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

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

**Source: Moderator (Nokia/NSB)**

**Title: FL** **Summary of Baseline Coverage Evaluation of DL and UL for FR2**

**Agenda Item: 8.8.1.2**

**Document for: Discussion/Decision**

# Introduction

This paper summarizes the content of contributions submitted to AI 8.8.1.2 (Study on NR coverage enhancement - Baseline coverage performance using LLS – FR2). Proposals related to simulation assumptions for the study of baseline performance in FR2 included in contributions submitted to AI 8.8.3 are also included.

The material is organized as follows:

* First, FR2-only open issues related to simulation assumptions, signals and channels configurations will be summarized. This includes both (i) issues that are not common to both FR1 and FR2, and (ii) common issues which may be solved differently for the two FRs.
  + All other common issues of FR1 and FR2 are included in the **Summary on A.I. 8.8.1.1 baseline coverage performance using LLS for FR1**,and thus are not reported here for the sake of efficiency.
* Second, FR2-only open issues related to evaluation assumptions and metrics will be summarized.
* Third, a summary of baseline evaluation results is provided.
* Additional sections will be populated as the discussion progresses.

Note that each section carries an additional label, according to the following logic:

* **[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.

Tentative Moderator’s proposals are added when items seem less controversial.

# Open issues

## [H] Open issue No.1 – Antenna array gain [FR2-specific observations]

Subitem 2.4 of the **FL Summary on A.I. 8.8.1.1 baseline coverage performance using LLS for FR1** summarizes companies’ position and proposals on antenna array gain modeling for both FR1 and FR2. Given the paramount importance of this issue, FR2-specific proposals are provided herein [verbatim], for the sake of completeness:

* The antenna array gain should be included in LLS based on CDL channel model for FR2. The analog beams used for LLS at the BS and UE should be further studied, and the beam directed to the strongest cluster in the CDL model can be a start point [1].
* For antenna array gain for LLS based methodology for FR2, Option 1 should be preferred, and theoretical calculations may suffice to determine the coverage bottleneck. Hybrid simulation approach to model antenna array gain could be adopted, whenever practically relevant cell radius estimations are necessary [2].
* Antenna array gain is included in the link budget template for TDL channel model. The value of antenna array gain loss need to FFS [8].
* Antenna array gain is included in the link budget template. Adopt the overall antenna gain given by Overall antenna gain G=10log10(M/N α)+ 10log10(N/L), where N, M, L as the number of TXRU, antenna elements and RF chains, respectively and 0<α≤1. [11].
* In FR2, the broadcast BF gain is about 8dB and 5dB lower than unicast BF gain, in urban and indoor scenarios, respectively [3] [17].
* The antenna array gain for unicast channels can be modeled as 10\*log(N/k) + 10\*log(M/N) - Δ, where k, M and N is the number of RF chains, TxRUs and antenna elements, respectively and Δ is the antenna array gain loss, which can be considered as zero or obtained by SLS [4].
* The antenna array gain for broadcast channels can be modeled as 10\*log(min(X, M/N)) - Δ, where X is the number of SSB beams, Δ is the antenna array gain loss, which can be considered as zero or obtained by SLS [4].

Summarizing, the following situation can be observed for FR2:

* At least 4 companies support Option 1 (include the antenna array gain in LB template)
  + At least 3 companies support the theoretical calculation of antenna array gain with a margin/factor to model the imperfection of beamforming.
  + At least 2 companies support the modelling of antenna array gain by SLS.
* One company supports Option 2 (include the antenna array gain in LLS)
* One company supports a fixed gap in beamforming gain for unicast and broadcast channel.

A Moderator’s proposal on this issue, covering both FR1 and FR2, is provided in Subitem 2.4 of the **FL Summary on A.I. 8.8.1.1 baseline coverage performance using LLS for FR1**. Comments/Views on the proposal should be added there.

## [M] Open issue No.2 – PUCCH formats

For link level simulations, the following agreement on PUCCH formats for FR2 was made during RAN1 #101-e.

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 UCI  FFS: Format 0, 2 |

Only one contribution considers PUCCH Formats 0 and 2, given that in the NW operation point of view, PUCCH with long duration may cause large overhead for NW operations [13]. All other contributions consider only Formats 1 and 3, as per agreement. One contribution in particular states that the motivation for PUCCH evaluation with shorter duration in a coverage limited setting is not clear [4].

