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

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

**Source: Moderator (SoftBank, Nokia)**

**Title: [102-e-Post-NR-CovEnh-01] Summary on email discussion/approval of remaining simulation assumptions**

**Agenda Item: 8.8.1.1 and 8.8.1.2**

**Document for: Information**

# Introduction

This paper summarizes the contributions submitted to A.I 8.8.1.1, 8.8.1.2 (Study on NR coverage enhancement - Baseline coverage performance using LLS – FR1 and FR2) and 8.8.3, which are relevant to simulation assumptions.

[102-e-Post-NR-CovEnh-01] Email discussion/approval of remaining simulation assumptions, including

* antenna array gain modeling for UE
* (Working assumption for FR2) UE antenna gain corresponds to row No.(11)+No(11bis)
* Resolution of square brackets

from 9/7 – 9/17 - Yosuke (Softbank)/Marco (Nokia)

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

* **1st round (Initial collection of companies view) … 9/7 – 12:00 UTC of 9/10**
* 2nd round (Provision of FL proposals and fine-tuning) … 9/11 - 9/16
* 3rd round (Final proposal) … 9/17 at the latest

# Open issues

## Issue No.1 - antenna array gain modeling for UE

At RAN1#102e meeting, the following agreements were made for antenna gain definition:

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:

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:

·         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

**Remaining issue:**

During the GTW session at RAN1#102-e, it was pointed out that the agreements so far don’t cover antenna gain modeling for UE. Thus, additional discussion on this aspect seems to be needed. Note that this is a relevant topic to FR2, while the concept of antenna gain modeling should be common to both FR1 and FR2.

* Antenna array gain modeling for UE:
  + Let *k* be the number of transmit antenna ports and *N* be the number of AEs at UE. With reference to IMT-2020 self-evaluation template, *N* is captured in (1) and *k* in (2). Antenna array gain value (dB) is captured in (5) and:
    - Alt1: it is obtained as 10 \* log 10(*N/k* ) -3. Companies report 3
    - Alt2: it is obtained as 10 \* log 10(N/k ).
    - Alt3: other [proposals are welcome]
  + Transmitter antenna gain at the UE (dBi) is added to LB template, with reference to IMT-2020 self-evaluation template, in (4):
    - Alt1: Companies agree on a specific value, e.g., 5 dBi.
    - Alt2: Companies report assumed value.

Companies are invited provide your view on these issues.

|  |  |
| --- | --- |
| Company | Comment |
| Ericsson | Since one total gain value is probably all that is needed for UE, suggest to follow what was done in the agreement for AGC 3+4:  Antenna Gain = Antenna Element Gain + 10 \* log 10(N/k) - 3  Where companies report 3.  Also, I think N is captured in (1) transmit antennas and k is in (1bis) antenna ports.  **Update**:  Support Alt1 for UE Tx antenna gain with 5 dBi. It will be even harder to align results if a value for UE antenna gain can’t be agreed. |
| Nokia/NSB | Agree with Ericsson. |
| Samsung | Fine with Ericsson’s suggestion with following clarification:  With reference to IMT-2020 self-evaluation template,  N is captured in (1), k is captured in (1bis), and Antenna Element Gain is captured in (4) |
| vivo | We would like to clarify/understand some aspects for this proposal:  Whether the UE array gain modeling in the proposal is common for both DL (Rx antenna) and UL (Tx antenna), and whether it is common for FR1 and FR2?  In FR1, for DL channels, UE may have 4Rx, which means N=k=4, and for UL, only 1 Tx is used, and N=k=1 for UL. Is this understanding correct?  Besides, we would like to clarify which non-ideal factors are supposed to be reflected by 3? According to the discussion in gNB side, 1 and 2 basically reflect the difference in antenna gain for broadcast and unicast, and antenna gain loss caused by tilt angle from the bore-sight direction of gNB panel. These factors are not applicable for FR1 UE, since it is less likely that a FR1 UE perform UL beamforming for UL transmission, and the antenna pattern in FR1 is usually omni-directional in FR1, according to ITU-M.2412. For FR2, the UE antenna is not omni-directional, then is 3 supposed to reflect the antenna gain loss caused by tilt angle from the bore-sight direction of UE panel, which means 3 at UE is similar to 2 at gNB side? |
| Qualcomm | Assuming the above proposal only applies to UE Tx.  We are okay to go with Alt 1 for both array gain and antenna element gain. We prefer to clarify that for FR1, N = 1. For FR2, N can be based on agreements in sub-agenda 8.8.1.2. We are okay to report a single gain that combines antenna element gain and antenna array gain.  Will there be an equivalent proposal for UE Rx? (It is not that important for FR1 but might matter for FR2) |
| Intel | We support Alt. 1 for UE antenna gain. In addition, we share similar view as other companies that k is captured in (1bis).  For the second bullet, transmit antenna gain at the UE (dBi) is already included in the LB template, i.e., in (4). We do not need to add this in the template. For the specific value, we slightly prefer Alt. 1 to align the results among companies. |

## Issue No.2 – UE receive antenna gain corresponds to row No.(11) + No(11bis)

As for MCL, MIL and MPL definition, the following agreements were made ad RAN1#102-e, where there is an working assumption:

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

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

**Remaining issues**

The following working assumption should be resolved:

* (Working assumption for FR2) UE antenna gain corresponds to row No.(11)+No(11bis)

