/(19b);
* Antenna array gain obtained through SLS is used for field (5);
* Antenna gain component 4 is used for field (4);
* Theoretical array gain calculation can be performed and practically relevant correction factors are used to account for non-idealities.

Finally, according to our results in [3], relative performance of all considered channels does not depend on how antenna array gain is modelled, except for the broadcast/unicast differentiation. Maybe this could be used as a starting point to simplify the discussion. |
| Intel | Option 1 | We are fine with FL’s proposal. As TDL channel model is considered for link level simulations, antenna gain needs to be included in the link budget template.  |
| NTT DOCOMO | Option 1 | The antenna gain can be considered in the link budget table as well as the antenna gain. |
| Ericsson | Option 1 | The key is to include realistic values of antenna gain that are reflective of what is observed at the system level. This is particularly important if we wish to have some notion of absolute coverage. We have a similar view to Nokia’s that relative coverage will be easier to align on rather than absolute coverage. |
| Qualcomm | Option 1 | We use the figure in Section 3.1 as a reference and suggest that this gain be split into the 4 components/parameters identified in that figure, along with additional correction factors to account for practical considerations. Companies should then be allowed to address some of these gains as part of LLS or SLS and be absorbed as part of minimum required SINR. |
| InterDigital | Option 1 | Considering there are some remaining issues on the definition of antenna gain, we can include it in the link budget template. |
| vivo | Option 1 | As TDL is expected channel model for FR1, antenna array gain should be included in the link budget template. Besides, the different between unicast BF and broadcast BF should also be considered in link budget template. |
| Samsung | Option 1 | Support moderator’s proposal. |
| Sharp | Option 1 | We are OK with FL proposal. |
| Apple | Option 1 | Option 1 simplify the link level simulation, the antenna array gain is included in link budget template.  |
| SONY | FR1: option 1FR2: option 2 | For FR2 the spatial properties are highly important. We therefore believe that the array gain with realistic antenna patterns should be a part of the LLS. The ability of including antenna array gains in LLS should be at least optional. We assume CDL.  |

## [M] Open issue No.5 – other parameters for PDSCH (FR1 only)

Open issue No.5 is about the simulation assumption for PDSCH. FFS is given here, but it is not clear what needs to be added here.

* For link level simulation, adopt the following table for PDSCH for FR1.

|  |  |
| --- | --- |
| Parameters | Values |
| Other parameters | FFS |

Companies are invited to propose parameters and their values, if any.

|  |  |
| --- | --- |
| Company  | Comment |
| China Telecom | Other parameters are reported by companies. |
| ZTE | Share with China Telecom. |
| Panasonic | We agree to China Telecom’s comment. |
| Intel | We share similar view as China Telecom.  |
| NTT DOCOMO | We agree with the comment by China Telecom. |
| Ericsson | Will check further in the week and see if there is something missing that would benefit from aligning upon. |
| InterDigital | We support the proposal from China Telecom. |
| vivo | Since PDSCH is less likely to be a bottleneck channel, we agree CTC that the detailed parameters can be reported by companies. |
| Samsung | Fine with China Telecom’s comment and we can simply remove the row for ‘Other parameters’. |
| Apple | We need to give the reference MCS and PRB number just like the PUSCH, otherwise the derived required SNR are quite diverse from different companies.  |

## [M] Open issue No.6 - DMRS for PUSCH (FR1 only)

Open issue No.6 is a DMRS configuration for PUSCH, which is currently a working assumption.

* For link level simulation, adopt the following table for PUSCH for eMBB data or VoIP for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| DMRS configuration for PUSCH | …Working assumption:For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data. |

According to the contributions in this meeting, there seems to be no proposal to overturn this working assumption. Therefore, moderator would like to propose the following:

**Moderator’s proposal**

* Confirm the working assumption on DMRS configuration for PUSCH:
	+ For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.

Interested companies are invited to input your views on this proposal. Note that from moderator point of view, changing working assumption is discouraged for our progress.

|  |  |
| --- | --- |
| Company  | Comment |
| China Telecom | Support confirming the working assumption on DMRS configuration for PUSCH for FR1. |
| OPPO | For 3km/h:* If the chosen MCS is same for 1 and 2 DMRS symbol: Type I, 2 DMRS symbol, no multiplexing with data.

If the chosen MCS is different: Type I, 1 DMRS symbol, no multiplexing with data. |
| CATT | Support FL’s proposal. |
| ZTE | Support the proposal. When the number of DMRS symbols is different, the chosen MCS may be different. In our contribution, we find that using one DMRS could result in a lower MCS in some cases, which will provide a better performance. In case the MCS is the same with one or two DMRS, the performance with assuming two DMRS is better. Thus, both one or two DMRS symbols could be considered.  |
| Panasonic | We support the moderator’s proposal. |
| Nokia/NSB | All the results we have seen in contributions seem to be based on the working assumption. Support. |
| Intel | We are fine to confirm the working assumption.  |
| NTT DOCOMO | We are fine with FL proposal, and if we will define a single number for DMRS symbol, we support to use 1 DMRS symbol for 3km/h. |
| Ericsson | From what we have seen so far, the working assumption is fine. However, we are open to other configurations if they can be shown to be better baselines. |
| Qualcomm | While we are okay with the proposal, we think 1 DMRS symbol is insufficient. We need at least 2 DMRS symbols at low SNR. We also have to contend with practical aspects like frequency errors. |
| InterDigital | We support the proposal from the FL. |
| vivo | Agree with the proposal. DMRS symbols can be 2 when considering frequency hopping, otherwise can be 1. |
| Samsung | Fine with moderator’s proposal. Prefer 1 DMRS symbol for comparison across companies |
| Sharp | We are OK with FL proposal. |
| Apple | We agree the FL’s proposal. |

## [L] Open issue No.7 – Repetition type B for PUSCH (FR1 only)

Open issue No.7 is about repetition type B for VoIP for PUSCH.

|  |  |
| --- | --- |
| Repetitions for PUSCH | For VoIP, w/ repetition. The actual number of repetitions is reported by companies.FFS: Repetition type B |

One contribution discusses this issue, and proposes NOT to employ Repetition type B [5] because no performance benefit is foreseen.

Interested companies are invited to input your views on the necessity of repetition type B.

|  |  |
| --- | --- |
| Company  | Comment |
| China Telecom | Companies can report repetition type for PUSCH. |
| CATT | We don’t think PUSCH type B is a typical case for coverage enhancement. PUSCH repetition type B pursue low latency instead of better coverage. |
| ZTE | The PUSCH duration is agreed as 14 symbols in LLS. In such case, there is no performance difference between different repetition types. Thus, no need to consider PUSCH repetition Type B specifically for simulation purpose. Of course, it doesn’t mean we will not consider Type B PUSCH in enhancement techniques discussion. |
| Panasonic | We agree to China Telecom’s comment. |
| Nokia/NSB | Fine with not considering repetition type B. |
| Intel | Given that PUSCH duration of 14 symbols is assumed in the link level simulations, we do not see the need to consider PUSCH repetition type B. In our view, PUSCH repetition type A would be sufficient.  |
| NTT DOCOMO | We defined to use 14 symbols for PUSCH and DDDSU for TDD pattern, so that it may be hard to apply type B repetition. |
| Ericsson | If Rel-16 repetition type B provides the best coverage, it can be a baseline. Whether repetition type B is enhanced should be discussed under another agenda point. |
| Qualcomm | We propose to not include this in the baseline. PUSCH repetition type B was proposed for URLLC in the context of latency reduction. We don’t think it is useful here. |
| InterDigital | We support the proposal from China Telecom. Companies can report whether repetition type A or B is used. |
| vivo | We suggest to use Type-A PUSCH repetition for voip. We do not see strong need to use type-B reprtition. If type B means occupying all UL resource for PUSCH, and it will affect other UL channels transmission; otherwise, type-A PUSCH repetition is more realistic for voip. |
| Samsung | Support China Telecom’s comment, i.e., company can report. It is desirable to utilize the available UL resources in flexible slot of TDD system in the context of coverage enhancement.  |
| Sharp | We assume the proposal is for baseline performance evaluation. We are OK with FL proposal. |
| Apple | Company can report the repetition type for VoIP, but repetition type B is not the baseline. |

## [L] Open issue No.8 – BLER for CSI (FR1 only)

Open issue No.8 is about BLER for PUCCH for CSI, i.e. 10% or 1%.

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| --- | --- |
| BLER for PUCCH | …FFS: BLER for CSI (10% or 1%) |

One contribution discusses this issue, and proposes not to perform evaluations for CSI [5]. Companies are invited to input the opinion to see

Interested companies are invited to input your views on BLER for CSI (10% or 1%) as well as the necessity of evaluation for CSI on PUCCH itself.

|  |  |
| --- | --- |
| Company  | Comment |
| ZTE | It’s sufficient to only evaluate the HARQ-ACK performance, which is more important and requires more stringent requirement, e.g., 0.1% for NACK to ACK probability. |
| Nokia/NSB | Studying PUCCH coverage for relaxed BLER target in case of CSI feedback may need significant additional work for the AI. Intuitively, one would expect that such relaxation could only result in better MPL/MCL for PUCCH. On the other hand, assessing the impact of less accurate CSI at gNB on MCL/MPL of DL channels would not be so straightforward. For instance, this may affect the way antenna array gain for PDSCH and unicast PDCCH would look like, as compared to the 1% BLER counterpart. Different gNB implementations may also handle this case differently. Other implications may exist. We would agree with the proposal in [5].  |
| Intel | We prefer 1% for CSI on PUCCH.  |
| Ericsson | We find that CSI is one of the bottlenecks even with 11 bits and 10% BLER. Note that HARQ-ACK can be repeated, whereas A-CSI cannot. CSI does not change so frequently, and so a 10% BLER may be sufficient in coverage limited scenarios. On the other hand, we have no objection to reporting both 10% and 1%, since this is simple to simulate. |
| Qualcomm | We prefer to evaluate PUCCH at the 1% BLER target for all cases. Reliable CSI can be critical to a cell-edge UE and even a short duration where CSI is not available can lead to link failure.  |
| vivo | We suggest not to associated the target BLER with UCI type. Since the HARQ-Ack and CSI may also multiplex on the PUCCH resource for CSI report, e.g. PF3 with 22 bits, the target BLER should still be 1%. |
| Samsung | Prefer 1% BLER. This is in line with current RAN4 requirements. |
| Sharp | We prefer 1% BLER for CSI. 10% BLER should be for transmission with HARQ. |

## [M] Open issue No.9 – gNB receive chains in LLS for TDL (FR1 only)

Open issue No.9 is gNB modelling in LLS for TDL. Two options are captured in the simulation assumption table.

