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

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

**Source: Moderator (SoftBank)**

**Title: [102-e-Post-NR-CovEnh-02] Summary on email discussion/approval of Phase 1 - link budget template**

**Agenda Item: 8.8.1.1**

**Document for: Information**

# Introduction

This paper aims at the completion of link budget template used for SI – NR coverage enhancement.

 [102-e-Post-NR-CovEnh-02] Email discussion/approval of link budget template, initial collection of simulation results for baseline and enhancements - Yosuke (Softbank)/Marco (Nokia)/Jianchi (CT)/Yi (Qualcomm)/Xianghui(ZTE)

· Phase 1 (9/10 to 9/29): link budget template

· Phase 2 (9/30 to 10/14): initial collection of simulation results for baseline

· Phase 3: (10/12 to 10/21): initial collection of simulation results for enhancements

This email discussion is composed of 3 rounds of email exchanges.

* 1st round (Initial collection of companies view) … 9/18 – **12:00 UTC of 9/23**
* 2nd round (Provision of FL proposals and fine-tuning) … 9/23 - 9/28
* 3rd round (Final proposal) … 9/29 at the latest

# Open issues

## Update of link budget template based on IMT-2020 self-evaluation

The updated link budget template based on IM-2020 is available in the server.

<https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.8.1.1/post_meeting/102-e-Post-NR-CovEnh-02/1-link_budget_template/1st_round>

Companies are encouraged to check it. Comment to each row should be provided in the excel sheet directly. General comment can be provided below.

