**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

### 1st round

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). |
| Ericsson | 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 elementsIn 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. |
| Sharp | Regarding (7), removing the term “pilot” seems better since we will not evaluate the case for power loss due to pilot boosting. We have agreed no DMRS multiplexing with data for PUSCH. As proposed by Ericsson ‘Control channel boosting or Data channel power loss (due to control channel boosting)’ is also OK to us.Regarding (30a/b), we support to remove square brackets to align uplink with downlink. |
| Samsung | For (1) (2) (2a) (10) (10a) (10b), we share the view from China Telecom – in line with RAN1 agreement. In case of (2) and (10a) from UE perspective, the added note is clear enough. For (16a) (16b) (29a) (29b), we agree with FL’s suggestion. It seems “Cell area reliability(1) for control/data channel (row#6, #7)” are not necessary similar with the removal of rows#8 - #12.With respect to the following agreement, ISD may be scenario dependent target. Therefore, it would be better to keep (30a)(30b) (and possibly (31a) (31b)) of ‘IMT-2020 Template’ into ‘Proposed R17 Template’.

|  |
| --- |
| 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.
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### 2nd round

**Summary of the 1st round discussion:**

So many remaining issues are identified by companies. The issues are categorized for 4 groups as below:

**(1) Critical issues for the completion of evaluations**

* **(1-1) Introduction of (11bis) for MCL definition**
	+ OK to include: Huawei/HiSilicon, Ericsson, Sharp, ZTE
	+ Should not be included: Intel, Qualcomm
	+ OK with either way: CATT (but the description should be clear)

🡪 FL perspective: Unfortunately, we have no agreement on uplink, and hence FL thinks this is an open issue. Therefore, argument by “alignment with the agreement” may not be true for this case. Considering this point and the number of supporting companies (slight majority), FL would like to propose to include (11bis) for the MCL definition. Companies are encouraged to further check this proposal, and provide their views especially the concern.

* **(1-2) Inclusion of Rx loss (12) in MIL (23a)(23b)**
	+ OK: Huawei/HiSilicon, Ericsson, ZTE, Samsung

🡪 FL perspective: Since no company showed their concern. It can be treated as offline consensus.

**(2) Structure of link budget template**

* **(2-1) Clean up for the rows used for UL - Huawei**
	+ “*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.

🡪 FL perspective: Understand the concern, but FL thinks we need to be careful to avoid further confusion (i.e. the agreement says that *N* is not defined for UL, but if we say (2)=(2a), it is not aligned with the agreement). Maybe appropriate use of excel function can solve this problem. So, FL would like to come back this issue at the later stage.

* **(2-2) Need for information on high level parameters (i.e. frequency, scenario, duplex mode, TDD UL-DL configuration, Channels, etc) – Ericsson, CTC**
	+ By introducing tabs for spreadsheet
	+ By adding rows
		- BS/UE height (Er, CTC)
		- CDL vs TDL
		- Correration value
		- Frequecny hoping or not
		- #PRBs
		- How the antenna gain correction values are derived
		- Etc

🡪 FL perspective: Agree the proposal. Link budget template v006 has addressed this issue.

* **(2-3) Marge rows for control and data – Ericsson, Sharp**
	+ (6) and (7) are merged
	+ (3bis-a/b), (9a/b), (15a/b) etc

🡪 FL perspective: Link budget template v006 has addressed this issue. Companies are encouraged to check the rows. From FL point of view, there is no issue to do so.

* **(2-4) Occupied channel bandwidth (17a)(17b) should be upfront – Qualcomm**

🡪 FL perspective: (17a/17b) is now moved to (3c). The name of the row is also modified to avoid the confusion.

* **(2-5) MCL should come first (compared with MIL and MPL) – Qualcomm**

🡪 FL perspective: MCL is now moved to (22bis)

* **(2-6) Cell area reliability(1) for control/data channel (row#6, #7) is not necessary – Samsung**

🡪 FL perspective: these rows can be now removed

* **(2-7) Necessity of the following two rows – Samsung**
	+ (30a) Maximum range for control channel (based on (29a) and according to the system configuration section of the link budget) (m)
	+ (30b) Maximum range for data channel (based on (29b) and according to the system configuration section of the link budget) (m)

🡪 FL perspective: Since the latest link budget template does not prepare separate rows for data and control, only one row can be introduced for this. FL is fine to revive this row, but RAN1 should not spend time on the formula of ISD derivation, i.e. companies to report.

**(3) Editorial issues for better understanding among companies**

* **(3-1) Explanation of rows (2)(2a)(10a)(10b)**
	+ Keep the same terminology (TxRU)
		- Huawei/HiSilicon, Intel, CATT, CTC, ZTE, Samsung
			* 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)
	+ Different terminology
		- Ericsson, (TxRx is vaild only for Tx side or #of Tx Chain = #of Rx Chain), Qualcomm (Confusing for UE side)

🡪 FL perspective: Considering the number of supporting companies and the consistency of our agreements, it would be a good way forward to adopt the following terminology in the link budget template.

* + - * 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)

In order to address the concern from the companies, we can add the following note that will be captured in the TR.

*Note: the terminology TxRU does not imply that the number of transmit chains is always same as that of receive chains.*

* **(3-2) Note for delta1~3**
	+ detla1~3 should not be used in the spreadsheet, i.e. “antenna gain correction factor” is sufficient . (delta1, delta2, delta3 is only for information in this email discussion)
		- Huawei/HiSilicon, Ericsson, CTC

🡪 FL perspective: delta1~3 is temporally added in the spreadsheet. These will be removed after we reach the common understanding.

* + It should be clarified that delta may be deferent depending on channels (including DL/UL) – ZTE

🡪 FL perspective: This has been discussed during [102-e-Post-NR-CovEnh-01], and FL believes this is the common understanding of the group. This concern can be solved by capturing the definition of delta in the TR, which will be handled by the rapporteur.