Companies are invited to input views on this aspect. Moderator’s proposal will be made based on companies’ inputs.

|  |  |
| --- | --- |
| Company | Comment |
| CATT | PUCCH Format 0 and 2 with short duration certainly has worse performance than the PUCCH formats with long duration. We don’t see the necessity to simulate PUCCH format 0 and 2 under the umbrella of coverage enhancement. Overhead is not an issue at all as the long PUCCH is used since LTE and can be proper handled by configuration or scheduling. Short PUCCH is introduced for low latency and is not suitable for the case wherein we intend to identify the maximum coverage. |
| ZTE | We don’t see clear motivation for PUCCH coverage evaluation with shorter duration. We prefer to not consider short PUCCH format at least for evaluation purpose. |
| NTT DOCOMO | Although the PUCCH short format shows the worse performance, we strongly support to consider PUCCH short formats in the SI of coverage enhancement (at least potential techniques for PUCCH short format should not be precluded). In the NW operation point of view, since large number of BS antenna beams would be used in FR2 to compensate coverage performance, PUCCH with long duration may not be appropriate for NW operation in FR2 due to large overhead. Therefore, PUCCH short format should be considered for the baseline coverage performance for FR2 with considering practical NW operation. |
| Intel | We do not see the strong need to evaluate the performance for short PUCCH format. The link budget difference between 2-symbol short PUCCH format and 14-symbol long PUCCH format can be ~8.5dB. This indicates that if long PUCCH format needs repetition due to coverage enhancement, short PUCCH format may need more than 7 times of repetitions to achieve similar coverage. In our view, for UE with enhanced coverage, it is expected that long PUCCH format would be used for proper operation. |

## [M] Open issue No.3 – PUCCH duration

For link level simulations, the following agreement on PUCCH duration for FR2 was made during RAN1 #101-e.

Agreements:

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

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| PUCCH duration | 14 OFDM symbols  FFS: 4 OFDM symbols |

Only one contribution considers PUCCH duration of 4 OFDM symbols, given that in the NW operation point of view, PUCCH with longer duration may cause large overhead for NW operations [13]. All other contributions consider only 14 OFDM symbols for PUCCH, as per agreement. One contribution in particular states that the motivation for PUCCH evaluation with shorter duration in a coverage limited setting is not clear [4].

Companies are invited to input views on this aspect. Moderator’s proposal will be made based on companies’ inputs.

|  |  |
| --- | --- |
| Company | Comment |
| CATT | Same comments as above. The FFS should be removed. |
| ZTE | Similar comments as above, we prefer to only consider 14 OFDM symbols for evaluation purpose. |
| NTT DOCOMO | If, short PUCCH format is considered, we are fine to remove 4 OFDM symbols for the PUCCH duration. |
| Intel | We suggest to remove FFS. |

## [M] Open issue No.4 – DMRS configuration for PUCCH

For link level simulations, the following agreement on DMRS configuration for PUCCH for FR2 was made during RAN1 #101-e.

Agreements:

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

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| DMRS configuration for PUCCH | FFS: [4] DMRS symbols for PUCCH Format 3. |

Only one contribution specifically states that no additional DMRS symbol is considered for PUCCH [6] . A larger number of contributions consider 4 DMRS symbols instead [4], [9], [12], [14]. The following tentative proposal is made:

**Moderator’s proposal**

* Consider 4 DMRS symbol for PUCCH Format 3.

Companies are invited to input views on this proposal/aspect.

|  |  |
| --- | --- |
| Company | Comment |
| CATT | Support FL’s proposal |
| ZTE | Support the proposal. |
| Intel | We are fine with FL’s proposal. We observed that PUCCH with 4 DMRS symbols can outperform than that with 2 DMRS symbols. |

## [M] Open issue No.5 – Number of UE panels in link budget

For link level simulations, the following agreement on PUSCH and PDSCH for FR2 was made during RAN1 #101-e.

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) |

No contribution submitted to AI 8.8.1.2 considers more than one panel in link budget. One contribution specifically proposes not to consider more than one panel in link budget given that it is not clear how to capture the impact of different panels into the link budget [10]. The following tentative proposal is made:

**Moderator’s proposal**

* Consider only one panel at the UE in link budget.