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| --- | --- |
| Number of ~~receive~~ TxRUs for BS |  ~~[~~gNB modeling in LLS for TDL:* Option 1: 2 or 4 gNB receive chains in LLS ~~(as starting point)~~. FFS: correlation
* Option 2: Number of gNB receive chains = number of TXRUs in LLS. FFS: correlation.~~]~~
 |

The FFS part for this parameter, i.e. correlation, should be solved. In addition, there are proposals to choose one option [2, 5, 22] from them. Companies are invited to input their views on correlation and the choice of option.

|  |  |
| --- | --- |
| Company  | Comment  |
| China Telecom | We prefer Option 1 to reduce the simulation burden.  |
| OPPO | We prefer Option 1.It can reduce the simulation burden if obtain the antenna gain which mapping from chains to TxRU in the link budget template. |
| CATT | Option1. |
| ZTE | Option 1 is preferred. Correlation is only needed in case of high number of RF chains is assumed for TDL channel. Thus, no need to consider the correlation for Option 1.  |
| Panasonic | Option 1 is preferred to simplify the link level evaluation. The correlation (gain) can be modelled as 10\*log(NTXRUs/NRx), where NTXRUs is the number of TXRUs and NRx is the number of gNB receive chains in LLS. |
| Nokia/NSB | Option 1. No correlation considered given the low number of receive chains. |
| Intel | We prefer Option 1. As for TDL channel model, 2 or 4 gNB receive chains in LLS is sufficient for link level simulation.  |
| Ericsson | Option 1. Medium correlation can be used to improve accuracy, especially for the 4 Rx antenna case. |
| Qualcomm | Option 2 is our preference since it leads to realistic link modelling. For Option 2, we can go with “low correlation”. |
| InterDigital | We support Option 1. |
| vivo | We prefer option 1, especially considering the simulation workload. In TDL, only 2 or 4 ports in LLS would greatly reduce the simulation effort. |
| Samsung | Option 1 |
| Apple | Option 1 is preferred.  |

## [M] Open issue No.10 – gNB receive chain in LLS for CDL (FR1 only)

Open issue No.10 is gNB architecture & modelling for CDL.

|  |  |
| --- | --- |
| Number of ~~receive~~ TxRUs for BS | [gNB architectures to study for CDL: * Urban: 64 receive chains for 2.6 and 4 GHz in LLS
* Rural: 8 receive chains for 4GHz and 2.6GHz in LLS
* 4 receive chains for 2GHz and 700MHz in LLS.]

[gNB modeling in LLS for CDL: Number of gNB receive chains = number of TXRUs in LLS.] |

This issue is related to open issue No.2 (necessity of CDL for LLS), the necessity of this bullet depends on the decision of open issue No.2.

**Moderator’s proposal**

* If necessity of CDL for LLS is agreed under open issue No.2, remove the square bracket.
* Otherwise, remove the whole bullets about gNB architectures to study for CDL and gNB modeling in LLS for CDL

Interested companies are invited to input your views on this moderator’s proposal.

|  |  |
| --- | --- |
| Company  | Comment |
| CATT | It is related to No.2 issue. As we agree with FL’s proposal on No.2 issue, we think the whole bullets can be removed and the antenna configuration can be reported by the interested companies. |
| ZTE | Fine with the proposal.  |
| Panasonic | We support the moderator’s proposal. |
| Intel | We are fine with FL’s proposal.  |
| Ericsson | Suggest to wait until issue 2 is decided. Then if there are results using CDL that we wish to capture in the TR (not necessarily in the link budget templates), we can do so.  |
| Qualcomm | Since we are focusing on TDL channel model, we think this is not necessary. |
| InterDigital | We support the proposal from the FL. |
| vivo | We agree with moderator’s proposal. |
| Samsung | Remove the whole bullets |
| Apple | We support FL’s proposal. |

## [L] Open issue No.11 – PDSCH duration for Msg.4 (FR1 only)

Open issue No.11 is about the link level simulation for Msg.4 PDSCH.

* For link level simulation, for PDSCH of Msg.4 for FR1.
	+ Reuse the following simulation assumption for PDSCH
		- Waveform, [PDSCH duration]

RAN1 should discuss whether to simply delete this square bracket, or apply different duration from normal PDSCH. Considering the fact that no contribution discusses this issue in this meeting, the following proposal can be made.

**Moderator’s proposal**

* The same PDSCH duration as PDSCH is used for Msg.4 PDSCH (i.e. remove the square bracket)

Companies are invited to provide their view on this proposal.

|  |  |  |
| --- | --- | --- |
| Company  | Agree to remove square bracket [Y/N] | Comment |
| ZTE | Yes | We are fine with the proposal. |
| Panasonic | Yes |  |
| Intel | Yes | We are fine with FL’s proposal. |
| Ericsson | Yes | Our understanding is that this does not preclude Msg4 retransmission as a baseline. |
| vivo | Y | We agree with moderator’s proposal |
| Samsung | Yes |  |
| Sharp | Yes |  |
| Apple | Yes | We agree with FL’s proposal |

## [L] Open issue No.12 – Payload size for Msg.4 (FR1 only)

* For link level simulation, for PDSCH of Msg.4 for FR1.
	+ FFS: Payload size: [3000bits].

According to the contributions in this meeting, no specific value other than 3000 bits was proposed. The following moderator proposal can therefore be made.

**Moderator’s proposal**

* **Adopt 3000 bis for Msg.4 PDSCH payload size (i.e. remove the square bracket) .**

Companies are invited to provide their view on this proposal.

|  |  |  |
| --- | --- | --- |
| Company  | Agree to adopt 3000bits [Y/N] | Comment |
| ZTE | Yes | Would be fine for us. BTW, a typo ‘bis’ to ‘bits’. |
| Panasonic | Yes |  |
| Intel | Yes | We are generally fine with the proposal. One minor comment: 3000 bits are not valid TBS. We can use 2976 bits for TBS in the simulation.  |
| Ericsson | No | We gave a look at values used in networks and think 130 bytes is more representative. Can someone explain where 3000 bits comes from? |
| Qualcomm | Disagree | 3000 bits is a little on the higher side. In our paper, we have assumed 130 bytes to align with evaluations being conducted under Redcap coverage recovery.  |
| vivo | Y | We agree with moderator’s proposal |

## [M] Open issue No.13 – VoIP packet size (FR1 only)

Open issue No.13 is about the packet size for VoIP.

* For VoIP performance evaluation based on link-level simulation for FR1.
* A packet size of **[320]** bits with 20ms data arriving interval is adopted.

[3] gives a very detailed proposal on this: AMR-WB 12.65 (kbit/s) for VoIP evaluations, which corresponds to 352 bits packet size.

|  |  |
| --- | --- |
|  | **Size (bits)** |
| Payload | 264 |
| CRC | 16 (TBS size lower than 3824 bits) |
| MAC | 16 (with 12 bits SN size) |
| RLC | 8 (with 6 bits SN size) |
| PDCP | 16 |
| RTP/UDP/IP | 32 (w RoHC) |

Thus, the necessary discussion in RAN1#102e is which payload size to adopt, 320 bits or 352 bits (or any other value).

|  |  |  |
| --- | --- | --- |
| Company  | Preferred bit size320, 352 or something else | Comment |
| China Telecom | 320 | We prefer 320bits, i.e. remove the brackets. |
| OPPO | 320 | The enhancement is about the coverage on top of baseline. It does not make much different by slightly different payload , in regards of coverage improvement.Even for the absolute MCL comparing to UTRA, the 12.2 would be more appropriate. |
| CATT | 320 |  |
| ZTE | 320 | As discussed in R1-070674 in LTE, 320 bits payload size is assumed. Given there is no big difference to the other proposed value, it would be ok for us to choose either value.  |
| Panasonic | Either 320 or 352 |  |
| Nokia/NSB | 352 (soft preference) | We prefer 352 bits, given the arguments we presented in our contribution [5]. |
| Intel | 320 | We prefer 320 bits for VoIP. |
| Ericsson | 320 | Exact value is not crucial. However, this value seems to imply that HARQ is used. Can this be clarified? |
| Qualcomm | Proposed packet components and their sizes are okay, but do not specify TB size. | We are in principle okay to go with Nokia proposal. We however don’t want this to be translated to TB size as we can potentially segment this payload. We can capture the table as is, and say TB size is to be derived based on this table depending on assumptions on segmentation. |
| InterDigital | 320 |  |
| vivo | 320 | We prefer TBS=320 bits with 20ms arrival interval in simulation. |
| Samsung | 320 | Also fine with 352 bits |

## [H] Open issue No.14 - target performance metric (FR1 & FR2 common)

Target performance metrics and values were discussed at RAN1#101e, but nothing was captured in the minute to lack of consensus. The landscape of companies’ preference is as follows: (please check if your view is correctly captured!)

* Option 1. Pathloss or MPL based
	+ Alt 1. Derived from target ISD
		- [Intel], [CMCC], [Apple], [ZTE], [CTC],[CATT], [Panasonic]
	+ Alt 2. Relative MPL
		- [Oppo], [CMCC], SoftBank (For eMBB, if the market/operator demand is not clear),
* Option 2. MCL or MCL based
	+ Alt.1 Derived from target ISD
		- [Panasonic], [CTC]
	+ Alt. 2 Fixed value
		- SoftBank (147dB for voice), [CTC (147dB for voice)], [Panasonic]
	+ Alt.3 Relative MCL(/MIL)
		- [DOCOMO], [SoftBank (For eMBB, if the market/operator demand is not clear)], [InterDigital], [Qualcomm]

It is hard to say that there is a clear majority for a specific option/alternative.

From moderator perspective, all of the options/alternatives are feasible for bottleneck identification. The question is how to set the threshold, i.e.

* For ISD based approach, we need more discussion on the exact value for target and why it is chosen. In addition, its scenario dependency should also be taken into account.
* For relative approach, we need more discussion on how many bottleneck channels can be solved.
* For fixed value approach, RAN1 had a discussion on voice only. We have no guidance for eMBB.