* + For FR2 with system level simulation, delta1, delta2 and delta 3 may not be separable – ZTE

🡪 FL perspective: New rows to explain delta1~3 is newly added from v006 link budget template. These rows can be used to report the fact.

* **(3-3) Necessity of note (in general) – Intel**

🡪 FL perspective: It should be treated case-by-case basis. If it is found that the note is not necessary anymore, it can be removed.

* **(3-4) Application of PSD constraint: (3bis-a) and (3bis-b) - Intel**
	+ It should be clarified that this applies to DL only (not UL)

🡪 FL perspective: This is clarified in row no. (3b)

**(4) Other issues**

* **(4-1) Resolution of parameters/values**
	+ Ericsson pointed out that more discussion is necessary for simulation values.
	+ FL also checked if there are unresolved values for evaluation. Unfortunately, we still have something to solve/clarify, i.e. square brackets still exist.

🡪 FL perspective: Additional column for the simulation values has been added for information. Companies are encouraged to check it. Please note that the discussion on the values is not the prime target of this email discussion.

**FL proposal:**

Based on the FL perspective above, the link budget template is updated and available from the following link:

<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/2nd_round/budget-template-v006.xlsx>

In this document, the agreed simulation values (except the parameters without optional values) are incorporated for your reference.

Companies are encouraged to check the latest version of link budget template and the FL perspective above. Please provide your view in the table below.

|  |  |
| --- | --- |
| Company  | Comment |
| ZTE | On Issue (1-1), as we commented in the first round, we support to include (11bis) for MCL definition. Regarding Issue (4-1), we are fine to resolve the parameters in bracket in this email discussion. Our view on these parameters is follows:* Urban/suburban: TDL-C for FR2 could be optional.
* For the number of RBs for baseline simulation, we suggest to keep the baseline values (by just removing the brackets).
* We are fine to remove [4bits (3 bits A/N + 1 bit SR)] or keep it as optional.
* The agreement on FR2 BW is for PUSCH and PDSCH (It is captured as for PUSCH and PUCCH in the template). We think 400MHz should be kept at least for FR2. If only 100MHz is used, it would force companies only use very high MCS, e.g. MCS#26 or higher MCS in urban scenario to accommodate 25Mbps eMBB.
* We find it is very unfortunate that we missed one channel for evaluation, i.e., PUCCH with HARQ-ACK for Msg4. We didn’t have explicit agreed assumptions on this. In our view, the agreed assumptions for normal PUCCH could be largely reused, and the only difference is 1 bit UCI and no PUCCH repetition should be assumed for HARQ-ACK for Msg4. We suggest to conclude on this together with resolving above issues. For instance, a proposal like: ‘*For link level simulation of PUCCH format 1 with 1-bit HARQ-ACK for Msg4 in FR1 and FR2, reuse the simulation assumptions of normal PUCCH with assuming no PUCCH repetition.*’

We are fine with FL’s suggestion on other issues.  |
| Nokia/NSB | We would like to ask for clarification regarding the wording in row B2 in LB template V006. What does it mean by “Following scenarios/frequencies are determined by choosing Excel tabs”? does it mean that the intention is to let companies submitting this template with each scenario in each tab? This would result in an unmanageable set of results to be captured in the TR. We would suggest collecting just the output MCL, MIL and MPL from the template for each scenario in each tab. Companies can then easily provide results one after another.Concerning the issues listed by the FL, we have the following comments:* **Issue (1-1):** Although we do not think that it is necessary to include AGC2 in MCL from the beginning, however we are OK to also include (11bis) in MCL for the completeness of the MCL definition. Could the proponents (of including AGC2 in MCL) please explain why the gNB AGC2 must be included for DL only but not for UL?
* **Issue (1-2):** Agree with the FL’s proposal to include (12) in (23).
* **Issue (2-2):** We share the same view as Qualcomm from the previous phase of discussion that, these parameters should be put in a separate tab (i.e. Excel sheet) to make the template be concise.
* **Issue (2-3):** We are fine to merge, if possible. However, this may lead to some confusion on whether positive or negative values should be included. For example, by merging (6) vs (7)🡪(6) and (9a) vs (9b) 🡪 (9), value in the new row (6) should be positive for control channel (power boosting gain) and negative for data channel (power loss) because (6) is added to the new row (9). This doesn’t apply for other rows where positive values are used regardless whether it’s gain or loss. In addition, there are some typos after merging, but we can fix them later.
* **Issue (2-7):** Agree with FL comment. Maximum range can be reported by companies depending on the target performance, which has been agreed to be discussed in RAN1#103-e.
* We are fine with FL’s suggestions for the remaining issues.
 |
| Intel | * For issue 1-1, with the clarification from FL, we are fine to include (11bis) into MCL calculation, with the note that (11bis) is zero for downlink, which aligns the agreements.
	+ - One editorial comment: for "(22bis) MCL for control channel", we may not need "for control channel".
* For issue 1-2, we are fine to include (12) in MIL calculation.
* For issue 2-2, we share similar view as Nokia and QC that it seems a bit messy to also include the simulation assumptions in the same tab as for link budget analysis. We agree that simulation assumptions are very important for link budget study, but it may be good to put all the simulation assumptions into the first tab in the Excel sheet. Note that same link budget template would be used also for RedCap coverage recovery study and it is more appropriate to make it more concise.
* For 2-3, we support to merge control and data into a single row to make it more concise.
* For 3-4, thanks for the update on the description in (3b). Our understanding is that we only need to provide values in (3) and (3bis) as they are equivalent for UL and do not need to determine the values in (3b) for PSD. Please clarify. Also it would be good to clarify that (3a) and (3c) are equivalent for UL.
	+ - For agreements, “FR1 PUSCH and PUCCH: - 20MHz for 2GHz (FDD - 20MHz (optional for 10MHz) for 700MHz. (FDD)”, as it is for uplink, only occupied bandwidth is needed. It is good to remove “PUSCH and PUCCH” as this is for system bandwidth.