Companies are invited to input views on this aspect.

|  |  |
| --- | --- |
| Company | Comment |
| CATT | Support FL’s proposal |
| ZTE | Support the proposal. |
| Intel | We are fine with FL’s proposal. |

## [L] Open issue No.6 – Target throughput for Suburban scenario

For link level simulations, the following agreement on the target throughput was made during RAN1 #101-e.

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)

Both DL and UL target throughput values sur Suburban scenario was left as FFS. Only one contribution submitted to AI 8.8.1.2 consider different values [12]. The following tentative proposal is made:

**Moderator’s proposal**

* Confirm the target throughput values of the REL-17 SID for the suburban scenario:
  + DL: 1 Mbps, UL: 50 kbps

Companies are invited to input views on this proposal/aspect.

|  |  |
| --- | --- |
| Company | Comment |
| CATT | Support FL’s proposal |
| ZTE | Support the proposal. |
| Intel | We are fine with FL’s proposal. |

## [L] Open issue No.7 – Repetition type B for PUSCH

For link level simulations, the following agreement on PUSCH repetitions was made during RAN1 #101-e.

|  |  |
| --- | --- |
| 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 use Repetition type B [4], because no performance benefit is foreseen.

Companies are invited to input views on the necessity of repetition type B. Moderator’s proposal will be made based on companies’ inputs.

|  |  |
| --- | --- |
| Company | Comment |
| CATT | We don’t think PUSCH type B is a typical case for coverage enhancement. PUSCH repetition type B pursues low latency instead of better coverage. |
| ZTE | The PUSCH duration is assumed 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. For enhancement, of course both repetition Type A and Type B could be considered. |
| 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. |
| 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. |

## [L] Open issue No.8 – CP-OFDM for PUSCH

For link level simulations, the following agreement on the waveform to consider for PUSCH (and PDSCH) was made during RAN1 #101-e.

Agreements:

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

|  |  |
| --- | --- |
| Waveform | DFT-s-OFDM for PUSCH, CP-OFDM for PDSCH  FFS: CP-OFDM for PUSCH |

No contribution considered CP-OFDM for the evaluation, thus the following tentative proposal is made.

**Moderator’s proposal**

* Study performance of PUSCH in FR2 only for DFT-s-OFDM.

Companies are invited to input views on this proposal/aspect.

|  |  |
| --- | --- |
| Company | Comment |
| CATT | Support FL’s proposal |
| ZTE | Fine with the proposal. |
| Intel | We are fine with FL’s proposal. |

## [L] Open issue No.9 – Msg1 missed detection probability

For link level simulations, the following agreement on the BLER target for PRACH was made during RAN1 #101-e.

|  |  |
| --- | --- |
| Performance metric | 0.1% false alarm, 1% miss-detection  FFS: 10% missed detection. |

Of all the contributions studying this aspect, only one considers both 1% and 10% missed detection probability [12]. All others consider 1%. The following tentative proposal is made.

**Moderator’s proposal**

* Study performance of PRACH for msg1 for 1% missed detection probability only.

Companies are invited to input their views on this proposal/aspect.

|  |  |
| --- | --- |
| Company | Comment |
| CATT | Support FL’s proposal |
| ZTE | Support the proposal. |
| Intel | We are fine with FL’s proposal. |

## [L] Open issue No.10 – Target BLER for CSI feedback over PUCCH

For link level simulations, the following agreement on the BLER target for CSI feedback over PUCCH was made during RAN1 #101-e.

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

Of all the contributions presenting performance analysis of CSI feedback over PUCCH, only one considers 10% BLER value for CSI feedback over PUCCH [12]. The following tentative proposal is made.

**Moderator’s proposal**

* Study performance of CSI feedback over PUCCH in FR2 only for 1% BLER.

Companies are invited to input views on this proposal/aspect.

|  |  |
| --- | --- |
| Company | Comment |
| CATT | Don’t see the necessity to simulate CSI individually considering we already simulate both 11 bits UCI and 22 bits UCI. Maybe proponents can provide more information. |
| ZTE | Share with CATT. |
| Intel | We prefer 1% for CSI on PUCCH. |

## [L] Open issue No.11 – Target BLER for PDCCH

For link level simulations, the following agreement on the BLER target for PDCCH was made during RAN1 #101-e.