From rapporteur point of view, the less controversial approach would be relative MPL/MCL/MIL based approach. The operators demand for specific ISD value(s) and MCL values for voice shall be taken into account when identifying the bottleneck channels requiring coverage enhancements.

**Moderator’s proposal**

* **Adopt relative MPL/MCL/MIL for target performance metric for both eMBB and VoIP**
	+ **ISD value of X m for scenario Y and fixed MCL value of Z dB for VoIP shall be satisfied when identifying bottleneck channel(s) requiring coverage enhancements**
		- **(set of) X and Y are decided based on operators’ request**
		- **Z is 147dB, but it may need adjustment depending on the definition of MCL**
* **On the down selection of relative MPL/MCL/MIL:**
	+ **Final decision will be made at the 2nd step discussion at RAN1#102e taking into account the definition of MPL, MCL and MIL discussed under section 3.1.**
* **On the identification of bottleneck channel(s) requiring coverage enhancements,**
	+ **Final decision will be made at RAN1#103-e based on the link budget analysis**

Interested companies are invited to input your views on this moderator’s proposal.

|  |  |
| --- | --- |
| Company  | Comment |
| China Telecom | From our view, we care more about what NR can achieve in term of coverage performance at present, e.g. coverage distance, as well as the gap between the baseline performance and target performance. We understand that some companies prefer MCL as the metric. Then we suggest both MCL and MPL can be the performance metric as MCL and MPL can be derived from each other. In our understanding, the absolute value can better reflect the requirements from operators. The target MCL and MPL can be derived from ISD, while ISD can be provided based on operators’ practical deployment. The typical values, e.g., 500m for urban, 1732m for rural, widely used in the simulation can be adopted. We understand that there may be the case that multiple channels cannot achieve the target. If the case happens, operators can better understand the gap between the baseline performance and the target, while the exact performance gain depends on the enhanced solutions.Thus, we have the following proposal.Performance metric for analysis* Both MCL and MPL are adopted as the metric for performance analysis.
* For VoIP, target MCL of 147dB or target MCL/MPL derived from typical ISD, e.g. 500m for urban and 1732m for rural, can be defined as the target performance.
* For eMBB, target MCL/MPL derived from typical ISD, e.g. 500m for urban and 1732m for rural, can be defined as the target performance.

Performance metric for enhancements* Relative MCL/MPL between different channels are adopted as the metric for enhancements.
 |
| OPPO | MCL is a simplified performance metric, without considering certain fading and penetration margins. We prefer the relative MPL as the target performance metric.  |
| CATT | We support alt.1 which is shown in our Tdoc submitted to Others AI. Our position is updated accordingly. From the positions shown above, alt.1 under umbrella of option 1 has the most proponents. It’s better to adopt alt.1 of option 1 as the proposal at this stage. |
| ZTE | Not quite follow the proposal here. The main bullet says to consider relative approach while the sub-bullet seems is to apply an absolute value for target performance. Anyway, our preference is to consider an reasonable absolute value for target performance for respective scenarios/service. The value could be from operators demand, e.g. specific ISD value or MCL with 147 dB for voice. We don’t agree to only consider relative MPL/MCL/MIL. We are not sure how to choose the channels to be enhanced based on relative approach.  |
| Panasonic | We support the moderator’s proposal. Although the proposal is to adopt relative MPL/MLC/MIL target performance metric, it also includes “ISD value of X m for scenario Y and fixed MCL value of Z dB for VoIP shall be satisfied when identifying bottleneck channel(s) requiring coverage enhancement.” It also seems to consider absolute value. At least the relative MPL/MCL/MIL target performance satisfying the absolute value, we are OK to use relative target to identify the how much coverage improvement for each channel is necessary. |
| Nokia/NSB | From our perspective, this issue cannot be decoupled from what will be decided on the antenna array gain. More precisely:1. If theoretical antenna array gain is considered, then MPL, MIL and MCL have the same descriptive power, i.e., they lead to the same conclusions. If this approach is chosen, then all metrics are equivalent.
2. If simulation-based antenna array gain is considered, then conclusions drawn for MCL, MIL and MPL may lead to different ones depending on broadcast/unicast setting, considered gNB implementation, CSI feedback accuracy, simulated ISD in SLS and so on. If this approach is chosen, then MPL should be preferred.

Switching the focus on how to determine the target performance of each channel, we observe the following. From our perspective, reference ISD targets could be considered as a reference to “put the bar somewhere reasonable” and give us some practically relevant support during the discussion. This could help us assessing realistically what we can expect from each channel. However, setting an ISD target and mapping it into corresponding MCL/MPL targets, without considering the actual achievable baseline MCL/MPL of each channel as a starting point, could be very close to an academic exercise if the ISD target itself is too optimistic. In fact, this would not give any guarantee that balanced coverage between UL and DL channels would be achieved, which is fundamental for a correct functioning of all NW operations. Conversely, focusing on minimizing/reducing the relative MCL/MPL difference between channels would help us assessing what needs to be improved to achieve such balanced coverage between DL and UL channels. Finally, we think that the priority should be given to enhancing the coverage of the identified bottleneck channel instead of defining a possibly unfeasible target performance. |
| Intel | We are generally fine with the proposal. It seems to us “ISD value of X m for scenario Y and fixed MCL value of Z dB for VoIP shall be satisfied” is clearly the absolute MPL/MCL for performance metric. If this is the intention, we are fine with the proposal. When determining the target performance for MPL/MCL, we need to take into account operator’s inputs on exact ISD for various deployment scenarios. |
| NTT DOCOMO | We support FL proposal. |
| SoftBank | From our side, the most important task of this SI/WI is to satisfy the market (operators’) requirement, which is basically given by absolute value. This should be considered as a top priority. If RAN1 wants to do more than that, absolute metric is not sufficient, and relative metric needs to be used. In this sense, our view is similar to China Telecom, and we support their requirements on ISD values.  |
| Ericsson | I’m not so clear on why this issue is something we have to resolve at this meeting. The link budget templates will provide measures of absolute as well as relative coverage, and so we can compare these to operator’s needs as well as take these into account when we decide on a work item in the plenary. I’m a bit concerned that we focus too much on setting precise targets: * If we do not reach the targets, will the study item remain open?
* Will we not also consider complexity, spec impact, power consumption, etc. as we normally do?

Is an alternative possible, where we first see what the performance is and then decide a way forward? |
| Qualcomm | We think we can revisit this after we have settled down on the link budget template and the definitions of the various terms are clear. We also think there is no pressing need to agree to this in this meeting. We can all converge on a single template this meeting and finalize the performance metric in the next meeting. |
| InterDigital | We support to use relative MPL/MCL/MIL for target performance metric. |
| vivo | MPL should be considered as a baseline. Other metrics, e.g. MCL, can be reported by companies.For a target ISD and relative approach, we are fine with both proposals. For the former one, the target ISD should be determined carefully to make sure the coverage gap can be compensated by enhanced solutions. For the latter one, the bottleneck channel should not be limited to the worst one, other channels, e.g. the 2nd or 3rd worst channel, should not be simply excluded for coverage enhancements. |
| Samsung | In general, we are fine with moderator’s proposal (though our preference is Option 1 and Alt.1.) As commented above, a clarification would be needed for the 1st bullet and its sub-bullet (relative vs. absolute) |
| Sharp | We support FL proposal. |
| Apple | Not fully understand the proposal, if ISD value is decided then it seems not relative MPL, it’s pathloss based performance metric. For us, the Option 1 is preferred, the ISD can be based on operator’s input. For relative MPL/MCL/MIL, it’s not clear which channel should be used as the benchmark channel.  |
| SONY | We are OK with the approach proposed by Ericsson / Qualcomm (see what the performance is and then determine a way forward).If we need to have a target now, we would prefer to have a target MCL / MIL. The target MCL / MIL would be “at least as good as” UMTS and / or LTE (we understand that that was the original motivation of Softbank proposing 147dB MCL for VoIP). We would be OK if the target MCL / MIL were determined based on a consideration of ISD / MPL, but once that determination of target MCL / MIL had been made, we would like to focus on that target MCL / MIL. |

## [L] Open issue No.15 – target BLER for PDCCH (FR1 only)

We have an FFS for Target BLER for PDCCH, i.e. 10% BLER needs further discussion in this meeting.

|  |  |
| --- | --- |
| BLER for PDCCH | 1% BLERFFS: 10% BLER |

One contribution discusses this issue, and proposes not to consider 10% BLER for PDCCH [5]. Companies are invited to input your views on this issue.

|  |  |
| --- | --- |
| Company  | Comment |
| China Telecom | Remove 10% BLER. |
| OPPO | Support removing 10% BLER. |
| CATT | Don’t see the motivation of 10% BLER for PDCCH. Remove 10% BLER. |
| ZTE | No need to consider 10% BLER for PDCCH.A low target BLER for PDCCH will have a great impact on system efficiency. Because once PDCCH is missed, a UE will be not aware of whether there is DL/UL transmission. Corresponding PDSCH/PUSCH re-transmission cannot be triggered in PHY layer. In addition, it will impact on PUCCH resource determination. This will decrease the HARQ-ACK BLER down to around 10%, meaning 1% target BLER for HARQ-ACK cannot be guaranteed. |
| Panasonic | We support removing 10% BLER. |
| Nokia/NSB | The motivation to consider 10% BLER is not clear and we agree with China Telecom and the proposal in [5]. |
| Intel | Remove 10% BLER |
| Ericsson | Reporting both 1% and 10% BLER allows us to understand a little better how sensitive the PDCCH is to a change in SINR, and so can be informative. Furthermore, there has been no discussion within this study of what an optimum PDCCH BLER is in a coverage limited scenario; why is 1% an ideal number? All that said, we do not insist that 10% is a mandatory value to simulate, and we do understand the wish to reduce the number of parameter settings to report upon. |
| Qualcomm | Let us stick to 1% BLER. It is well studied, and we know how the network behaves under this requirement. |
| vivo | For PDCCH, 1% BLER is needed. |
| Samsung | Remove 10% BLER |
| Sharp | Support removing 10% BLER. |
| Apple | 1% BELR for PDCCH is enough. |

# Other issues related to evaluations

## [H] Definition of MCL, MIL and MPL (FR1 & FR2 common)

As discussed in [12], it is proposed to clarify the definition of MCL. The main proposal by [12] is to include array gain to the conventional MCL definition to address the concern. Similarly thing is discussed by [14], which propose to add antenna and beamforming gain to the MCL based link budget table.