|  |  |
| --- | --- |
| Company | Comment |
| Huawei , Hisilicon | Support the updated link budget template based on IMT-2020 and have the following suggestions,  Firstly, regarding notes in (2)(2a)(10a)(10b), we prefer to follow previous agreements and keep the terminology of   * transmit TxRUs in (2) * transmit chains in (2a) * receive TxRUs in (10a) * receive chains in (10b)     As a result, we suggest to remove the corresponding notes from the template, i.e. “Note: RAN1 needs to decide which wording is better, "transmit chains" or "transmit TxRUs"”  Secondly, we prefer the terminology in the template is well defined by the template itself. Regarding the note “Note: delta2 for downlink and delta3 for uplink” in (4b) and (11b), suggest to remove it because the note does not provide additional value but causes unnecessary confusion by introducing terms that have not been defined in the template. Delta2 and Delta3 have both been named by “antenna gain correction factor” in the template. Similarly, the Note about delta1 in (5b) and (11bis-b) are redundant.  Thirdly, regarding the notes “*Note: void (=zero) for uplink*” for (5a) and (5), *“(4c) + 10 log ( (1) / (2a) ) (dB) for uplink*” in (4a) and “*this row is void (empty) for uplink*” in (2), they are correct but spreading out multiple rows and thus seems to create different branches for companies to enter inputs into the template which makes the template unfriendly. The template can be more concise by a single equivalent note in (2) saying “It is equal to (2a) for uplink”, so that those notes above can be replaced and a generic description for both uplink and downlink can be achieved for the rows (5a), (5) and (4a). Similarly, the same benefit for rows (11a), (11bis-a), (11bis) and (10a). Just a suggestion.  Regarding MCL in (30a) and (30b), it is OK to include (11bis).  Regarding (16a) and (16b), as commented in first email thread, it is incorrect to include (12) here. Value (12) should be included by (23a) and (23b). |
|  | We’ll comment here rather than in the template for brevity’s sake.  Regarding (2), ((2a), (10a), and (10b), TxRU means 'transmit-receive unit', and this only applies when the number of transmit chains is equal to the number of receive chains. UEs typically have more receive chains than transmit chains, so 'transmit chains' is appropriate for the general case.  Agree with Huawei that the notes with references to Delta reduce the readability of the template, but think we should keep them as is for our reference for now. The full agreements (like the values that Delta1, Delta2, and Delta3 take on) are not fully reflected in the spreadsheet, and it is easier to relate the proposed template to the agreements with the notes. Once the template is finalized, we can clean up the Delta value terminology if needed at that time.  Regarding (16a), (16b), (29a), and (29b) we are OK with FL proposal to have (12) in (23a) and (23b) instead.  Regarding (30a/b), since we have antenna gain component 2 for downlink at gNB, we would need it for uplink as well. So we think (11bis) should be added in (30a/b).  If they are not captured by tabs in the spreadsheet, we may need some additional cells containing high level parameters such as scenario, carrier frequency, and TDD frame structure.  A row should be added identifying which channel is simulated.  Do we need the base station and UE antenna height rows? Since only a few different values will be used according to the scenario, these seem better to capture as part of a scenario definition saved somewhere else.  For us, it seems redundant and a bit confusing to have control and data on separate rows of the same columns, when each column should refer to a channel, and so only the data or control rows will be used for that column. Data and control will have different values for e.g. total antenna gain, and so will need different columns anyway. Can we instead just have each column adjusted according to if it is data or control? Then we would merge (6) and (7) into something like ‘Control channel boosting or Data channel power loss’ (noting that most companies anyway will likely set these to zero). Rows like (3bis-a/b), (9a/b), (15a/b), etc. will then all be merged.  Suggest to add a cell to captured detailed assumptions since we have quite a few possibilities, e.g.   * CDL vs. TDL * Correlation value * Frequency hopping or not * #PRBs * Etc.   How antenna gain correction values are derived (system sims, some analytical approach, etc.) should also be captured/referenced in a cell somewhere.  I may miss some fine tuning here, but this may be best addressed in a later round of discussion anyway. |
| Intel | General comment: it would be good to clarify that “note” in some rows in link budget template would be removed or kept after the discussion?  Some detailed comments for some rows:  We share similar view as Huawei that terminologies in (2)(2a)(10a)(10b) should follow the agreements on the block diagram for the definition of antenna array gain. For instance, N is number of transmit TxRUs, k is number of transmit chains and M is number of transmit antenna elements.  Further, the following changes are needed to align the agreements:   1. Number of transmit antenna elements.   (10) Number of receive antenna elements  In addition, our understanding is that (3bis-a) and (3bis-b) are only calculated for downlink control/data channel transmission. For uplink control/data channel transmission, we may not need to include the row (3b) for calculation of power spectrum density. Note that we only had agreements to the PSD values for DL transmission but not for UL transmission. It is good to clarify this.  Regarding MCL, based on agreement as captured below:   * Further clarify the Definition of MCL for downlink   + Total transmit power – Receiver sensitivity + gNB antenna gain (component 2), where     - Total transmit power corresponds to row No.(3) + {(6) or -(7)} (for control & data channels)     - Receiver sensitivity corresponds to row No.(22a/22b)   According to the agreement, receiver antenna gain is not included in MCL. We support not to include (11bis) in MCL. |
| CATT | In general, we are fine with the proposed R17 template. We have following two comments on terminology issues and the definition of MCL:   1. For notes in (2)(2a)(10a)(10b), we share the same views as HW that the terminology defined in the previous agreements should be respected.   2. For MCL in (30a) and (30b), we are fine with including (11bis) although it is a step further with the current definition agreed in the last meeting. However, the current wording is a bit confusing with bracket and question mark. We think clear definition should be pursued at such a late stage. Hence we propose either to keep the current MCL definition (i.e. not include 11bis) or update the MCL definition with including (11bis) (i.e. removing the bracket and question mark followed 11bis). |
| China Telecom | We support FL’s updated template basically with some clarifications.  Regarding the wording of (2) (2a) (10a) (10b), just use “transmit chains” may bring misunderstanding on (2) and (2a), (10a) and (10b) as well. This template is applied for both UL and DL. Thus, the wording is “transmitter” and “receiver”, not “gNB” and “UE”. In order to achieve alignment with the previous agreements, we prefer to keep the contents as:   * transmit antenna elements in (1) * transmit TxRUs in (2) * transmit chains in (2a) * receive antenna elements in (10) * receive TxRUs in (10a) * receive chains in (10b)   Since the definition of antenna gain is well descripted in the agreements which would be captured in Section 4 “Evaluation methodology” in TR 38.830, we think the notes for Delta are just for reference under this email discussion. It may be a little redundant for the finalized template version.  In order to distinguish different cases for different channels, some detailed and necessary descriptions are needed, e.g. adding a cell/row as Ericsson suggested.  The base station and UE antenna height rows are used for path loss formula to calculate coverage distance. Different scenarios have different values for BS and UE antenna heights, so we prefer to keep them for companies’ report for MPL related calculation. |
| ZTE | Regarding (2)(2a)(10a)(10b), we prefer the wording as provided by China Telecom above.    Regarding (16a)(16b)(29a) (29b), we agree with FL’s suggestion.  About (30a)(30b), we think component 2 at receiver side should be included in MCL, i.e., including (11bis) in (30a)(30b). Because, component 2, no matter at transmitter side or receiver side, has direct impacts on the required SNR, and we should keep the same principle for both DL and UL.  Following are some general comments from us.   1. For now, we have introduced three correction factors for antenna gain. In the template, we use the same terminology, i.e., delta1~3, for both DL and UL. While, it should be clarified that the detailed values for these correction factors could be different between DL and UL depending on the scenarios.   ***gNB antenna gain:***  *Component 2 = 10 \* log 10( N/k ) - Δ1.*  *Components 3 and 4 = Antenna Element Gain + 10 \* log 10( M/N ) -Δ2*  ***UE antenna gain:***  *Components 3 and 4 = Antenna Element Gain + 10 \* log 10( M/k ) -Δ3*   1. For FR2, a unified beamforming gain across transmitter and receiver may be obtained via SLS. It means the correction of the beamforming gain is a summation of delta2 and delta3. In other words, it should be allowed for companies to report the overall correction into one of the delta, e.g., delat2 while making the other delta, e.g., delta3, as zero. Similarly, for some of scenarios in FR1, companies could report a joint antenna gain correction into one of Δ1 and Δ2 while leaving the left one as zero. Take Urban at 4GHz for instance, network may jointly use all the antenna elements per RF chain to form the DL broadcast beams, e.g., 48 elements per RF chain in case of a total of 4 RF chains. In such case, the correction is a summation of delta1 and delta2. |
| Qualcomm | Let us go with transmit chains and receive chains. TxRUs gets confusing to use, especially on UE side.  Regarding 3(b), BWs can be different as well. We’ll need to account for this.  11bis should not be added as part of MCL. This is not in line with the agreements as well.  Can 17a and 17b be specified further upfront? Some level of reorganization of the parameters involved might help to make the template easier to follow.  Just as in the agreements, can we structure the template so that MCL is computed first, then used as a basis to compute MIL, followed by MPL? I see that this is already done for MIL to MPL, will be good to have the same for MCL to MIL.  Okay to have a separate sheet for system config/parameters. No need to mix it up with link budget template --- will be good to have this concise. |