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

One contribution considers this aspect and proposes not to consider 10% BLER for PDCCH [4]. Companies are invited to input their views on this aspect. Moderator’s proposal will be made based on companies’ inputs.

|  |  |
| --- | --- |
| Company | Comment |
| 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. |
| Intel | We don’t see the need of 10% BLER for PDCCH performance evaluation. The FFS should be removed. |

# Other issues related to evaluations

## [M] Downlink Tx power

Three contributions proposed values for DL Tx power in FR2 scenarios.

* 40 dBm for Urban and Suburban [1].
* The total transmit power for DL channels is based on the occupied BW and power spectrum density. PSD of 36 dBm/MHz for urban/suburban and 23 dBm/MHz for indoor scenario [4].
* 26 dBm for all scenarios in FR2 [13].

This is a new issue. Companies are encouraged to share views on these proposals. Moderator’s proposal will be made based on companies’ inputs.

|  |  |
| --- | --- |
| 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 | The PSD for DL should be decided because the actual DL transmission power is based on the occupied BW and PSD.  After a further check, we prefer to reuse the values defined in TR 38.802. That is 40 dBm per 80MHz for urban/suburban and 23 dBm per 80MHz for indoor. |
| NTT DOCOMO | We support to use 26 dBm based on ITU-R assumptions. |
| 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 the system bandwidth. |

## [M] Uplink Tx power

Three contributions proposed values for UL Tx power in FR2 scenarios.

* 16 dBm for all scenarios in FR2 (EIRP of 26 dBm) [1].
* UE transmission EIRP is 22.24 dBm [3].
* 22 dBm for all scenarios in FR2 [13].

This is a new issue. Companies are encouraged to share views on these proposals. Moderator’s proposal will be made based on companies’ inputs.

|  |  |
| --- | --- |
| Company | Comment |
| ZTE | Prefer 23 dBm as defined in TR 38.802. |
| NTT DOCOMO | We support to use 22 dBm based on ITU-R assumptions. |
| Intel | We prefer 23dBm for uplink Tx power. |

## [L] Shadow fading margin

Two contributions proposed values of shadow fading for FR2 scenarios which can be summarized as follows.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Indoor hotspot | Urban Macro | Suburban |
| [1] | 5.2 dB | O2O: 4.85 dB  O2I: 6.41 | O2O: 6.61  O2I: 6.3 |
| [6] | * For 95% ACR: 2.96 dB (LOS) & 8.5 dB(NLOS) * For 90% ACR: 1.69 dB (LOS) & 5.17 dB (NLOS) | * For 95% ACR: 9.04 dB (O2I) & 6.11 dB (O2O, LOS) & 8.03 dB (O2O NLOS) * For 90% ACR: 5.6 dB (O2I) & 3.36 dB (O2O, LOS) & 4.79 dB (O2O NLOS) |  |

Companies are invited to provide initial views on these proposals. Moderator’s proposal will be made based on companies’ inputs.

|  |  |
| --- | --- |
| Company | Comment |
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## [L] Penetration margin

Three contributions proposed values of penetration margin for FR2 scenarios which can be summarized as follows.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Indoor hotspot | Urban Macro | Suburban |
| [1] | - | 41.55 dB (derived according to high loss model defined in TS 38.901) | 41.55 dB (derived according to high loss model defined in TS 38.90) |
| [6] | 0 dB | 26.02 dB (O2I) & 9 dB (O2O) |  |
| [4] | 0 dB | 17.83 dB (high loss)/37.95 dB (low loss)/27.89 dB (50% high + 50% low loss) |  |

Companies are invited to provide initial views on these proposals. Moderator’s proposal will be made based on companies’ inputs.

|  |  |  |  |
| --- | --- | --- | --- |
| Company | | Comment | |
| CATT | | The penetration calculation depends on the distribution of UE, 41.55dB may be the most pessimistic UE distribution, i.e. all the UEs are indoor. Maybe a moderate UE distribution can be used for calculating the penetration margin. | |
| ZTE | We suggest using the models defined in TR 38.901. Assuming  is a uniformly distributed variable between 0 and 25 m, the values for different models are updated as follows. Note that,  is not considered in the values captured above from [4], therefore we update here.   |  |  |  | | --- | --- | --- | | Urban/Suburban | | | | High | Low | 50% High +50% Low  (A direct average in dB) | | 44.2 | 24.08 | 34.14 | | |
|  | |  | |
|  | |  | |
|  | |  | |
|  | |  | |

## [L] Simulation assumptions for SLS based evaluation

SLS based evaluation has been agreed as an optional method for coverage analysis. The detailed simulation assumptions are provided by one company [18].