From these discussions, it seems that the exact definition of MCL is not aligned. In addition, we should make sure that the definition of MIL and MPL are aligned among companies.

* **For TDL Option 1 (see section No.9 in section 2.9 for the definition)**
	+ Definition of MCL
		- Alt 1-1: Total transmit power - Receiver sensitivity + gNB antenna gain (component 2)
		- Alt 1-2: Total transmit power - Receiver sensitivity + gNB antenna gain (component 2 + 3) + UE antenna gain
		- Alt 1-3: Total transmit power - Receiver sensitivity + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain
	+ Definition of MIL
		- Total transmit power - Receiver sensitivity + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain
	+ Definition of MPL
		- Total transmit power - Receiver sensitivity + gNB antenna array gain (component 2+3+4 for TDL option 1) + UE antenna gain - (8) Cable, connector, combiner, body losses (Tx side) - (20) Receiver implementation margin + (21a/b) H-ARQ gain - (25a/b) Shadow fading margin + (26) BS selection/macro-diversity gain - (27) Penetration margin + (28) Other gains – (12) Cable, connector, combiner, body losses (Rx side)



* **For TDL Option 2 and CDL (see section No.10 in section 3.10 for the definition):**
	+ Definition of MCL
		- Alt 2-1: Total transmit power - Receiver sensitivity
		- Alt 2-2: Total transmit power - Receiver sensitivity + gNB antenna gain (component 2) + UE antenna gain
		- Alt 2-3: Total transmit power - Receiver sensitivity + gNB antenna gain (component 2 + 3) + UE antenna gain
	+ Definition of MIL
		- Total transmit power - Receiver sensitivity + gNB antenna gain (component 2 + 3) + UE antenna gain
	+ Definition of MPL
		- Total transmit power - Receiver sensitivity + gNB antenna array gain (component 2+3 for TDL option 2 and CDL) + UE antenna gain - (8) Cable, connector, combiner, body losses (Tx side) - (20) Receiver implementation margin + (21a/b) H-ARQ gain - (25a/b) Shadow fading margin + (26) BS selection/macro-diversity gain - (27) Penetration margin + (28) Other gains – (12) Cable, connector, combiner, body losses (Rx side)



|  |  |  |  |
| --- | --- | --- | --- |
| Company  | Preference on MCL definition for TDL opt.1 | Preference on MCL definition for TDL opt.2 and CDL | Other comments |
| China Telecom | Alt 1-1 |  | We prefer TDL opt.1 with Alt 1-1. The definition of MCL should be clearly defined for NR.  |
| OPPO | Alt 1-3 |  | We prefer TDL opt.1 with Alt 1-3. The definition of MCL should consider the antenna gain. |
| CATT | Alt 1-3 |  |  |
| ZTE | Alt 1-1 |  |  |
| Panasonic | Alt. 1-1 |  |  |
| Nokia/NSB | Alt. 1-x |  | We prefer TDL Option 1. On the other hand, we are not sure we understand the rationale of the proposed alternatives. We have the following observations:* MCL as per IMT-2020 self-evaluation template does not include antenna array gains. This seems a reasonable approach because it allows to clearly differentiate among MCL, MIL and MPL. In particular, MCL depends exclusively on the channel configuration, i.e., on the considered features and configurations, whereas MIL and MPL also include factors related to architecture, gNB implementation, NW deployment and so on. In this context, we do not understand why all the Alt 1-x alternatives include a certain version of antenna array gain in the definition of MCL.
* Connected to the previous point, if MCL as per any of the proposed alternatives is used, then it is not very clear why we need to discuss MIL. The two metrics would be extremely similar. Indeed, they would be identical in case of Alt 1-3, and have small difference (as compared to MCL vs. MPL) depending on how antenna array gain is modelled.
* We do not understand why antenna gain component 4, which is a static value, should be considered a differentiating factor (it is between Alt 1-2 and Alt 1-3). This parameter should always be included in any of the “MCL versions”, if antenna array gain is included in MCL.
* Definition of MPL is ok in our view.

In summary, we think that if MIL and MPL are defined as per above description, then MCL should be defined as per IMT-2020 self-evaluation template or dropped completely and use MIL instead.  |
| Intel | Alt 1-3  |  | We are fine with Option 1. For Alt 1-1, we are not sure why UE antenna gain is not included. In our view, we should consider both gNB and UE antenna gain in order to have meaningful study for link budget analysis in practical deployment scenarios.  |
| NTT DOCOMO | Alt. 1-3 |  | Generally, we are open for the MCL definition. It may be clear to us that MCL include both BS and UE antenna gains with beamforming gain. |
| SoftBank | Alt. 1-X |  | We see a strong necessity of a metric that does not include antenna gain. This is because legacy passive antenna will also be used in some scenario in the practical network. In addition, if antenna gain is included in MCL, it means that the definition of “conventional” MCL is changed from Rel-17. The definition of MCL should be kept as much as possible. In addition, the definition of MCL by IMT-2020 is to exclude antenna gain for both BS and UE. So, we would like to understand why option 1 family includes antenna gain component 2, and option 1-0 (Total transmit power - Receiver sensitivity) is not there.  |
| Ericsson | MIL + MCL Alt 1, updated |  | Similar comments to Nokia. MIL (or ‘hardware link budget’ in the IMT-2020 template) includes both dynamic and static array and antenna gain, so it’s straightforward. However, it’s a bit of a philosophical question on whether to include receive array gain (‘component 2’) in MCL. If MCL does not include fixed array gain, then why should it include dynamic array gain? However, multiple receive chains can be seen as a way to improve sensitivity, and then dynamic array gain (and diversity gain) is included. For simplicity, our proposal is then **MCL = MIL – antenna\_gain.**As said earlier, MPL seems like extra effort, and it’s not clear to us why MCL and MIL are not sufficient for the study. |
| Qualcomm | Alt 1-1 |  | We are okay with definitions for MCL and MIL. For MPL, we prefer to comment (if necessary) after link budget template is finalized. |
| InterDigital | Alt 1-3 |  |  |
| vivo |  |  | We prefer MPL |
| Samsung |  |  | Prefer TDL Option 1. We share the view from Nokia as pointed in above observations |
| Sharp |  |  | We prefer not including antenna gains for MCL metric. |
| Apple | Alt 1-1 |  | According to our understanding, RAN4 gives the MCL definition. In 36.942, the MCL is defined as: *MCL is the parameter describing the minimum loss in signal between BS and UE or UE and UE in the worst case and is defined as the minimum distance loss including antenna gains measured between antenna connectors.* BS type 1-H defined in 38.104 is the gNB type we simulated, according to the gNB spec, the conducted test should be at the point after antenna gain component 2 in the figure. Then, the Alt 1-1 is aligned with the MCL definition.  |
| SONY | Alt 1-X |  | Agree with comment from Softbank about inclusion of option 1-0 (Total transmit power - Receiver sensitivity). This seems to be the “classic” definition of MCL.MIL definition for TDL option 1 is OK.We think that MCL and MIL are sufficient and do not see the extra need for MPL. |

## [M] Downlink Tx power (FR1 only)

Three contributions pointed out the necessity of modifying the DL Tx power.

* 46.06 dBm [2]
* A power spectrum density of 33 dBm/MHz [5]
* the misalignment of the bandwidth in the template of IMT-2020 needs to be solved[12]

This is a new issue, and hence it would be appropriate to companies’ view on these proposals. Moderator’s proposal will be made based on the companies’ input.

|  |  |
| --- | --- |
| Company  | Comment |
| CATT | We think the PSD for DL should be constant. The available power for DL transmission should be determined by the constant PSD and the occupied bandwidth. |
| ZTE | In current IMT-2020 template, the total transmit power for DL channels is based on the whole system BW, which is the maximum limit of gNB transmission power. But it seems not correct because the actual DL transmission power is based on the occupied BW and PSD.There are two ways to go, one is correct the (3) Total transmit power in IMT-2020 template to be the PSD or we can change (17a)/(17b) Occupied channel bandwidth for DL data/control channel to be the system BW.  |
| Nokia/NSB | We think a more intuitive way to model the Tx power used by gNB could be to set a constant EPRE value, e.g., 14-15 dBm, and obtain the total Tx power by scaling the EPRE by the occupied BW.  |
| Intel | In the link budget analysis, constant PSD in DL should be assumed. It is more appropriate to assume that gNB transmits DL signals/channels within whole system bandwidth.  |
| NTT DOCOMO | We support to use 44.07 dBm for the DL Tx power which is captured by the IMT-2020 template. |
| Ericsson | 33 dBm / MHz seems a common number within the industry to use and appropriate here for coverage studies. A constant EPRE can be a starting point for simulations. |
| Qualcomm | We prefer to go by the numbers suggested by the ITU M.2412 document ([link](https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2412-2017-PDF-E.pdf)): Rural deployment:49 dBm for 20 MHz bandwidth46 dBm for 10 MHz bandwidthUrban deployment:51 dBm for 100 MHz bandwidth |
| vivo | The transmission power/PSD used in R-REP-M.2412 can be considered as baseline. If parameters in real deployment can be provided by operators, we are fine to align with it. |
| Apple | For DL, the constant PSD is assumed, 33dBm/MHz is reasonable value. |

## [M] Antenna gain adjustment (FR1 and FR2 common)

Because behaviour of beamforming is different depending on the channels, the antenna gain and interference margin may need to be handled differently depending on the channels. This issue has been pointed out by some contributions. Note that this is related to open issue No.4 in section 2.4. The companies views in their contributions are captured below:

* The difference between broadcast and unicast beamforming gain should be considered in the evaluation. About 8dB broadcast beamforming gain loss is observed compared to unicast beamforming gain.[4]
* 10\*log(min(X, M/N)) - Δ, where X is the number of SSB beams [5]
* The losses of antenna array gain due to the UE location and the broader beam of common channels should be considered in the link budget. Introducing a beamforming gain loss could be considered. [12]
* Use antenna gain and interference margin values derived from system simulations in link budget analyses [19]
* Array gain = AGC1 +AGC2=10 \* 1og10 (number of antenna elements/number of TxRUs) + 10 \* 1og10 (number of TxRUs /number of RF chains) [28]