We are fine with the FL’s suggestions on the remaining issues. We have some further comments: * One additional comment on row "(6) Control channel power boosting gain (dB) or data channel power loss due to control boosting (dB)": for data channel power loss due to control boosting, our understanding is that this is for the case when data and control channel are multiplexed in a FDM manner in a same symbol, where gNB may borrow some power from data for control channel power boosting. For CE study, we do not have such simulation assumptions for FDM of control and data for downlink. It may be good to remove it.
* One minor comment on (10): it would be good to modify this as “(10) Number of receive antenna elements”
* For the newly added rows for “The derivation of the value in antenna gain correction factor (4b), (5b), (11b), (11bis)”, is it for companies to report the evaluation methodology on how to obtain the delta values?
 |
| Sharp | For Issue 4-1, regarding channels for evaluation, as commented by ZTE, we also think that PUCCH for msg 4 acknowledgement should be included in this evaluation.For row (6), we also support Intel’s argument removing row (6). If we don’t assume FDM scenario for control and data, the value should be 0. |
| Qualcomm | Comments on the link budget table:* Regarding (2): Transmit chains is the appropriate terminology to use. Transmit TxRUs expands as transmit transmission-reception units --- which doesn’t seem right. Please consider describing this as “Number of transmit chains”. While this row many not be necessary for UE, we suggest to include it for clarity. Let us not say that this row is to be void for uplink.
* Regarding (2a): Can we say “Number of transmit chains modelled in LLS”? This makes it rather clear on why this row is included.
* Further clarification on 3, 3a-c rows for uplink will be helpful.
* 22 & 22bis can remove “for control channel” since we are now not making a distinction between data and control channels.
* MCL definition should start with 3bis and not 3bis-a
* List (24) under system parameters
* Upon closer inspection we support including 11bis in MCL.
* For better clarity, can we express MIL using the equivalent formula: MIL = (22bis) + 4 - 8 + (11) − (12) (dB). This clearly show how MIL is computed from MCL. MCL is (22bis). EIRP calculation can then be dropped, although I do understand that companies may want to preserve this especially in FR2 context.

Regarding 4-1, we don’t see any pressing need for further agreements. We prefer to keep the purpose of this discussion limited to finalizing the template. If any critical items are identified, please handle it in a separate email discussion. |
| China Telecom | Regarding Issue (2-2), we think there is no need to list parameters related to link-level simulation to obtain required SNR, which would be captured in Annex in TR 38.830. It just needs necessary descriptions for distinguishing cases for link budget template, like scenario. Thus, we suggest to delete row B18-B40 to keep the readability. There are some typos for the 2nd updated template.* (1) Number of transmit antenna~~s~~ elements.
* After merging (6) and (7), the results of (9) EIRP may need more clarifications on whether positive or negative values are included. And we are OK to delete (6) if it is majority.

(9a) Control channel EIRP = (3bis-a) + (4) + (5) + (6) – (8) dBm(9b) Data channel EIRP = (3bis-b) + (4) + (5) – (7) – (8) dBm* (10) Number of receive antenna~~s~~ elements.
* (22) Receiver sensitivity ~~for control channel~~
* (22bis) MCL ~~for control channel~~ = (3bis~~-a~~) + (6) - (22a) + (5) + (11bis) (dB)
* (29a) Available path loss ~~for control channel~~
* We support to add (30) maximum range for companies’ reporting.
 |
| Ericsson | Given the deadline, we primarily focus on the identified issues and the added rows rather than the specific values of the parameters. We hope to comment more in the next round on these specific values.* We are OK with the FL proposals above for the listed issues except for (3-1).
* Issue (3-1): In my understanding ‘TxRU’ was introduced for AAS systems, e.g. in Rel-12 37.840, as ‘transceiver unit’. A non-AAS gNB e.g. at 700 MHz can have 2 or 4 Rx, and 2 or 4 Tx, and it is historically common for gNBs to have more receive than transmit chains. So ‘transceiver unit’ for many non-AAS gNBs does not make sense. Also, UEs even more commonly have more receive than transmit antennas, and so ‘TxRU’ does not make sense for them. Furthermore, ‘transmit TxRU’ = ‘transmit transceiver unit’ is not logically consistent, since this refers to only the transmit chains, whereas a TxRU must also have a receiver to be a transceiver. Note that 37.840 uses ‘TXU’ and ‘RXU’ when referring to transmit-only and receive-only functions. Can we instead build on CTC’s proposal with the following?
* transmit antenna elements in (1)
* modeled transmit chains in (2)
* transmit chains in LLS in (2a)
* receive antenna elements in (10)
* modeled receive chains in (10a)
* receive chains in LLS in (10b)
* Agreed parameters for Msg2 PDSCH should be added.
* Our understanding is that CSI is one of the potential bottleneck channels, and if CSI coverage is enhanced for PUCCH we should enhance CSI on PUSCH as well. Unfortunately, the assumptions for CSI on PUSCH may not be crystal clear. We propose the following clarification: Simulations of CSI on PUSCH can reuse parameters for CSI on PUCCH, with the following updates:
* 1 PRB, [4] DMRS
* Only CSI is on PUSCH (no UL-SCH data)
* Regarding the note for BWP size, this is relevant to more than frequency hopping, e.g. full bandwidth allocation of PDSCH.
* We think 4bits (3 bits A/N + 1 bit SR) is important to simulate, since this is needed for the TDD configurations we simulate. Therefore, it should also be listed (i.e. remove the square brackets).
* TxD should be applicable to downlink in general, including Msg2 & Msg4. If gNB can use it for PDCCH, why would it not be able to use it for Msg2 or Msg4?
* Similar to ZTE, having an optional 400 MHz system bandwidth makes sense to us for FR2, since this bandwidth is more reflective of commercial deployment.
 |
| Huawei, Hisilicon | We have the following suggestions:* For issue (2-2), we agree that these simulation scenarios and assumptions are important and should be incorporated. Please note that we have three dimensions of inputs to capture, i.e. scenarios, company source, physical channels while only three degrees of freedom to accommodate them, i.e. name of excel file, excel tabs, excel column. It seems better to use different excel file for different scenarios.
* For issue (2-3), we are OK to merge (6) & (7).
* For issue (2-5), we are OK that MCL is moved to (22bis) but we don’t think that MPL needs to refer to MCL because some companies have different views on the inclusion of (11bis).
* For issue (2-6), cell reliability (1) for control/data channel (row #6, #7) should be kept, because cell reliability is an input for shadow fading margin (25a) in MPL calculation. A higher cell reliability requirement in (1) would lead to a larger shadow fading margin in (25a).