# References

[1] RAN1 Chairman’s Notes of RAN1#102-e

# Annex 1 – 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 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:///D:\2020年度工作\RAN1%23102\during%20the%20meeting\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.

# Annex 2 – Agreements at RAN1#102e

Agreements:

* TDL models are used to generate results in the link budget templates for FR1
  + This does not preclude companies from performing the link-level simulations using CDL

Agreements (for both FR1 & FR2):

* For the definition of antenna array gain, adopt option 1, i.e. Antenna array gain is included in the link budget template, where there are four antenna gain components
  + Note: the four components are illustrated below – the figure is for illustration purpose only
  + FFS which component(s) are NOT part of the definition of antenna array gain
* 

Agreements:

* For TDL Option 1
  + Definition of MCL
    - Total transmit power - Receiver sensitivity + gNB antenna gain (component 2)
  + Definition of MIL
    - Total transmit power - Receiver sensitivity + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain
  + Definition of MPL
    - Further discussion offline the definition using below as a starting point:
      * 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)
  + Note: whether/how to use the above definitions is to be discussed

Update on 8/20: to check on 8/21

Update on 8/21: to check on 8/24

Update from GTW on 8/24

Agreements:

* Adopt single link budget template for both FR1 and FR2 based on IMT-2020 self-evaluation with rows for MIL, MCL, MPL, and necessary revisions, including adding/removing/revising/simplifying some parameters
  + [For LLS based methodology, ]coverage bottleneck(s) identification is performed using at least [MCL and] MIL.
  + [MCL values can also be considered to compare channels with similar antenna (and antenna array) gain]

Agreements:

* MPL can be used as supplemental information for coverage bottleneck(s) identification
* The results based on MPL are to be captured in TR
  + Note: this is uself to show the achievable ISD.
* The definition of MPL shall be determined in RAN1
* RAN1 will not further discuss on specific values for the parameters related to MPL
  + IMT-2020 values are as a starting point, but:
    - companies may use other values, and
    - for the parameters that companies think IMT-2020 self-evaluation does not clearly define the values for some scenarios, it is up to companies to report

Agreements:

* RAN1 strives for satisfying appropriate targets identified by companies particularly operators
  + The targets may be in the form of one or more of the following:
    - 1. Scenario dependent targets, e.g., ISD/MPL
    - 2. Service dependent targets, e.g., [MCL=147] dB for VoIP;
    - 3. Relative difference between channels, e.g, MIL(/[MCL])
  + Further values and details of such targets will be clarified at RAN1#103-e
  + Note: there is no intention in RAN1 to update the study item objectives due to the identified targets.