Companies are invited to provide their views on this aspect.

|  |  |
| --- | --- |
| Company  | Comment |
| China Telecom | Whether the antenna gain is included in the link budget template or in LLS depends on the antenna structure. For TDL option 1, there are two alternatives of modelling of component 2 and 3. * For TDL option 1, 2 or 4 gNB receive chains in LLS.
	+ Antenna component 1 is included in LLS and reflected in the required SNR.
	+ Antenna component 2/3/4 is are included in link budget template.
	+ Regarding the modelling of component 2 and 3, there can be two alternatives:
		- Alt 1:
			* Antenna gain component 2 = 10\*log(N/k).
			* Antenna gain component 3 = 10\*log(M/N).
		- Alt 2:
			* Antenna gain component 2 = 10\*log(N/k) – Δ1
			* Antenna gain component 3 = 10\*log(M/N) – Δ2
			* Δ1, Δ2 can be reported by companies

The ranges of Δ1 and Δ2 vary from the value of M, N, k, and they also depend on gNB implementation. Hence, it seems difficult to align Δ1 and Δ2. Then, Alt 1 can be baseline, while Alt 2 can be optional with Δ1 and Δ2 reported by companies. |
| OPPO | Array gain = AGC1 +AGC2 -Δ=10 \* 1og10 (number of antenna elements/number of TxRUs) + 10 \* 1og10 (number of TxRUs /number of RF chains) -ΔΔ is the losses of antenna array gain due to the UE location and the broader beam of common channels. |
| ZTE | Given a UE would be most possibly not in the bore sight of a beam, a more realistic modeling on the antenna array gain is preferred. That is, we prefer Alt 2 as provided by China Telecom. For broadcast channels, the beamforming gain is not only limited by the number of elements per TxRU but also limited by SSB beam number (denoted as X). A model as 10\*log(min(X, M/N)) - Δ can be considered. |
| Nokia/NSB | We are fine with both using SLS or suitably corrected theoretical antenna array gain calculation. If the chosen approach is based on corrected theoretical antenna array gain calculation, then we are fine with Alt. 2 as proposed by China Telecom. |
| Intel | In our view, Alt. 1 mentioned by China Telecom is the maximum antenna gain that can be considered as an upper bound for link budget analysis. For realistic analysis, it is more appropriate to consider Alt. 2 with additional antenna gain loss so as to identify the performance bottleneck for different physical channels in various deployment scenario. Accordingly, corresponding performance gap may be derived, i.e., how many dB needs to be improved for the physical channels with performance bottleneck. Further, SLS needs to be conducted to evaluate the antenna gain loss and companies can report their own findings in link budget analysis.  |
| NTT DOCOMO | We are fine to use a single value for the antenna gain with beamforming gain. |
| Ericsson | Support China Telecom’s Alt 2. More realistic values than simply 10log(N) are needed, and that the non-idealities are different for components 2 and 3. For example, channel estimation can drive receive array gain losses for component 2, and the UE may not be in the boresight of the fixed antenna pattern of component 3. The fixed antenna pattern can have significant losses since ‘cell edge’ UEs may not be in the main beam of the antenna. We discuss more in R1-2006611 (section 4) and R1-2006616. |
| Qualcomm | Please see our comment in Section 2.4. In addition to the four gain components identified in the figure in Section 3.1, we need at least 2 correction factors here. One correction term is for imperfect beamforming/combining due to channel estimation errors (ΔchEst). A second correction term (Δbcast) is needed to differentiate between broadcast and unicast channels, and could be tied the number of SSB beams especially in the FR2 context. |
| InterDigital | Our view is aligned with Alt. 2 from China Telecom. Deltas can be reported by companies. |
| vivo | The 5-th sub bullet can be considered as the baseline array gain, that is the unicast beamforming gain is 10 \* 1og10 (number of antenna elements/number of TxRUs) + 10 \* 1og10 (number of TxRUs /number of RF chains)Beamforming gain loss due to other factors, e.g. tilt angle and difference between broadcast and unicast BF, can be reported by companies. Based on our simulation, the difference between broadcast and unicast beamforming gain should be considered in the evaluation. About 8dB broadcast beamforming gain loss is observed compared to unicast beamforming gain. |
| Samsung | Fine with Alt.1 from China Telecom for the alignment among company’s results |
| Sharp | For broadcast channels, array gain should be 10\*log10(NSSB) where NSSB is the number of SS/PBCH blocks. The value ofΔ can be further discussed. |
| Apple | We are not clear how to differentiate the Δ1 and Δ2 from the system level simulation. Do we intend to calibrate the antenna array gain loss from SLS? If not, I believe the results will be quite diverse. As the results only impact on the link budget, I agree with CTC, the Alt1 can be the baseline. |

## [M] Interference handling (FR1 and FR2 common)

Two contributions discuss about the necessity to consider the interference margin for link budget, which may be derived from SLS.

* Use antenna gain and interference margin values derived from system simulations in link budget analyses [19]
* Receiver interference density for FR1 can reuse the values from ITU self-evaluation if available, or via SLS [5]

Companies are invited to provide their views on this aspect.

|  |  |
| --- | --- |
| Company  | Comment |
| China Telecom | We prefer to reuse the values of receiver interference density for FR1 as much as possible from ITU self-evaluation. |
| OPPO | We prefer to reuse the values of receiver interference density which can be find in the ITU self-evaluation, and obtain receiver interference density via SLS if the values are not included in the ITU self-evaluation. |
| CATT | Share the same views as CTC. |
| ZTE | Interference density is highly dependent on the deployment scenarios and carrier frequency. We can only anticipate to get this value by SLS if there is no value can be referred in existing IMT 2020 template.  |
| Panasonic | To reuse the values from ITU self-evaluation if available, could reduce evaluation effort, but we are open to use SLS. |
| Nokia/NSB | Agree with China Telecom. We prefer this number to be spelled out in an agreement, if possible, to avoid ambiguities. |
| Intel | We share similar view as China Telecom.  |
| Ericsson | Similar comment to ZTE: realistic interference margins derived from SLS should be used and these should be according to a clearly defined scenario. That said, our observations are that antenna gains will dominate interference margins. |
| Qualcomm | This proposal is dependent on the link budget template we choose to use. We will provide additional input after we agree on link budget template. |
| vivo | Option 2 is preferred. If via SLS, specific value of interference density may need to be discussed. As guided by the SID, the evaluation should be based on LLS, and spending too much time on discussing the SLS simulation assumptions should be avoided. Companies can report their parameters which are different from the assumptions in ITU self-evaluation. |
| Samsung | Agree with reusing the values from ITU self-evaluation |
| Apple | We share the same view as China Telecom. If we don’t have agreed SLS assumption, how to calibrate the results from different companies?  |

## [M] Shadow Fading (FR1 only)

Contribution [2] proposes to modify shadow fading margin because IMT-2020 doesn’t cover the particular scenario.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | UrbanTDD | Rural NLoSTDD | Rural NLoSFDD | Rural with long distance FDD |
| (24) Lognormal shadow fading std deviation (dB) | 7 (NLoS) | 8 (NLoS) | 8 (NLoS) | 6 (LoS) |
| (25a) Shadow fading margin for control channel (function of the cell area reliability and (24)) (dB) | 7.56 | 10.45(O2O)8.45(O2I) | 10.45(O2O)8.45(O2I) | 6 |
| (25b) Shadow fading margin for data channel (function of the cell area reliability and (24)) (dB) | 4.48 | 6.61(O2O)5.13 (O2I) | 6.61(O2O)5.13 (O2I) | 4.79 |
| (27) Penetration margin (dB) | 26.25 | 9(O2O)14.53 (O2I) | 9(O2O)12.5 (O2I) | 9 |

Companies are invited to provide their initial view on this proposal.

|  |  |
| --- | --- |
| Company  | Comment |
| China Telecom | We prefer to reuse the values of shadowing fading for FR1 as much as possible from ITU self-evaluation. |
| OPPO | If the scenario is not in the IMT-2020, the parameters for the scenario need to determine. |
| CATT | Share the same views as CTC. |
| ZTE | We are fine with the proposed values in above table which makes sense to us to align the values for different channels. |
| Nokia/NSB | For SF margin, the value for Rural NLoS O2I seems incorrect. For example, for data channel with STDSF = 8 dB, STDPenetrationLoss = 4.4 dB (for O2I, low-loss) and slope = 38.63 (BS high = 35m), considering the Effective STD = sqrt(STDSF2 + STDPenetrationLoss2), the correct value for Rual NLoS O2I should be 6.34 dB.We are fine with other SF values. |
| Intel | We share similar view as China Telecom.  |
| Ericsson | If it is necessary to define a shadow fading margin, it should be according to a clearly defined scenario / use case. |
| Qualcomm | This proposal is dependent on the link budget template we choose to use. We will provide additional input after we agree on link budget template. |
| vivo | Share the same views as CTC.The value of shadow fading margin is based on effective shadow fading standard deviation and area coverage probability requirement, and effective shadow fading standard deviation will be same when carrier frequency is under 6GHz. Therefore, once the scenario and pathloss model are confirmed, shadow fading margin should be same in all carrier frequency when under 6GHz. |
| Apple | We share the same view as China Telecom.  |

## [M] Penetration margin (FR1 only)

There are two proposals for penetration margin:

* For penetration margin determination for O2I case, a more accurate model as in Table 7.4.3-1 and Table 7.4.3-2 of TR 38.901 should be used [5]
* Penetration margin for urban TDD is proposed as follows [2]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | UrbanTDD | Rural NLoSTDD | Rural NLoSFDD | Rural with long distance FDD |
| (27) Penetration margin (dB) | 26.25 | 9(O2O)14.53 (O2I) | 9(O2O)12.5 (O2I) | 9 |

Companies are invited to provide their initial view on this proposal.

|  |  |
| --- | --- |
| Company  | Comment |
| China Telecom | We prefer to reuse the values of penetration margin for FR1 as much as possible from ITU self-evaluation. |
| OPPO | We prefer to use a more accurate model as in Table 7.4.3-1 and Table 7.4.3-2 of TR 38.901. |
| CATT | Share the same views as CTC. |
| ZTE | More accurate model in Table 7.4.3-1 and Table 7.4.3-2 of TR 38.901, which is frequency and penetration material dependent, should be used. For urban scenario, 50% low-loss and 50% high-loss models can be considered. Only the low-loss model is applicable to rural scenario. More specifically, the penetration margins for different O2I cases are given in the following table (IMT-2020 value is also given as a reference).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 4G (Urban) | 2.6G (Urban) | 4G (Rural) | 2.6G (Rural) | 2G (Rural) | 700MHz(Rural) |
| IMT-2020 Template | 26.25 | - | ~~-~~ | - | - | 12.5 |
| TR 38.901 | 26.68 | 24.56 | 15.38 | 14.76 | 14.33 | 12.74 |