For issue (2-7), we suggest to keep the maximum range for control and data channel (30) where the formula of ISD derivation can reuse IMT-2020 template. |
| CMCC | **Issue (2-2):** Generally agree with Qualcomm and Nokia to move those parameters to another sheet, such as BS/UE height, CDL vs TDL and how the antenna gain correction factor derived. But the #PRB from our thinking could be kept in this sheet to derive the occupied bandwidth or corresponding PRB numbers. And for the graph illustrated antenna gain component # 1~4 could also be captured in the other sheet. And the illustration of delta could be captured in the same figure for understanding. **Issue (2-6):** we suggest to keep the **Cell area reliability (1)** for control/data channel or merged into one row. Since **Cell area reliability** is used to derived the shadow fading margin which is used to derive MPL. As it was agreed to capture MPL in both link budget and TR, it should be shown clearly to readers how those values be calculated.For the rows (24)~(28), as it was agreed in the last meeting IMT-2020 values are as staring point, and to further put this agreements into practice, we propose to add notes with example values from IMT-2020. Examples could be like this.“ (24) Lognormal shadow fading std deviation (dB)* Option 1: e.g. 7.56 dB for control channel and 4.48dB for data channel (from IMT-2020 self-evaluations)
* Option 2: Notes, 7.56dB (control channel) and 4.48dB (data channel) from IMT-2020 self-evaluations could be a starting point,”

**Issue (2-7):** Agree with FL to merge the rows of control and data. But we suggest to leave the merge rows (30a+30b) in the table, since it was agreed in the last meeting that MPL should be captured in the TR and it is useful to show the achievable ISD. And operators concern about the coverage distance.Issue (3-1): we propose to add notes in this table to illustrate receive chains and transmit chains are used in the link level simulation to derive the receiver sensitivities of channels. Echo ERICSSON’s suggestion in the emails thread. We also propose to capture the transmit power or EIRP discussion into the some document for easy finding or avoiding crossed with this email discussion. |

### 3rd round

**Summary of the 2nd round discussion:**

**(1) Critical issues for the completion of evaluations**

* **(1-1) Introduction of (11bis) for MCL definition**
	+ Nokia/NSB : OK to also include (11bis) in MCL for the completeness of the MCL definition
	+ Intel: OK with FL proposal but it should be clarified that (11bis) is zero for downlink
	+ Qualcomm: Upon closer inspection we support including 11bis in MCL

🡪 FL perspective: Now no concern is raised for the inclusion of (11bis) for MCL. Therefore, this proposal can be treated as offline consensus.

* **(1-2) Inclusion of Rx loss (12) in MIL (23a)(23b)**
	+ Nokia/NSB, Intel: agree

🡪 FL perspective: Again, this proposal can be treated as offline consensus.

**(2) Structure of link budget template**

* **(2-1) Clean up for the rows used for UL - Huawei**

🡪 FL perspective: No comment was provided. Hence as FL suggested, this issue can be discussed later.

* **(2-2) Need for information on high level parameters (i.e. frequency, scenario, duplex mode, TDD UL-DL configuration, Channels, etc) – Ericsson, CTC**
	+ Nokia/NSB: suggest collecting just the output MCL, MIL and MPL from the template for each scenario in each tab. Companies can then easily provide results one after another.
	+ Nokia/NSB/Intel/CMCC: these parameters should be put in a separate tab (i.e. Excel sheet) to make the template be concise
	+ CTC: parameters to obtain required SNR should not included in the list because it is captured in TR 38.830. B18-B40 should be deleted.
	+ Intel: the meaning/intention of new rows “The derivation of the value in antenna gain correction factor (4b), (5b), (11b), (11bis)” should be clear
	+ Huawei/Hisilicon agree that these simulation scenarios and assumptions are important and should be incorporated. Better to use different excel file for different scenarios.
	+ CMCC: #PRB from our thinking could be kept in this sheet to derive the occupied bandwidth or corresponding PRB numbers
	+ CMCC: the graph illustrated antenna gain component # 1~4 and delta could be captured in the other sheet.

🡪 FL perspective: Most of the companies want to have a concise template for the readability while (some of) the information is important. Hence, use of different tabs/files makes sense. On the other hand, the purpose of using “file name”, “tabs”, “columns” is better management, which will be taken care of rapporteur and/or feature leads. In addition, it can be easily predicted that more and more comments will be received in each round, which is a risk to miss the deadline of this email discussion. Given this analysis, FL would like to propose the following:

**FL proposal 1:**

* Further sophistication of the link budget template, which aims at the efficient collection of companies’ input, is up to rapporteur and feature leads.
* Rapporteur and feature leads will prepare the final version of link budget template tanking into account the companies’ views provided in this email discussion.
* In this email discussion, companies are encouraged to check if all the necessary parameters are listed.
* If necessary, another round of email discussion will take place under “3GPP\_TSG\_RAN\_WG1\_NR” reflector.

Note: it is not necessary to capture this proposal in Chairman’s note.