Agreements:

* Adopt single link budget template for both FR1 and FR2 based on IMT-2020 self-evaluation with rows for MIL, MCL, MPL, and necessary revisions, including adding/removing/revising/simplifying some parameters
  + For LLS based methodology, coverage bottleneck(s) identification is performed using at least MIL or MCL (assuming the set of simuation assumptions)
    - Even when SLS is used to obtain some components of MIL or MCL, it is categorized as LLS based methodology.
    - MCL values can also be used to identify the coverage bottleneck(s) when applicable
      * “applicable” above means the following situation:
        + [comparing channels with similar antenna (and antenna array) gain, and/or
        + the simulation results with MIL from companies are diverse, and the comparison with MIL is not easy]

Update on 8/27:

Agreements:

* for SIP invite message
  + Payload of 1500 bytes can be a starting point.
  + The assumptions (TB size, time period etc.) are reported by companies.
  + Contributions R1-2003464 and [R1-2005259](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2005259.zip) are taken into account for the evaluation.
    - In addition, 1 second time period can also be considered.

Agreements:

For PDSCH, other parameters are reported by companies.

Agreements:

* Confirm the working assumption on DMRS configuration for PUSCH:
  + For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.
* The number of DMRS symbols is reported by companies

Agreements:

* Update the description on Repetitions for PUSCH as follows:
  + For VoIP, w/ type A repetition. (optional for type B repetition)  
    The actual number of repetitions is reported by companies.  
    ~~FFS: Repetition type B~~

Agreements:

* Update the row for BLER for PUCCH as follows:
  + ~~FFS:~~ BLER for CSI (~~10% or~~ 1%, (optional for 10%) )

Agreements:

|  |  |
| --- | --- |
| Number of TxRUs for BS | gNB modelling in LLS for TDL:   * ~~Option 1:~~ 2 or 4 gNB receive chains in LLS. ~~FFS:~~ * Optional ~~Option 2~~: Number of gNB receive chains = number of TXRUs in LLS~~. FFS: correlation.~~ * Companies can report if and how correlation is modelled |

Agreements:

* Remove the whole bullets about gNB architectures to study for CDL and gNB modelling in LLS for CDL
* Note: if CDL is used for link level simulation for a certain purpose, the assumption for the number of TxRUs for BS is reported by companies, which implies that the assumption will be captured in the TR.

Agreements:

* The same PDSCH duration as PDSCH is used for Msg.4 PDSCH (i.e. remove the square bracket)
  + Note: this does not preclude Msg4 with retransmission as a baseline.

Agreements:

* Update the BLER for PDCCH as follows:

|  |  |
| --- | --- |
| BLER for PDCCH | 1% BLER  ~~FFS:~~ (optional for 10% BLER) |

Agreements:

* The agreement at RAN1#101-e remains: the simulation assumptions for SLS are up to companies’ reports
* The target performance of SLS based methodology, it is recommended to refer the agreements for LLS based methodology as much as possible.
* Note: these proposals are not necessary to be captured in the chairman’s note.

Update from 8/28 GTW

Agreements:

Update the agreements as follows:

* For VoIP performance evaluation based on link-level simulation for FR1

A packet size of ~~[~~320bits~~]~~ with 20ms data arriving interval is adopted, ~~which component is as follows~~:

|  |  |
| --- | --- |
|  | Size (bits) |
| Payload | 256 |
| 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 | 24 (w RoHC) |
|  |  |

~~­      The following packet component for AMR-WB 12.65 (kbit/s) is optionally adopted.~~

|  |  |
| --- | --- |
|  | ~~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)~~ |
|  |  |

~~­      [A packet size of 160 bits with 20ms data arriving interval is optionally adopted for rural scenario with long distance]~~

­      If applicable, companies report TB size assumed in evaluation

Agreements:

* For the evualation, it is assumed that Msg. 4 PDSCH payload size is 1040 bits.

Agreements:

* For receiver interference density
  + Up to each company to report for all scenarios as baseline
    - E.g. obtained by SLS, the ones for ITU self-evulation, etc.

