**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

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| 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

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## [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.

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

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## [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:

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| Company | Preferred option | Comments |
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## [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.

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## [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.

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| Parameters | Values |
| Other parameters | FFS |

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

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## [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.

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| **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.

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## [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.

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| 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.

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## [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.

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## [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.~~]~~
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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.

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

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

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| 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.

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## [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.

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| Company  | Agree to remove square bracket [Y/N] | Comment |
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## [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.

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| Company  | Agree to adopt 3000bits [Y/N] | Comment |
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## [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.

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|  | **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).

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| Company  | Preferred bit size320, 352 or something else | Comment |
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## [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]
	+ 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.

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## [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.

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| 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.

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# 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)



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| Company  | Preference on MCL definition for TDL opt.1 | Preference on MCL definition for TDL opt.2 and CDL | Other comments |
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## [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.

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## [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.

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## [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.

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## [M] Shadow Fading (FR1 only)

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

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| 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.

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## [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]

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| --- | --- | --- | --- | --- |
| 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.

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## [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

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| **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.

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## [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 |
|  |  |  |
|  |  |  |
|  |  |  |

# 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 |
|  |  |
|  |  |
|  |  |

# 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. R1-2006346 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](../../Docs/R1-2005005.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.