* **(2-3) Merge rows for control and data – Ericsson, Sharp**
	+ Nokia/CTC: OK but should be careful not to mix positive/negative value, i.e. (7)🡪(6) and (9a) vs (9b) 🡪 (9)
	+ Intel: Support to merge control and data into a single row
	+ Huawei/HiSilicon: OK to merge (6) & (7).

🡪 FL perspective: No concern was raised to merge the rows for control and data even though we should pay attention to positive/negative. Therefore, FL thinks this proposal can be treated as offline consensus.

* **(2-4) Occupied channel bandwidth (17a)(17b) should be upfront – Qualcomm**

🡪 FL perspective: No comment was provided. Hence it is assumed that everyone is OK for this proposal.

* **(2-5) MCL should come first (compared with MIL and MPL) – Qualcomm**
	+ Qualcomm: MIL is derived by (22bis) + (4) – (8) + (11) − (12)
	+ Huawei/HiSilicon: don’t think that MPL needs to refer to MCL because some companies have different views on the inclusion of (11bis).

🡪 FL perspective: No comment was provided. Hence it is assumed that everyone is OK to move MCL row upfront. Regarding the derivation of MIL, we can choose either of [ (9) + (11) + (11bis) − (12) − (22) ] or [(22bis) + (4) – (8) + (11) − (12)] because no company shows their concern to include (11bis) now. FL has no strong opinion on this because the result is the same.

**FL proposal 2:**

* Choose one from the following alternative:
	+ Alt 2-A
		- MIL = (9) + (11) + (11bis) − (12) − (22)
	+ Alt 2-B
		- MIL = (22bis) + (4) – (8) + (11) − (12)

Note that FL would like to suggest Alt 2-A if there is no clear majority, because Alt 2-A looks more consistent with the definition used for IMT-2020 self-evaluation.

* **(2-6) Cell area reliability(1) for control/data channel (row#6, #7) is not necessary – Samsung**
	+ Huawei/HiSilicon: cell reliability (1) for control/data channel (row #6, #7) should be kept, because cell reliability is an input for shadow fading margin (25a) in MPL calculation.
	+ CMCC: suggest to keep the **Cell area reliability (1)** for control/data channel or merged into one row

🡪 FL perspective: FL understands the motivation, and would like to proposes to revive one row, i.e. (30) Cell area reliability ~~for control channel~~  (%).

* **(2-7) Necessity of the following two rows – Samsung**
	+ (30a) Maximum range for control channel (based on (29a) and according to the system configuration section of the link budget) (m)
	+ (30b) Maximum range for data channel (based on (29b) and according to the system configuration section of the link budget) (m)
	+ Nokia/NSB: Agree with FL comment. Maximum range can be reported by companies depending on the target performance
	+ CTC: support to add (30) maximum range for companies’ reporting.
	+ Huawei/HiSilicon: suggest to keep the maximum range for control and data channel (30) .
	+ CMCC: suggest to leave the merge rows (30a+30b) in the table

🡪 FL perspective: Based on the supporting comments for (30) Maximum range, FL assumes that the offline consensus is to keep this row. Note that this row is for companies’ report, and hence RAN1 will not discuss the formula.

**(3) Editorial issues for better understanding among companies**

* **(3-1) Explanation of rows (2)(2a)(10a)(10b)**
	+ Qualcomm: for (2) Transmit chains is the appropriate terminology to use. Transmit TxRUs expands as transmit transmission-reception units --- which doesn’t seem right. Please consider describing this as “Number of transmit chains”. While this row many not be necessary for UE, we suggest to include it for clarity. Let us not say that this row is to be void for uplink.
	+ Qualcomm: for (2a), “Number of transmit chains modelled in LLS” is more appropriate
	+ Ericsson: for non-AAS system, it is common for gNBs to have more receive than transmit chains. So ‘transceiver unit’ for many non-AAS gNBs does not make sense. Also, UEs even more commonly have more receive than transmit antennas, and so ‘TxRU’ does not make sense for them. ‘transmit TxRU’ = ‘transmit transceiver unit’ is not logically consistent. Suggest:
		- * transmit antenna elements in (1)
			* modeled transmit chains in (2)
			* transmit chains in LLS in (2a)
			* receive antenna elements in (10)
			* modeled receive chains in (10a)
			* receive chains in LLS in (10b)
	+ CMCC: propose to add notes in this table to illustrate receive chains and transmit chains are used in the link level simulation to derive the receiver sensitivities of channels.

🡪 FL perspective: It seems that companies have a common understanding what (1), (2), (2a), (10), (10a) and (10b) mean. In this sense, FL thinks that this issue is not so urgent that the resolution can be postponed to RAN1#103e. FL would like to ask companies which alternative is preferred (note that underline part is added to address the comment from CMCC & Qualcomm)

**FL proposal 3:**

* Choose one from the following alternative
	+ (Alt 3-A): stick to the terminology we have used:
		- transmit TxRUs in (2)
		- transmit chains modeled in LLS in (2a)
		- receive TxRUs in (10a)
		- receive chains modeled in LLS in (10b)
	+ (Alt 3-B): update the terminology for TxRU and transmit/receive chain as follows:
		- modeled transmit chains in (2)
		- transmit chains modeled in LLS in (2a)
		- modeled receive chains in (10a)
		- receive chains modeled in LLS in (10b)

If we cannot reach the consensus, FL keeps both terminologies with square bracket. The final decision will be made at RAN1#103e.

* **(3-2) Note for delta1~3**

🡪 FL perspective: No view is provided. Hence, it is assumed that companies are OK with FL view, i.e. the note is used to confirm the common understanding, and will be deleted at the final version.

* **(3-3) Necessity of note (in general) – Intel**

🡪 FL perspective: No view is provided. Hence, it is assumed that companies are OK with FL view, i.e. the note is used case-by-case basis.