Agreements:

Further clarify the agreement on antenna gain and antenna gain components including antenna gain correction factors as follows:

* For both TDL option 1 (table A below) and TDL option 2 & CDL (table B below)
  + The gain of antenna gain component 1 is included in LLS results
  + The gain of antenna gain component 2 is included in link budget template
    - The gain is expressed by 10 \* log 10( N/k ) - Δ1
    - For TDL option 2 & CDL, the gain is 0 dB
  + The gain of antenna gain component 3 is included in link budget template
  + The gain of antenna gain component 4 is included in link budget template
    - The gain of antenna gain components 3 and 4 is expressed by Antenna Element Gain + 10 \* log 10( M/N ) -Δ2
    - For Tx, One row is used represent the gain of antenna gain component 3 + 4, i.e. row No. (4)
    - For Rx, One row is used represent the gain of antenna gain component 3 + 4, i.e. row No. (11)
    - Note: more appropriate name or explanation will be added to row No.(4) and (11). Details can be discussed when the link budget template is updated.

Agreements:

* Define PSD for DL Tx power, which is depend on deployment scenario
  + For 4GHz frequency,
    - For rural with long distance scenario, PSD is 24 and 33 dBm/MHz
    - For rural scenario, PSD is 24 and 33 dBm/MHz
    - For urban scenario, PSD is 24 and 33 dBm/MHz
  + For 2.6 GHz frequency,
    - For rural with long distance scenario, PSD is 33 dBm/MHz
    - For rural scenario, PSD is 33 dBm/MHz
    - For urban scenario, PSD is 33 dBm/MHz
  + For 700MHz, 2GHz frequency
    - For rural with long distance scenario, PSD is 36 dBm/MHz
    - For rural scenario, PSD is 36 dBm/MHz
    - For urban scenario, PSD is 36 dBm/MHz
* Modify the description of row(s) of link budget template:
  + Keep the meaning of Total transmit power (row (3) ) and adding a new row (3 bis):
    - (3bis) means the transmit power for occupied channel bandwidth for control channel (17a) or data channel (17b)
* Companies are requested to set appropriate values for parameters, which is used to determine total transmit power ( row (3) and/or (3bis) ), to satisfy the PSD value above
* Note: RAN1 will further check the consistency of the definition of row(s) in link budget table when the IMT-2020 based link budget tale is updated

Agreements:

For FR1 and FR2:

* Further clarify the Definition of MCL for downlink
  + Total transmit power – Receiver sensitivity + gNB antenna gain (component 2), where
    - Total transmit power corresponds to row No.(3) + {(6) or -(7)} (for control & data channels)
    - Receiver sensitivity corresponds to row No.(22a/22b)
* Further clarify the Definition of MIL for downlink
  + Total transmit power – Receiver sensitivity + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain, where
    - Total transmit power + gNB antenna gain (component 2 + 3 + 4) corresponds to row No.(9a/9b), i.e.
      * (3) + (4) + (5) + (6) – (8) for control channel
      * (3) + (4) + (5) – (7) – (8) for data channel
      * Note: the derivation of (9a/9b) will be modified depending on the discussion on antenna gain & antenna gain correction
    - Receiver sensitivity corresponds to row No.(22a/22b)
    - (Working assumption for FR2) UE antenna gain corresponds to row No.(11)+No(11bis)
* Note: further refinement/definition of (3) and/or (22a/22b) can be discussed when link budget table is updated.

Agreements:

Definition of MPL for TDL option 1

* MPL = MIL + [(21a/b) H-ARQ gain] – [ (25a/b) Shadow fading margin – (27) Penetration margin ] + [(26) BS selection/macro-diversity gain ] + [(28) Other gains] – [(12) Cable, connector, combiner, body losses (Rx side) ]
* Note1: (8) is not necessary because it is included in the definition of MIL
* Note2: (20) is not necessary because it is included in receiver sensitivity, which is used to derive MIL

Update on 8/28:

Agreements:

·         As for the agreement on antenna gain and antenna gain components including antenna gain correction factors, Table A and Table B are defined as below



Table A. antenna gain components for TDL option 1



Table B. antenna gain components for TDL option 2 and CDL

Agreements:

* Latency requirements assumed in VoIP evaluation for TDD and FDD are reported by companies

Agreements:

* For link level simulations in FR2, only PUCCH format 1 and format 3 are considered for baseline performance evaluation.
* For link level simulations in FR2, only PUCCH duration of 14 OFDM symbols is considered for baseline performance evaluation.
* For link level simulations in FR2, consider 4 DMRS symbol for PUCCH Format 3.
* Consider only one panel at the UE in link budget in FR2.
* For link budget calculation in FR2, downlink transmit power is scaled by the occupied bandwidth. The following downlink transmit power vs occupied bandwidth values are considered as baseline for the calculations:
  + 40 dBm for 100 MHz Urban scenario,
  + 23 dBm for 100 MHz Indoor scenario.
* For link budget calculation in FR2, an uplink transmit power of 23dBm is considered for baseline performance evaluations. Other values can be reported by companies.
* Confirm the target throughput values of the REL-17 SID for the suburban scenario:
  + DL: 1 Mbps, UL: 50 kbps
* Study performance of PUSCH in FR2 only for DFT-s-OFDM.
* For link level simulations, only 1% BLER should be considered for baseline performance evaluation of PDDCH in FR2.
* For link level simulations in FR2, only PUSCH repetition type A is considered for baseline performance evaluation.
  + Note: companies are not precluded to report results for repetition type B.
* Suburban scenario is deprioritized for NR coverage enhancement SI.
* Baseline performance evaluation of msg1 transmission is studied for 1% missed detection probability in FR2.
* Only 1% BLER target should be considered for baseline performance evaluation of PUCCH in FR2, regardless of whether UCI includes CSI feedback or not.
* Simulation assumptions for SLS in FR2 are up to companies’ reports, i.e., no more clarification is needed, as per agreement during RAN1#101-e.

# Annex 3 – Agreements at post-email discussion of RAN1#102e

To be updated after formal agreements are made.

**FL updated proposal:**

* Antenna array gain at a UE for FR1 and FR2 is clarified as follows:
  + The meaning of *k, N* and *M:*
    - is the number of Tx/Rx chains, e.g., number of SRS/CSI-RS ports to be simulated in LLS.
    - is the number of antenna elements used both for transmission and reception, i.e., xpol antenna elements.
    - A formal definition of *N* is not necessary for UE antenna array gain modeling.
  + The values for *k* and the relationship between *k* and *M* are clarified as follows:
    - For FR1, *k* = *M* is assumed for the simulations, and
      * for Tx (optional *k* = 2)
      * for Rx
    - For FR2, there are two possibilities for simulations:
      * ; for Tx and for Rx; or
      * .
  + Antenna array gain in transmission/reception to input in link budget template is given by
    - , where
      * is a correction factor to account for various non-idealities impacting the actual antenna array gain, if any
        + For FR1, .
        + For FR2, 3 is channel procedure/dependent, and reported by companies.
* The values for antenna element gain:
  + 0 dBi for FR1
  + 5 dBi for FR2

**FL Proposal:**

* The working assumption for FR2 is updated as follows:
  + UE receive antenna gain ~~corresponds to row~~ is given by row No.(11) + row No. (11bis) -
* UE transmit antenna gain is given by row No. (4) + row No. (5) -

**FL Proposal:**

* The agreement on the definition of MIL for downlink is updated by adding Rx loss as follows:
  + Total transmit power – Receiver sensitivity – Rx loss + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain, where
    - Rx loss corresponds to row No. (12)
* MPL = MIL – (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) ]~~
* It is confirmed that H-ARQ gain is included in sensitivity
  + H-ARQ gain should be included in LLS. In this case, “(21a/b) H-ARQ gain” is set to zero
  + If not, “(21a/b) H-ARQ gain” can be used for companies report
* Note: as per the former agreement, the values for rows (25a/b) (26) (27) (28) and (12) are left to companies’ report, which includes the values for IMT-2020 self evaluation and/or using 0 dB
* Note: (12) Cable, connector, combiner, body losses (Rx side) is not included in MCL, but included in MIL and MPL
* The definition of MCL, MIL and MPL for TDL Option 2 & CDL is the same as that for TDL option 1
* Note: The agreements on MIL, MCL and MPL definition is used to show which components of link budget template are included / not included. The sophistication of MIL, MCL and MPL formula will be discussed under [102-e-Post-NR-CovEnh-02] email discussion by using draft link budget template prepared by the FL.
* Note: Companies are encouraged to further check the values for (12) Rx losses proposed by a company, in addition to the values used for IMT-2020 self-evaluation
  + feeder loss at gNB (1dB for 700MHz, 0dB for 4GHz with AAS)
  + 0dB for the loss at UE