RAN1 needs to discuss whether the same is applied to FR2, or some clarification/modification is necessary. Companies are encouraged to provide their view the two issues above

|  |  |
| --- | --- |
| Company | Comment |
| Ericsson | The working assumption should be modified to allow for 3 in UEs, as discussed in issue 1 of section 2.1  **Update**:  Agree (11) and (11bis) correspond to receive antennas, and support Nokia’s clarification.  Regarding Samsung’s question, our understanding is that the correction factor is reported per channel per configuration. So transmit and receive as well as gNB and UE antenna gain correction factors can be different. That said, we can further check on if the antenna gain correction values can be set to be the same for transmit and receive for FR2 UE. |
| Nokia/NSB | Propose the following modification for this Issue   * Issue 1   + (Working assumption for FR2) UE receive antenna gain corresponds to row No.(11)+No(11bis)   The working assumption should also be modified to allow account for the presence of 3 for the transmit antenna gain of UEs, [Row No. (4)], as discussed in issue 1 of section 2.1. |
| Samsung | Fine with modifying “UE receive antenna gain…”  Since the corresponding agreement is for downlink case, antenna gain correction factor (3) should be for receive antenna not for transmit antenna.  One clarification question – is the antenna gain correction factor the same or not between TX and RX? |
| Qualcomm | Same views as Nokia. |
| Intel | We are fine to modify the proposal to “UE receive antenna gain…”.  We think it is good to include the antenna gain correction factor only in Tx or Rx at gNB and UE side, but not both. |

## Issue No.3 - Resolution of square brackets on Definition of MCL, MIL and MPL

At RAN1#102-e, we clarified the definition of MCL, MIL and MPL for TDL option 1, as captured in section 2.2. However for MPL, we still have many square brackets, for which companies don’t see the strong necessity. In addition, all the related agreements at the meeting are for TDL option 1, and hence we need to agree whether or not the same definition applies to TDL option 2 and CDL, as well.

**Open issues**

* **Issue 3-1 (Step 2)**
  + Resolution of square brackets in MIL definition
    - [(21a/b) H-ARQ gain]
      * Alt 1-1: remove this assuming that HARQ-gain is included in LLS result
      * Alt 1-2: keep it, and companies can report the value if HARQ-gain is not included in LLS result
      * (note: this can be dropped because HARQ gain has already included in sensitivity)
    - [ (25a/b) Shadow fading margin – (27) Penetration margin ]
      * Alt 2-1: they are merged and one row is prepared
      * Alt 2-2: keep both of them separate
    - [(26) BS selection/macro-diversity gain ]
      * Alt 3-1: remove this row
      * Alt 3-2 keep this row
    - [(28) Other gains]
      * Alt 4-1: remove this row
      * Alt 4-2 keep this row
    - [(12) Cable, connector, combiner, body losses (Rx side) ]
      * Alt 5-1: remove this row, because this parameter is ~~which~~ not used for MCL/MIL but MPL, which looks inconsistent
      * Alt 5-2: keep this row
* **Issue 3-2 (Step 3)**
  + Confirm that definition of MCL, MIL and MPL for TDL Option 2 & CDL is the same as that for TDL option 1
* **Issue 3-3 (Step 4)**
  + Discuss whether to allow companies to select appropriate value for each parameter
    - (note: we have an agreement saying “RAN1 will not further discuss on specific values for the parameters related to MPL”.)

Companies are encouraged to provide their view on these issues above

|  |  |
| --- | --- |
| Company | Comment |
| Ericsson | **Issue 3-1**:   * H-ARQ gain should be included in MIL (as well as MCL), and therefore indirectly in MPL. If H-ARQ gain is in the link sims it is in MCL and MIL, and having it only in MPL if explicitly simulated does not make sense. * No strong view on Shadow fading and penetration margin being separate, as long as how they are calculated is clear. * Macro-diversity and ‘other’ gain can be provided by proponents if they wish, otherwise they should be zero. * (21) on cable losses etc. can be included in MCL and MIL if values can be agreed.   **Issue 3-2**: Support FL proposal.  **Issue 3-3**: Not sure what there is to discuss, so do not support the proposal. According to the agreement, it is clear that companies are allowed to select the appropriate value for each parameter, with IMT-2020 as a starting point.   * + 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 |
| Nokia/NSB | Agree with Ericsson on HARQ gain. Every other parameter contributing to MPL calculation should be reported by companies if not set to zero. |
| Samsung | Our preference on HARQ gain is Alt 1-2. As per agreed PUSCH/PDSCH eMBB evaluation assumptions, whether HARQ is adopted is reported by companies. If HARQ is not adopted in LLS result, the value of (21a/b) can be reported. Otherwise, it should be set to ‘0’  For the others, we are fine to keep them to be aligned with IMT-2020 self-evaluation assumption as much as possible  For Issue 3-2, we are OK to have the same definition. |
| vivo | We prefer keeping above parameters, which can be set to zero if not considered in evaluation. |
| Qualcomm | **Issue 3.1**  HARQ gains must be reflected in MCL, MIL and MPL. It is absorbed as part of LLS. No need to include this separately.  On shadow fading and penetration, prefer to have a single row --- they are two independent random variables and only their sum matters. If alignment with IMT is preferred, then okay to keep them as separate rows.  On macro diversity, okay to keep as some companies prefer to align with IMT-2020 evaluation.  On cable losses, okay to include this in MPL, but would like to leave it out of MCL/MIL calculation so that more divergence across companies does not emerge.  On “Other gains” --- can be removed, but wont object if some companies prefer to keep.  **Issue 3.2**  Support  **Issue 3.3**  We are assuming no further discussion is needed on the other parameters. They are left to each company’s preference. |
| Intel | Issue 3.1/3.3  Our view is that it is more appropriate to keep the rows as in IMT-2020 self-evaluation link budget template, i.e., do not remove or merge the rows. For MIL calculation, if some of the parameters are not needed, we can simply set to 0. This also includes HARQ gain, where company can report the value.  Issue 3.2  We are fine with the proposal. |

# Agreements after this email discussion

To be incorporated

# 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#101e

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.