* **(3-4) Application of PSD constraint: (3bis-a) and (3bis-b) – Intel**
	+ Intel: want to clarify that the value for (3b) is not necessary for UL and that (3a) and (3c) will be equivalent.
	+ Intel: for agreement, the statement for PUSCH and PUCCH is not necessary
	+ Qualcomm: further clarification for (3a)-(3c) for uplink is necessary.

🡪 FL perspective: The views from companies are understandable, but at the same time, common framework for UL and DL in the spreadsheet is also important. Hence, FL would like to address the concern by adding the note.

**(4) Other issues**

* **(4-1) Resolution of parameters/values**
	+ ZTE: OK to resolve it in this email discussion
	+ Qualcomm: don’t see any pressing need for further agreements. Should be handled under different email discussion/thread.
	+ Ericsson: Agreed parameters for Msg2 PDSCH should be added.
	+ CMCC: suggest to capture values for IMT-2020 self-evaluation:

🡪 FL perspective: it seems removal of (6) is reasonable. Also as a side effect, positive/negative issue at (6) can also be solved. FL would like to propose remove (6).

* **(4-2 New) motivation & use case for (6)**
	+ Intel/Sharp: we do not have such simulation assumptions (borrow some power from other channel) for FDM of control and data for downlink. It may be good to remove it.
	+ CTC: OK to remove it if it is the majority view.

🡪 FL perspective: it seems removal of (6) is reasonable. Also as a side effect, positive/negative issue at (6) can also be solved. FL would like to propose remove (6).

* **(4-3 New) minor typos**
	+ Intel: (10) Number of receive antenna elements
	+ Qualcomm/CTC: (22bis) MCL for control channel = (3bis~~-a~~) + (6) - (22a) + (5) + (11bis) (dB)
	+ Qualcomm/CTC: 22 & 22bis can remove “for control channel”
	+ CTC: (1) Number of transmit antenna~~s~~ elements.
	+ CTC: (22) Receiver sensitivity ~~for control channel~~
	+ (29a) Available path loss ~~for control channel~~

🡪 FL perspective: These typos are corrected.

* **(4-4 New) handling of (24) Lognormal shadow fading std deviation (dB)**
	+ Qualcomm: This should be under system parameters

🡪 FL perspective: Let’s check if companies are OK with this proposal.

* **(4-5 New) EIRP limit for FR2**
	+ CMCC: propose to capture the transmit power or EIRP discussion into the some document for easy finding or avoiding crossed with this email discussion.

🡪 FL perspective: This discussion is managed by different email thread. FL thinks overlapping discussion should be avoided. This email discussion will capture the agreement there.

Companies are invited to provide their views on the FL proposals 1, 2 and 3 as well as the FL perspective, and the latest link budget template

<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/3rd_round/budget-template-v007.xlsx>

|  |  |
| --- | --- |
| Company  | Comment |
| CATT | We are fine with FL proposal 1.We are supportive of Alt 2-A in FL proposal 2.We are supportive of Alt 3-A in in FL proposal 3. |
| ZTE | Fine with Proposal 1, and our preference is to keep the parameters in a separate tab. Regarding Proposal 2, we have no strong preference, while slightly prefer Alt 2-A since it is more straightforward and there seems no strong need to bundle MIL with MCL.Regarding Proposal 3, we understand the intention of Alt 3-B, while it may cause confusions considering the terminology we used before. So, we slightly prefer Alt 3-A to align the previous agreements and the modeling figure for antenna gain.Regarding (4-4 New), we are fine to move (24) to system parameters. Regarding (4-2 New)/(4-3 New)/(4-5 New), agree with FL’s suggestion.  |
| Huawei, HiSilicon | For FR1, the values of “(13) Receiver noise figure (dB)” can follow IMT-2020 (7dB for UE and 5dB for BS) which has only evaluated FR1. However, those values are not applicable for FR2, and should be updated to (10dB for UE and 7dB for BS) according to ITU-R M.2412-0. Please capture this into the note of #(13).For all other parameters that have no agreed value but are up to companies to report, a note can say that the values in IMT-2020 TR 37.910 and ITU-R M.2412-0 are recommended. For FL’s Proposal 2, we think Alt 2-A is a better choice for the definition of MIL which is more consistent with that used in IMT-2020 template. For FL’s proposal 3, we prefer Alt-A as the agreement we have, and we are also OK with revision that transmit antenna ports and receive antenna ports are used for (2) and (10a), respectively, which have been used by IMT-2020 TR 37.910. Because we’d better to use different terms from transmit/receive chains that have been occupied by LLS modeling (2a) and (10b). |
| OPPO | We are fine with FL proposal 1.We are supportive of Alt 2-A in FL proposal 2.We are supportive of Alt 3-A in in FL proposal 3.For (8) and (12), LB has the same description for the agreement values:* "We have two proposal so far:
* Option 1:
* - feeder loss at BS (1dB for 700MHz, 0dB for 4GHz with AAS)
* 0dB for the loss at UE
* Option 2:
* values for IMT-2020 self evaluation (1dB for DL and 3dB for UL)"
* Actually, the values of (8) is incorectly refered from IMT-2020. Should be:

values for IMT-2020 self evaluation (~~1~~3dB for DL and ~~3~~1dB for UL)" |
| Intel | We are fine with FL proposal 1. We share similar view as other companies that it is better to keep the simulation assumptions in a separate tab to make the link budget analysis more concise.For FL proposal 2, we slightly prefer Alt 2-A, as explained by FL. For FL proposal 3, we prefer Alt 3-A to align the agreements. It would be more appropriate to include the agreed antenna gain block diagram along with the simulation assumptions to avoid the confusion.For issue (3-4), thanks for adding the note to address our concern. We suggest to remove "for uplink, (3a) = (3c) ~~if FDM is not used to multiplex different channels~~" as we do not support multiplexing different channels in a FDM manner in UL in a CC. For issue (4-2), we are fine to remove (6). |
| Sharp | We are OK with FL proposal 1.We are OK with FL proposal 2. One minor comment regarding row (22bis), component (6) should be deleted in row (22bis).We are OK with FL proposal 3. We can discuss it at the next meeting. We slightly prefer Alt 3-A. |
| CMCC | For the parameters that have no agreements and depends on companies’ report, one note can be added saying the values in IMT-2020 self-evaluation are recommended, e,g. from TR 37.910 and ITU-R M.2412-0.Alt 2-A is preferred for FL proposal 2, since it is more straight forward and more align with IMT-2020 template. Alt 3-A is preferred in in FL proposal 3. It seems that TxRU is a term for base station and the Tx and Rx chain is for the UE side. So the antenna port could be a compromise. For the noise figure for FR2, reusing the FR1 value (7dB for UE and 5dB for BS) is too optimistic. The values (10dB for UE and 7dB for BS) from ITU-R M.2412-0 for FR2 could be considered as a reference. |
| Ericsson | Agree with the approach in FL proposal 1. However, it is important that at least the key parameters used to generate results (including required SINR) are clearly identified in the TR rather than e.g. references to tdoc numbers. This can be further discussed later, though.For FL proposal 2, we slightly prefer alt 2-A, as it seems a bit easier to relate to common definitions of MIL.For issue (3-1), while companies do seem to have common understanding on what is meant by (1), (2), (2a), (10), (10a), and (10b), we think it is important that terminology used in a TR is clear and consistent with general usage in RAN, especially RAN1. Even within the NR coverage enhancement study, we have different numbers of receive and transmit chains in some setups, so ‘TXRU’ is not correct terminology for all setups studied. Our understanding of the use of ‘TxRU’ in the antenna gain figures is that the terminology was not intended to restrict number Tx and to be the same as the number of Rx chains, as this would conflict with other agreements. One solution could be to clarify from ‘TxRU’ to ‘Tx or Rx’ in the antenna gain figures in the TR.On (4-2 new): We are OK to remove (6) as FL proposes.For (4-4 new): moving (24) to system parameters is OK, but we should not debate these values related to MPL, and they can be left to company reports.Regarding (4-5 new): Thanks for the clarification on how the UE Tx power discussion will be captured. Agree with CMCC that the outcome should be captured into a document. In our view, there should be some clear reflection of the motivation for the different UE Tx power values captured in the TR, but we can take that discussion in that email thread.There is a typo: ‘PDSCH of Msg.2’ needs to be added to ‘Channel for evaluation’Minor comment: (3) may be updated rather than (9a) according to FR2 discussions on power. Also a minor suggestion on FL comment for (3) for clarity: This is for UE tx power, although (3) is for both gNB and UE; suggest to say for FR1: ‘No agreements for UE tx power’, and for FL proposal ‘used for UE tx power in FR1, i.e. 23 dBm’.Regarding TDL-C, we see some notable difference in performance for wider band channels between TDL-A 30ns and TDL-C 100ns, and so think that TDL-C should be kept.PRACH 10% missed detection should be kept. The difference between 1% and 10% can be 4-6 dB or so, and assuming 1% will have a dramatic impact on the results as compared to 10%. PRACH ramping implies multiple transmissions, and so the intuition for only 1% in a coverage limited scenario is not clear. Moreover, there has been no justification offered on why 1% is a suitable value.Regarding (8) and (12), they both say ‘enumerate sources’, that is, to identify what the values represent. Can companies proposing to reuse 3 dB for gNB loss and 1 dB for UE loss say what the values represent, i.e. do they only have feeder losses in mind or something else? If there are multiple proposals, we then at least need a place somewhere for companies to fill in this information.Agree with Huawei and CMCC that FR1 noise figures for gNB and UE should be 5 & 7 dB respectively, while for FR2 they should be 7 and 10 dB for gNB and UE, respectively.  |
| Samsung | FL proposal 1: OKFL proposal 2: The result would be the same between Alt 2-A and Alt 2-B subject to the removal of (6) -- (6) is included in Alt 2-B but not in Alt 2-A. Assuming the remove of (6) (FL already proposed it in (4-1) and (4-2 New)), we are OK with either Alt 2-A or Alt 2-B.FL proposal 3: Prefer Alt 3-A |
| Qualcomm | Support Proposal 1.For Proposal 2: Prefer Alt 2-B. Please note that both options give the same result. We can take Alt 2-A as the “official formula”, with a note saying 2-B can also be used. This serves as a reminder to people on how MIL relates to MCL. Given that agreements were made on how to derive MIL from MCL, I feel this little note will help folks looking at this table 3-5 years down the lane. For Proposal 3: Prefer Alt 3-B. Tend to agree with what E/// is saying. Important to use appropriate terminology. Issue 4-2: We are okay to remove (6). 22bis needs to be updated.Issue 4-3: support.Issue 4-4: support.Regarding column D in the link budget table: If this column is retained in the final version, only provide suggestions for parameters with agreements. For parameters with no agreement, please do not reference IMT-2020 as the values there have not been thoroughly vetted. Suggest deleting the suggestive text in cells D91, D80, D79, D78, D63. Qualcomm may prefer to use other values after checking internally. We do not wish to recommend IMT-2020 parameter settings as they are sometimes erroneous and don’t apply across all bands.  |
| Nokia/NSB | We are fine with FL's proposal 1. In addition, we do not think it is necessary to have another round of email discussion regarding the LB template before RAN1#103-e.Concerning FL's proposal 2, both alternatives result in the same MIL if (6) is removed, as also pointed out by some companies. (6) should be removed from (22bis) in the template if we have an offline consensus for not considering (6). We are fine with Alt 2-A as suggested by the FL.We prefer Alt 3-A. The terminologies in Alt 3-A were used for many agreements. Changing the terminologies at this stage could make confusion and may need some clarifications by modifying the agreements (e.g. figures illustrating antenna gain components where TxRU was used for N), which should be avoided. |