Table 2 SLS specific parameters

|  |  |
| --- | --- |
| Parameters | Urban/Indoor scenario for FR2 |
| Layout | Urban: Single layer - Macro layer: Hex. Grid  Indoor: 12BSs per 120m x 50m |
| Channel model | UMa in TR 38.901  Indoor-office in TR 38.901 |
| Min distance of UE2gNB | 35m for urban  0m for indoor |

The following was proposed:

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

**Comment from the Moderator:** In RAN1#101-e, it was noted that “[…] the simulation assumptions for SLS are up to companies’ reports”. Given that SLS is not supported by the majority as a tool for coverage analysis, determining simulation assumptions for SLS does not seem a paramount step to take in the study. Therefore, the following tentative moderator proposal is made.

**Moderator’s proposal:**

* Simulation assumptions for SLS are up to companies’ reports, i.e. no more clarification is needed, as per agreement during RAN1#101-e.

Companies are invited to provide views on this proposal/aspect.

|  |  |
| --- | --- |
| Company | Comment |
| CATT | Support FL’s 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. |
| Intel | We are fine with FL’s proposal. |

## [L] Others

Additional proposals related to evaluations have been made in [12].

* **(Item 1) Beamforming implementation constraints**
  + Constraints imposed by certain beamforming implementation, such as the possibility to simultaneously receive or transmit with maximum gain in more than one direction, should be neglected as a starting point.
* **(Item 2) Phase noise models and compensation algorithms**
  + PTRS overhead and compensation algorithms should be neglected.

Companies are invited to input views on items 1 and 2.

|  |  |
| --- | --- |
| Company | Comment |
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|  |  |

# Updated link budget analyses

Companies have updated the link budget analyses. Results can be summarized in the following table (ISD value for which bottleneck is identified, when applicable, is included for the sake of completeness).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | PUSCH | | PDSCH | PUCCH | PDCCH |
| eMBB | VoIP |  |  |  |
| Suburban NLOS | O2I | **(5)** Huawei/HiSilicon (1732m ISD), OPPO (500m ISD), Samsung (400m ISD), Ericsson | **(1)** OPPO (500m ISD) | **(4)** Huawei/HiSilicon (1732m ISD), Samsung (400m ISD), Ericsson | **(2)** OPPO (500m ISD), Samsung (400m ISD) | **(1)** Samsung (400m ISD) |
| O2O | **(6)** Huawei/HiSilicon (1732m ISD), CATT, Intel, Ericsson, Qualcomm |  | **(3)** Huawei/HiSilicon (1732m ISD), Ericsson | **(1)** Samsung (400m ISD) | **(1)** Qualcomm (broadcast PDCCH) |
| Urban  NLOS | O2I | **(10)** Huawei/HiSilicon (400/500m ISD), vivo, ZTE (200m ISD), OPPO (500m ISD), Samsung (150m ISD), CMCC, Ericsson, Nokia/NSB | **(1)** OPPO (500m ISD) | **(4)** Huawei/HiSilicon (400/500m ISD), Ericsson, NTT DOCOMO | **(5)** vivo, ZTE (200m ISD), OPPO (500m ISD), Samsung (150m ISD), NTT DOCOMO |  |
| O2O | **(13)** Huawei/HiSilicon (400/500m ISD), vivo, ZTE (200m ISD), CATT, Intel, OPPO (500m ISD), Samsung (150m ISD), Ericsson, NTT DOCOMO, Qualcomm, Nokia/NSB |  | **(2)** Ericsson, NTT DOCOMO | **(3)** vivo, ZTE (200m ISD), NTT DOCOMO | **(1)** Qualcomm (broadcast PDCCH) |
| Indoor | | **(2)** Intel, Qualcomm |  |  |  | **(1)** Qualcomm (broadcast PDCCH) |

In addition, one contribution states that RACH procedure in FR2 (including Msg1, Msg2 and Msg3) should be enhanced [14].