For O2O case, 9 dB penetration margin is suggested.  |
| Nokia/NSB | For penetration margin, we would like to understand why the penetration margin for Rural NLoS O2I are different for FDD and TDD, given that both scenarios are sub-6GHz. |
| Ericsson | If it is necessary to define a penetration margin, it should be according to a clearly defined scenario / use case. |
| Qualcomm | This proposal is dependent on the link budget template we choose to use. We will provide additional input after we agree on link budget template. |
| vivo | We agree with this proposal. |
| Apple | We share the same view as China Telecom.  |

## [M] Simulation assumptions for SLS based evaluation (FR1 only)

SLS based evaluation has been agreed as an optional method for coverage analysis. The detailed simulation assumptions are provided by [27]

Table 2 SLS specific parameters

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Urban/Rural scenario for FR1**  | **Urban/Indoor scenario for FR2** |
| Layout | Single layer - Macro layer: Hex. Grid | Urban: Single layer - Macro layer: Hex. GridIndoor: 12BSs per 120m x 50m |
| Channel model  | UMa in TR 38.901RMa in TR 38.901 | UMa in TR 38.901Indoor-office in TR 38.901 |
| Min distance of UE2gNB | 35m for urban35m for rural | 35m for urban0m for indoor |

Also, they have provided a proposal

* For SLS based methodology, the target performance for SLS is determined by the 5th percentile SINR value in CDF curve for different physical channels.

On the other hand, the agreement at RAN1#101-e says that “Note: the simulation assumptions for SLS are up to companies’ reports”. Considering the fact that small number of companies supports SLS for coverage analysis, it is not good idea to spend time on determining simulation assumptions for SLS. Therefore, the following moderator proposal can be made.

**Moderator’s proposal:**

* The agreement at RAN1#101-e remains: the simulation assumptions for SLS are up to companies’ reports, i.e. no more clarification is needed.

Companies are invited to provide their view on the moderator proposal above.

|  |  |
| --- | --- |
| Company  | Comment |
| China Telecom | Support the moderator’s proposal. |
| OPPO | Support the moderator’s proposal. |
| CATT | Agree with the proposal. |
| ZTE | For SLS, most of the simulation assumptions can reuse that of defined for LLS. For the remaining very few SLS specific parameters, it’s fine for us to only note but not agree on detailed assumptions.But, for the target performance of SLS, we believe this should be discussed together with the target performance for LLS based methodology. Actually it is once discussed in last meeting and seems no objections received at that time. **Proposal:**Identify the target performance and coverage bottlenecks based on target performance metric for FR1.* FFS: the target performance metric and potential down selection.
* Option 1: The target path loss is considered as the target performance.
	+ Alt1: Derived from the target ISD.
	+ Alt2: Relative MPL.
* Option 2: ~~The target MCL~~ An MCL or MCL based metric is considered as the target performance.
	+ Alt1: Derived from the target ISD, considering shadow fading margin, penetration loss, etc.
	+ Alt2: Fixed target MCL, e.g. 147dB for VoIP to achieve better performance than other RAT(s).
	+ Alt3: Relative MCL
* If optional SLS is performed, the target performance for SLS is determined by the 5th percentile SINR value in CDF curve for different physical channels
* Other target performance metrics are not precluded.
 |
| Panasonic | We support the moderator’s proposal. |
| Intel | We are fine with FL’s proposal.  |
| Ericsson | Some further clarification could help. For example, a 95% coverage target in system simulation (similar to ZTE’s comment) seems reasonable. |
| vivo | We agree with moderator’s proposal. |
| Apple | Generally, we are ok with FL’s proposal. We are wondering if we don’t have the common simulation assumption, how to calibrate the results? it seems that some companies propose the antenna array gain loss and interference modelling could need the inputs from SLS. |

## [M] Others

Some contributions propose to include additional simulation parameters in order to achieve a better performance.

* **(Item 1) Inter-slot frequency hopping**
	+ Inter-slot frequency hopping should be used for rural [9]
* **(Item 2) Target error rate for PUSCH**
	+ the rural PUSCH baseline configuration should be with HARQ enabled and without restrictions on iBLER [9]
* **(Item 3) Use of MCS table for URLLC**
	+ the qam64-LowSE MCS index table (table 3) shall be considered for the study of NR coverage enhancement. The maximum coverage of PUSCH shall be evaluated for the combination of number of allocated PRBs and MCS index which yields the largest MCL value. [3]
* **(Item 4) Combination on MCS and TBS**
	+ The maximum coverage of PUSCH shall be evaluated for the combination of number of allocated PRBs and MCS index which yields the largest MCL value.[2]
* **(Item 5) Channel estimation for rural PUSCH**
	+ The rural PUSCH baseline configuration should be with practical channel estimation , FFS: on configuration details (e.g. maximum time and frequency averaging) [9]
* **(Item 6) HARQ processes for TDD Voice**
	+ For evaluation of uplink FR1 TDD VoIP, use at least 2 HARQ processes are used to prevent large accumulation in buffer [13]

From moderator’s point of view, these

**Moderator’s proposals**

* The proposals above will be added if sufficient number of positive comments is received.
* Even if they are not captured in the simulation assumption table, companies are still allowed to perform the simulations using these parameters.

Companies are invited to input their views on moderator’s proposal and proposed items 1-6.

|  |  |  |
| --- | --- | --- |
| Company  | Item # | Comment |
| Nokia/NSB | 3,4 | These two items have a non-negligible impact on the code rate for PUSCH. A lower code rate implies a lower 10% BLER SINR, i.e., a longer range for the transmission. It seems only natural to consider these options as a baseline to assess the merit of possible PUSCH enhancements. Concerning item 3 in particular, it is true that this feature has been added to Rel-15 to provide URLLC support. However, it does not seem unreasonable to make use of it in other contexts as well, e.g., eMBB or VoIP, if this can deliver better transmission range in coverage limited settings (which need to operate at very low SINR). |
| Ericsson | 2 | We also expect HARQ and higher iBLER can improve performance vs fixed iBLER of 10%. |
| Qualcomm |  | We think it is sufficient for individual companies to report the various optimizations they have considered. No need for explicit agreements/proposals. |
| InterDigital | 6 | Similar to the analysis presented in TR 36.824, the latency requirements for VoIP need to be considered in the evaluation. The latency requirement of 50ms or 100ms will make a difference in coverage performance for VoIP, as shown in our contribution R1-2006243. In addition, the latency requirements will impose constraints on the number of repetitions and maximum transmissions. Therefore, the number of HARQ processes must be optimized to increase capacity to accept VoIP packets which are generated every 20ms. If we assume only one HARQ process for a long latency requirement, as pointed out in R1-2006242, the VoIP packets will start accumulating in the buffer at low. The issue must be dealt in both FDD and TDD and we believe the issue is critical for TDD given that there are not many uplink slots. Our proposal is to report the number of HARQ processes for evaluation of TDD VoIP, noting that the latency requirements of 50ms and 100ms should be considered when choosing the parameters for # of repetitions, # of HARQ processes and # of maximum retransmissions for TDD VoIP evaluations. |
| vivo | 1 | When considering repetition, inter-slot frequency hopping may need to be used |
| 2 | 10% BLER of eMBB PUSCH is already necessary to be enhanced, no need to consider a higher BLER. |
| 3,4 | It is too ideal to assume the best parameter combination, the network is less likely to have sufficient information and such a complicated scheduler to schedule PUSCH using the best combination, which would vary with the wireless channel and environments. |
| Apple | 3,4 | It could be better we have those two items at least for PDSCH evaluation. The assumptions on MCS and PRB for PDSCH from different companies are quite different.  |

# Updated link budget analyses

Updated link budget analyses are shown in [2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22], and they have identified some potential bottleneck channels (e.g. PUSCH, PUCCH, PRACH). Since evaluation parameters have not fixed yet, any of the official agreements/observations shouldn’t be made. Hence, the following proposal can be made:

**Moderator’s proposal**

* The updated link budget analyses and the observations from each company are considered in our further study.

Please input your view to the following table, if any:

|  |  |
| --- | --- |
| Company  | Comment |
| ZTE | Support the proposal |
| Intel | We are fine with FL’s proposal.  |
| NTT DOCOMO | We support FL proposal. |
| vivo | We agree with moderator’s proposal.  |

# Summary of the proposals for the discussion on 8/20.

To be incorporated later.

# Summary of the proposals for the discussion on 8/26.

To be incorporated later.

# Summary of the proposals for the discussion on 8/28.

To be incorporated later.

# Summary of the agreements

To be incorporated later.