**Comment from the moderator:** Performance metrics have not been agreed yet. Some open issues are also to be addressed. For these reasons, further detailed comments on the performance analyses reported by companies are not reported and can be found in the corresponding contributions. Having said this, it can be observed that at least PUSCH is labelled as bottleneck in most of the considered scenarios and propagation conditions.

Companies are encouraged to check the summary and provide additional views to the following table, if any:

|  |  |
| --- | --- |
| Company | Comment |
|  |  |
|  |  |
|  |  |

# Summary of the proposals on high priority items

To be populated later.

# Summary of the proposals on medium priority items

To be populated later.

# Summary of the proposals on lower priority items

To be populated later.

# Summary of RAN1 #102-e agreements for AI 8.8.1.2

To be populated later.

# References

1. R1-2005257, Evaluation on the baseline performance for FR2, Huawei/HiSilicon
2. R1-2005298, Baseline coverage evaluation of UL and DL channels – FR2, Nokia, Nokia Shanghai Bell
3. R1-2005394, Evaluation on NR coverage performance for FR2, vivo
4. R1-2005426, Discussion on baseline coverage performance for FR2, ZTE
5. R1-2005490, Evaluation on NR coverage performance for FR2, China Unicom
6. R1-2005723, Baseline coverage performance for FR2, CATT
7. R1-2005888, Discussion on baseline coverage performance for FR2, Intel Corporation
8. R1-2006046, Evaluation on NR coverage performance for FR2, OPPO
9. R1-2006161, Baseline coverage performance using LLS for FR2, Samsung
10. R1-2006225, Discussion on the baseline performance in FR2, CMCC
11. R1-2006244, FR2 baseline coverage performance using LLS, InterDigital, Inc.
12. R1-2006612, Link and System Evaluation of Coverage for FR2, Ericsson
13. R1-2006740, Baseline coverage performance for FR2, NTT DOCOMO, INC.
14. R1-2006819, Baseline FR2 coverage performance, Qualcomm Incorporated
15. R1-2005259, Discussions on simulation assumptions for VoIP, Huawei/HiSilicon
16. R1-2005303, Evaluation assumptions for NR coverage enhancement evaluation, Nokia/Nokia Shanghai Bell
17. R1-2005398, Considerations on Evaluation Assumptions for Coverage Enhancements, vivo
18. R1-2005430, Discussion on evaluation methodology for NR coverage, ZTE
19. R1-2005727, Discussion on the methodology for baseline coverage performance using LLS, CATT
20. R1-2005733, Remaining issues on evaluation methodology for NR coverage enhancements, China Telecom
21. R1-2005892, Discussion on simulation assumptions for NR coverage enhancement, Intel Corporation
22. R1-2006050, Functionality of Coverage Enhancement and other SI/WI, OPPO
23. R1-2006293, Reducing PDCCH load of coverage-limited UEs, InterDigital, Inc.
24. R1-2006616, Evaluation methodology for coverage enhancements, Ericsson
25. R1-2006823, Other coverage enhancement aspects, Qualcomm Incorporated

# Annex – Agreements made during 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 4GHz  DDDSUDDSUU (S: 10D:2G:2U) only for 4GHz  DDDDDDDSUU (S: 6D:4G:4U) only for 2.6GHz  Other frame structures can be reported by companies. |
| Pathloss model (select from LoS or NLoS) | Urban: NLoS  Rural: NLoS and LoS |
| BWP | 100MHz for 4GHz and 2.6GHz.  20MHz for 2GHz (FDD  20MHz (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 indoor  Rural: 3km/h for indoor, 120km/h (optional 30km/h) for outdoor |
| Frequency hopping | w/ or w/o ~~Intra-slot~~ frequency hopping for PUSCH  w/ 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:///C:\Users\maso\AppData\Local\Microsoft\Windows\INetCache\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/h  Urban 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: 300ns  Rural: 300ns  Rural 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% 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 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 probability  FFS: 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 PDSCH  FFS: 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 | 2  Note: 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: 30ns  Urban scenario: 100ns  Suburban 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/PUSCH  Optional: 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 UCI  FFS: 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 symbols  FFS: 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-detection  FFS: 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.