# References

1. R1-2006242 Discussion on simulation assumptions for VoIP InterDigital, Inc.
2. R1-2005256 Evaluation on the baseline performance for FR1 Huawei, HiSilicon
3. R1-2005297 Baseline coverage evaluation of UL and DL channels – FR1 Nokia, Nokia Shanghai Bell
4. R1-2005393 Evaluation on NR coverage performance for FR1 vivo
5. R1-2005425 Discussion on baseline coverage performance for FR1 ZTE
6. R1-2005722 Baseline coverage performance for FR1 CATT
7. R1-2005731 Baseline performance for NR coverage enhancements for FR1 China Telecom
8. R1-2005887 Discussion on baseline coverage performance for FR1 Intel Corporation
9. R1-2005939 FR1 PUSCH Coverage Performance Sierra Wireless, S.A.
10. R1-2006045 Evaluation on NR coverage performance for FR1 OPPO
11. R1-2006160 Baseline coverage performance using LLS for FR1 Samsung
12. R1-2006224 Discussion on the baseline performance in FR1 CMCC
13. R1-2006243 FR1 baseline coverage performance using LLS InterDigital, Inc.
14. R1-2006990 Baseline coverage performance analysis in FR1 Panasonic Corporation
15. R1-2006455 Baseline coverage performance for uplink Indian Institute of Tech (H)
16. R1-2006530 Evaluation on FR1 coverage performance Apple
17. R1-2006534 Baseline coverage performance for FR1 Xiaomi Technology
18. R1-2006578 Evaluation results of coverage for FR1 Urban scenario Sharp
19. R1-2006611 Link and System Evaluation of Coverage for FR1 Ericsson
20. R1-2006645 Views on target performance metric and values for FR1 coverage enhancements SoftBank Corp.
21. R1-2006652 Baseline coverage performance for FR1 Charter Communications
22. R1-2006739 Baseline coverage performance for FR1 NTT DOCOMO, INC.
23. R1-2006818 Baseline FR1 coverage performance Qualcomm Incorporated
24. R1-2005259 Discussions on simulation assumptions for VoIP Huawei, HiSilicon
25. R1-2005303 Evaluation assumptions for NR coverage enhancement evaluation Nokia, Nokia Shanghai Bell
26. R1-2005398 Considerations on Evaluation Assumptions for Coverage Enhancements vivo
27. R1-2005430 Discussion on evaluation methodology for NR coverage ZTE
28. R1-2005727 Discussion on the methodology for baseline coverage performance using LLS CATT
29. R1-2005733 Remaining issues on evaluation methodology for NR coverage enhancements China Telecom
30. R1-2005892 Discussion on simulation assumptions for NR coverage enhancement Intel Corporation
31. R1-2006050 Functionality of Coverage Enhancement and other SI/WI OPPO
32. R1-2006293 Reducing PDCCH load of coverage-limited UEs InterDigital, Inc.
33. R1-2006616 Evaluation methodology for coverage enhancements Ericsson
34. R1-2006823 Other coverage enhancement aspects Qualcomm Incorporated

# Annex – Agreements at RAN1#101e

Update on 6/1: to check 6/2

Update from 6/4 GTW:

Agreements:

* Adopt the following target data rates for eMBB performance evaluation for FR1.
* Urban scenario: DL 10Mbps, UL 1Mbps
* Rural scenario: DL 1Mbps, UL 100kbps
* Rural with long distance scenario: DL 1Mbps, UL 100kbps, ~~[~~30kbps~~]~~ (optional)

**Agreements:**

* For VoIP performance evaluation based on link-level simulation for FR1.
* A packet size of [320] bits with 20ms data arriving interval is adopted.
* ~~FFS~~TBD: TBS for SIP invite message. Payload of 1500 bytes can be a starting point.

Agreements:

* The basic evaluation methodology is based on link-level simulation for FR1.
* Step 1: Obtain the required SINR for the physical channels under target scenarios and service/reliability requirements.
* Step 2: Obtain the baseline performance based on required SINR and link budget template.
* Note: asepcts related to identifying target performance and coverage bottlenecks based on target performance metric is to be handled separately
* ~~FFS:~~ The evaluation methodology based on system-level simulation is optional for FR1.
* Note: The simulation assumptions for SLS are up to companies’ reports.

Agreements:

* For link level simulation, adopt the following table for PUSCH and PUCCH for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Scenario and frequency | Urban: 4GHz (TDD), 2.6GHz (TDD) Rural: 4GHz (TDD), 2.6GHz (TDD), 2GHz (FDD), 700MHz (FDD)Rural with long distance: 700MHz (FDD), 4GHz (TDD)  |
| Frame structure for TDD | DDDSU (S: 10D:2G:2U) only for 4GHzDDDSUDDSUU (S: 10D:2G:2U) only for 4GHz DDDDDDDSUU (S: 6D:4G:4U) only for 2.6GHzOther frame structures can be reported by companies. |
| Pathloss model (select from LoS or NLoS) | Urban: NLoSRural: NLoS and LoS |
| BWP | 100MHz for 4GHz and 2.6GHz.20MHz for 2GHz (FDD20MHz (optional for 10MHz) for 700MHz. (FDD) |
| SCS | 30kHz for TDD, 15kHz for FDD. |
| Channel model for link-level simulation | TDL-C for NLOS, TDL-D for LOS.[CDL] |
| UE velocity | Urban: 3km/h for indoorRural: 3km/h for indoor, 120km/h (optional 30km/h) for outdoor |
| Frequency hopping | w/ or w/o ~~Intra-slot~~ frequency hopping for PUSCHw/ frequency hopping for PUCCH ~~is enabled~~. |

* FFS whether there are any additional simulation considerations for the extreme coverage scenarios (e.g., rural)

Update on 6/5:

Agreement:

* Down selection on the following options for the link budget template for FR1 in next meeting.
* Option 1: Adopt single link budget template based on IMT-2020 self-evaluation with necessary revisions, including adding/removing/revising some parameters.
	+ FFS: The template provided by FL in Tdoc [R1-2005005](file:///D%3A%5C2020%E5%B9%B4%E5%BA%A6%E5%B7%A5%E4%BD%9C%5CRAN1%23102%5Cduring%20the%20meeting%5CDocs%5CR1-2005005.zip).
* Option 2: Adopt both templates, i.e. link budget template in IMT-2020 self-evaluation and link budget template in TR 36.824.
* Option 3: Adopt single link budget template in TR 36.824 with necessary revisions, including adding/revising some parameters.

Agreement:

Down selection on the following options for antenna array gain for LLS based methodology for FR1 in next meeting.

* Option 1: Antenna array gain is included in the link budget template.
* FFS: array gain = 10 \* 1og10 (number of antenna elements/number of TxRUs)
* FFS: For TDL channel model
* FFS: Values reflective of realistic implementation and network operation.
* Option 2: Antenna array gain is included in LLS.
* FFS: For CDL channel model

Agreement:

* For link level simulation, adopt the following table for PDSCH for FR1.

|  |  |
| --- | --- |
| Parameters | Values |
| Waveform | CP-OFDM |
| PRBs/MCS/TBS | Reported by companies. |
| PDSCH duration | 12 OS |
| Other parameters | FFS |

Agreements:

* For link level simulation, adopt following TBS for Msg3 for FR1
* 56 bits

Agreements:

* For link level simulation, the packet size of VoIP for FR2 is the same as FR1.

Agreements:

* For link level simulation, TBS of Msg3 for FR2 is the same as FR1.

Agreements:

* The evaluation methodology for FR2 is the same as FR1.

Agreements:

* The link budget template for FR2 is the same as FR1.

Agreements:

* For link level simulation, adopt the following table for PUSCH and PDSCH for FR2.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Scenario and frequency | 28GHz |
| Frame structure for TDD | DDDSU (S: 10D:2G:2U)DDSU (S: 11D:3G:0U)Other frame structures can be reported by companies. |
| Subcarrier Space | 120kHz |
| UE velocity | Indoor scenario:3km/hUrban scenario: 3km/h for indoor, 30km/h for outdoor. Suburban scenario: 3km/h for indoor, 30km/h, (optional: 120km/h) for outdoor. |
| Occupied channel bandwidth for | 100MHz, [400MHz] |
| Frequency hopping for PUSCH | w/ or w/o frequency hopping |

Final summary in R1-2005004.

**//Update on 6/7, post e-Meeting additional email approval**

**[101-e-Post-NR-Cov-Enh] Email discussion/approval focusing on remaining evaluation assumptions till 6/17 – Jianchi (CT)**

* **Focusing on high priority proposals first, target 6/11 for early approvals**
* **Followed by medium priority/low priority proposals**

Update on 6/11: check on 6/12 for potential agreements

Update on 6/12:

Agreements

* For link level simulation, adopt the following table for PUSCH for eMBB data or VoIP for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| BLER for PUSCH | For eMBB, w/ HARQ, 10% iBLER; w/o HARQ, 10% iBLER.For VoIP, 2% rBLER. |
| Number of UE transmit chains for PUSCH | 1，2 (optional)  |
| DMRS configuration for PUSCH | For 120km/h, (Optional: 30km/h): Type I, 2 or 3 DMRS symbol, no multiplexing with data.For frequency hopping: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.PUSCH mapping Type and DMRS position are reported by companies.Working assumption:For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data. |
| Waveform for PUSCH | DFT-s-OFDM, CP-OFDM (optional) |
| Repetitions for PUSCH | For eMBB, w/o repetition as baseline, w/ repetition (optional).  For VoIP, w/ repetition. The actual number of repetitions is reported by companies.FFS: Repetition type B |
| HARQ configuration for PUSCH | For eMBB, whether HARQ is adopted is reported by companies. For VoIP, w/ HARQ.The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. |
| Latency requirements for voice | 50ms/100ms |
| PUSCH duration  | 14 OS |

Agreements

* For link level simulation, adopt the following table for PUCCH for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| PUCCH format type | Format 1, 2bits UCI.Format 3, [4bits (3 bits A/N + 1 bit SR)]/11/22 bits UCI |
| BLER for PUCCH | For PUCCH format 1: DTX to ACK probability: 1%. NACK to ACK probability: 0.1%.ACK missed detection probability: 1%.For PUCCH format 3: BLER for Ack/Nack, SR: 1%FFS: BLER for CSI (10% or 1%) |
| Number of PRBs for PUCCH | 1 PRB |
| Number of UE transmit chains for PUCCH | 1 |
| Number of repetitions for PUCCH | w/ repetition (optional), w/o repetition for PUCCH.The maximum number of repetitions is 8. |
| PUCCH duration  | 14 OS |
| DMRS configuration for PUCCH | FFS: number of DMRS symbols for PUCCH Format 3. |

Agreements:

* For link level simulation, adopt the following table for eMBB data or VoIP on PUSCH and for PUCCH for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Number of ~~receive~~ antenna elements for BS | Urban: 192 antenna elements for 4GHz and 2.6GHz, (M,N,P,Mg,Ng) = (12,8,2,1,1)(optional) 128 antenna elements for 4GHz, (M,N,P,Mg,Ng) = (8,8,2,1,1)Rural: 64 antenna elements for 4GHz and 2.6GHz(M,N,P,Mg,Ng) = (8,4,2,1,1)32 antenna elements for 2GHz(M,N,P,Mg,Ng) = (8,2,2,1,1)16 antenna elements for 700MHz(M,N,P,Mg,Ng) = (4,2,2,1,1) |
| Number of ~~receive~~ TxRUs for BS | ~~TBD~~gNB architectures to study ~~for TDL~~:* 2 or 4 TXRUs for 2GHz, 700 MHz
* 64TxRUs for 2.6 and 4 GHz.
* Optional: 32 TXRUs at 2 GHz

~~[~~gNB modeling in LLS for TDL:* Option 1: 2 or 4 gNB receive chains in LLS ~~(as starting point)~~. FFS: correlation
* Option 2: Number of gNB receive chains = number of TXRUs in LLS. FFS: correlation.~~]~~

[gNB architectures to study for CDL: * Urban: 64 receive chains for 2.6 and 4 GHz in LLS
* Rural: 8 receive chains for 4GHz and 2.6GHz in LLS
* 4 receive chains for 2GHz and 700MHz in LLS.]

[gNB modeling in LLS for CDL: Number of gNB receive chains = number of TXRUs in LLS.] |
| Delay spread | Urban: 300nsRural: 300nsRural with long distance: 30ns |
| PRBs/TBS/MCS for eMBB for PUSCH | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use 30 PRBs for 1Mbps, 4 PRBs for 100kbps, 1 PRB for 30kbps as a starting point.TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |
| PRBs/MCS for VoIP for PUSCH | [4 PRBs] for VoIP as starting point. Other values of PRBs can be reported by companies.QPSK, pi/2 BPSK (optional) |

Note: For TDL models, companies report whether antenna array gain, ~~obtained from mapping antenna elements to TXRU,~~ is included in LLS or link budget template. Array gain calculation method and how channel estimation is accounted for is reported by companies

Agreements:

* Adopt the following target data rates for eMBB performance evaluation for FR2.
* Indoor: DL: 25Mbps, UL:5Mbps
* Urban: DL: 25Mbps, UL: 5Mbps
* Suburban: FFS: (DL: 1Mbps, UL: 50kbps)

Other proposals?

* # Number of receive TxRUs for BS – 6/15
* Others?

Update on 6/17

Regarding # Number of receive TxRUs for BS – see the update of the agreement above.

Agreements:

* ~~For link level simulation, adopt the following table for SSB for FR1.~~

|  |  |
| --- | --- |
| **~~Parameters~~** | **~~Values~~** |
| ~~Periodicity~~ | ~~20ms~~ |
| ~~Performance metric~~ | ~~Combination of 4 SSBs in 80ms.~~ |
| ~~Other parameters~~ | ~~Reported by companies.~~ |

* For link level simulation, adopt the following table for Msg.3 for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Number of PRBs | 2 |
| Waveform | DFT-s-OFDM |
| Number of DMRS symbol | w/o frequency hopping: 3,w/ frequency hopping: 2 for each hop |
| PUSCH duration | 14 OS |
| Other parameters | Reported by companies. |

Other proposals 6/18

Update on 6/18:

Agreements:

* For link level simulation, adopt the following table for PDCCH for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Aggregation level | 16 |
| Payload | 40 bits |
| CORESET size | 2 symbols, 48 PRBs |
| Tx Diversity | Reported by companies |
| BLER for PDCCH | 1% BLERFFS: 10% BLER |
| Number of SSB for broadcast PDCCH of Msg.2 | Reported by companies |
| Other parameters | Reported by companies |

Agreements:

* For link level simulation, adopt the following table for SSB for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Periodicity | 20ms |
| Performance metric | Combination of 4 SSBs in 80ms.Note: UE is not assumed to know the SS/PBCH block index |
| Other parameters | Reported by companies. |

Agreements:

* For link level simulation, adopt the following table for PRACH for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Format | Format 0, Format B4, or Format C2 |
| SCS | Reported by companies. |
| Performance metric | 1% missed detection at 0.1% false alarm probabilityFFS: 10% missed detection. |
| Other parameters | Reported by companies. |

Agreements:

* For link level simulation, for PDSCH of Msg.4 for FR1.
	+ Reuse the following simulation assumption for PDSCH
		- Waveform, [PDSCH duration]
	+ FFS: Payload size: [3000bits].
	+ Other parameters: Reported by companies.

Agreements:

* For link level simulation, for SSB, PDCCH, PDSCH and PDCCH of Msg.2, PDSCH of Msg.4 and PDSCH for FR1.
	+ Reuse following simulation assumptions agreed for PUSCH.
		- Scenario and frequency, frame structure, SCS, pathloss model, channel model, delay spread, UE velocity, number of antenna elements and TxRUs for BS.
	+ The number of UE receive chains: ~~is 2.~~
		- 4 for 4GHz/2.6GHz
		- 2 or 4 for 2GHz
		- 2 for 700MHz
	+ For PDSCH, reuse ~~DM-RS configuration,~~ BLER, HARQ, Latency requirements for voice agreed for PUSCH.
		- Reuse DM-RS configuration agreed for PUSCH except that 3 DMRS symbols is used for Msg2.
* For link level simulation, for PRACH and Msg.3 for FR1.
	+ Reuse following simulation assumptions agreed for PUSCH
		- Scenario and frequency, frame structure, pathloss model, channel model, delay spread, UE velocity, number of antenna elements and TxRUs for BS and Number of UE transmit chains.
	+ For Msg.3, reuse SCS, HARQ configuration, frequency hopping agreed for PUSCH.

Agreements:

* For link level simulation, adopt the following table for eMBB data or VoIP on PUSCH and on PDSCH for FR2.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| BLER | For eMBB, w/ HARQ, 10% iBLER, Optional: companies report rBLER.w/o HARQ, 10% iBLER.For VoIP, 2% rBLER. |
| DMRS configuration | For 30km/h (optional: 120km/h): Type I, 2 or 3 DMRS symbol, no multiplexing with data.For frequency hopping for PUSCH: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.PUSCH/PDSCH mapping Type and DMRS position are reported by companies.Working assumption:For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data. |
| Waveform | DFT-s-OFDM for PUSCH, CP-OFDM for PDSCHFFS: CP-OFDM for PUSCH |
| Repetitions for PUSCH/PDSCH | For eMBB, w/o repetition as baseline, w/ repetition (optional).  For VoIP, w/ repetition. The actual number of repetitions is reported by companies.FFS: Repetition type B for PUSCH. |
| HARQ configuration for PUSCH/PDSCH | For eMBB, whether HARQ is adopted is reported by companies. For VoIP, w/ HARQ.The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. |
| PUSCH/PDSCH duration | 14 OS for PUSCH, 12 OS for PDSCH |

Agreements:

* For link level simulation, adopt the following table for eMBB data or VoIP on PUSCH and on PDSCH for FR2.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Number of antenna elements for BS | Indoor scenario: 128(M, N, P, Mg, Ng) = (8, 8, 2, 1, 1)Urban/suburban scenario: 256, (M,N,P,Mg,Ng) = (4, 8, 2, 2, 2)Optional: 512, (M,N,P,Mg,Ng) = (8,8,2,2,2) |
| Number of TxRUs for BS | 2Note: Analog beamforming is assumed. |
| Number of UE Tx/Rx chains | 1T2R, 2T2R |
| Channel model for link-level simulation | CDL- A, TDL-A, [urban/suburban: TDL-C]Note: company can provide simulation results based on either TDL channel or CDL model |
| Delay spread | Indoor scenario: 30nsUrban scenario: 100nsSuburban scenario: 100ns |
| Latency requirements for voice | 50ms/100ms |
| PRBs/TBS/MCS for eMBB for PUSCH/PDSCH | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use [30] PRBs for 5Mbps for PUSCH and full bandwidth for 25Mbps for PDSCH as a starting point.TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |
| PRBs/MCS for VoIP for PUSCH/PDSCH | [4 PRBs] for VoIP as starting point. Other values of PRBs can be reported by companies.QPSK for PDSCH/PUSCHOptional: pi/2 BPSK for PUSCH |

Agreements:

* For link level simulation, adopt the following simulation assumption for eMBB data or VoIP on PUSCH and on PDSCH for FR2.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Number of UE antenna elements | 8, one panel:(M, N, P) = (2,2,2), FFS: Two panels in link budget, one panel in LLS, 16 for each panel: (M, N, P) = (4,2,2) |

Agreements:

* For link level simulation, adopt the following table for PUCCH for FR2.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Format | Format 1, 2bits UCI.Format 3, [4bits (3 bits A/N + 1 bit SR)]/11/22 bits UCIFFS: Format 0, 2 |
| BLER for PUCCH | The same as FR1 |
| Number of PRBs for PUCCH | The same as FR1 |
| Number of UE transmit chains for PUCCH | The same as FR1 |
| Number of repetitions for PUCCH | The same as FR1 |
| PUCCH duration | 14 OFDM symbolsFFS: 4 OFDM symbols |
| DMRS configuration for PUCCH | FFS: [4] DMRS symbols for PUCCH Format 3. |

Agreements:

* For link level simulation, adopt the following table for PDCCH for FR2.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Aggregation level | 16 |
| Payload | 40 bits |
| CORESET size | 2 symbols, 48PRBs  |
| Tx Diversity | Reported by companies |
| BLER for PDCCH | 1% BLER.FFS: 10% BLER |
| Number of SSB for broadcast PDCCH of Msg.2 | Reported by companies |
| Other parameters | Reported by companies |

Agreements:

* For link level simulation, adopt the following table for PRACH for FR2.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Format | Format B4, (Optional: Format C2) |
| SCS | Reported by companies. |
| Performance metric | 0.1% false alarm, 1% miss-detectionFFS: 10% missed detection. |
| Number of SSB beams | Reported by companies |
| Other parameters | Reported by companies. |

Agreements:

* For link level simulation, for SSB, PDCCH, PDSCH and PDCCH of Msg.2, PDSCH of Msg.4 for FR2.
	+ Reuse following simulation assumptions for PDSCH
		- Scenario and frequency, frame structure, SCS, channel model, delay spread, UE velocity, number of antenna elements and TxRUs for BS, number of UE Tx/Rx chains and UE antenna elements.
* For link level simulation, for PUCCH, PRACH and Msg.3 for FR2.
	+ Reuse following simulation assumptions for PUSCH
		- Scenario and frequency, frame structure, channel model, delay spread, UE velocity, number of antenna elements and TxRUs for BS, number of UE antenna elements for PUSCH.
	+ For PRACH and Msg.3, reuse number of UE Tx chains for PUSCH.
	+ For PUCCH, reuse SCS for PUSCH.
	+ For Msg.3, reuse SCS, HARQ configuration, frequency hopping for PUSCH.

Final summary in R1-2005192.