### Fine Tuning

**(1) Critical issues for the completion of evaluations**

* **(1-1) Introduction of (11bis) for MCL definition**

No comments, closed

* **(1-2) Inclusion of Rx loss (12) in MIL (23a)(23b)**

No comments, closed

**(2) Structure of link budget template**

* **(2-1) Clean up for the rows used for UL – Huawei**

Temporally closed, come back later if necessary

* **(2-2) Need for information on high level parameters (i.e. frequency, scenario, duplex mode, TDD UL-DL configuration, Channels, etc) – Ericsson, CTC**

**FL proposal 1:**

* Further sophistication of the link budget template, which aims at the efficient collection of companies’ input, is up to rapporteur and feature leads.
* Rapporteur and feature leads will prepare the final version of link budget template tanking into account the companies’ views provided in this email discussion.
* In this email discussion, companies are encouraged to check if all the necessary parameters are listed.
* If necessary, another round of email discussion will take place under “3GPP\_TSG\_RAN\_WG1\_NR” reflector.
* XX companies are basically OK with this proposal.
	+ CATT, ZTE, OPPO, Intel, Sharp, Ericsson, Samsung, Qualcomm
* Some additional comments
	+ ZTE/Intel: prefer to keep the parameters in a separate tab.
	+ Ericsson: it is important that at least the key parameters used to generate results (including required SINR) are clearly identified in the TR rather than e.g. references to tdoc numbers.
	+ Nokia: no need for additional round of email discussion.

🡪 FL perspective: Proposal 1 is agreeable to everyone, and the rapporteur and FLs can try to develop the final version of link budget template, which satisfies the companies’ preference as much as possible.

* **(2-3) Merge rows for control and data – Ericsson, Sharp**

No comments, closed

* **(2-4) Occupied channel bandwidth (17a)(17b) should be upfront – Qualcomm**

No comments, closed

* **(2-5) MCL should come first (compared with MIL and MPL) – Qualcomm**

**FL proposal 2:**

* Choose one from the following alternative:
	+ Alt 2-A
		- MIL = (9) + (11) + (11bis) − (12) − (22)
		- Supported by CATT, ZTE(slightly), Huawei/HiSilicon, OPPO, Intel, CMCC, Ericsson, Samsung (either one is OK), Qualcomm (OK if a note saying “saying 2-B can also be used” is added), Nokia
	+ Alt 2-B
		- MIL = (22bis) + (4) – (8) + (11) − (12)
		- Supported by Samsung (either one is OK), Qualcomm

Comment for this proposal:

- Sharp/Samsung/Nokia: (6) should be deleted in row (22bis).

🡪 FL perspective: The type for the presence of (6) in (22bis) can be corrected. It seems that majority of companies prefer Alt.2-A, and one company can compromise by adding a note. FL would like to adopt Alt.2-A with a note. Please see the latest spreadsheet.

No comments, closed

* **(2-6) Cell area reliability(1) for control/data channel (row#6, #7) is not necessary – Samsung**

No comments, closed

* **(2-7) Necessity of the following two rows – Samsung**

No comments, closed

**(3) Editorial issues for better understanding among companies**

* **(3-1) Explanation of rows (2)(2a)(10a)(10b)**

**FL proposal 3:**

* Choose one from the following alternative
	+ (Alt 3-A): stick to the terminology we have used:
		- Supported by CATT, ZTE, Huawei/HiSilicon/CMCC (2 and 10a can be transmit antenna ports and receive antenna ports respectively), OPPO, Intel (antenna gain block diagram should be added), Sharp (Slightly), Samsung, Nokia
		- transmit TxRUs in (2)
		- transmit chains modeled in LLS in (2a)
		- receive TxRUs in (10a)
		- receive chains modeled in LLS in (10b)
	+ (Alt 3-B): update the terminology for TxRU and transmit/receive chain as follows:
		- Supported by Ericsson (clarify from ‘TxRU’ to ‘Tx or Rx’ in the antenna gain figures in the TR for compromise), Qualcomm
		- modeled transmit chains in (2)
		- transmit chains modeled in LLS in (2a)
		- modeled receive chains in (10a)
		- receive chains modeled in LLS in (10b)

🡪 FL perspective: It seems that the situation has not changed, except that the compromise idea was proposed from both side. However, it is foreseen that the compromise proposal has an impact on the agreements so far, which is actually a concern from many companies. FL would like to propose to keep this issue open aiming at the resolution at RAN1#103-e.

* **(3-2) Note for delta1~3 i.e. the note is used to confirm the common understanding, and will be deleted at the final version.**

No comments. Since the next version of link budget template is the (almost) final version, the note will be removed.

* **(3-3) Necessity of note (in general) – Intel**

No comments, closed

* **(3-4) Application of PSD constraint: (3bis-a) and (3bis-b) – Intel**
	+ Intel: "for uplink, (3a) = (3c) ~~if FDM is not used to multiplex different channels~~"
* 🡪 FL perspective: Agree with this proposal.

**(4) Other issues**

* **(4-1) Resolution of parameters/values**
	+ **Additional comments are provided by companies**
		- Huawei/HiSilicon/CMCC: (13) Receiver noise figure (dB)” can follow IMT-2020 (7dB for UE and 5dB for BS) which has only evaluated FR1. However, those values are not applicable for FR2, and should be updated to (10dB for UE and 7dB for BS) according to ITU-R M.2412-0
		- Huawei/HiSilicon/CMCC/Ericsson: values with no agreement is for up to compenies’ report. We can say that the values used in IMT-2020 TR 37.910 and ITU-R M.2412-0 are recommended.
		- Qualcomm: do not wish to recommend IMT-2020 parameter settings as they are sometimes erroneous and don’t apply across all bands.

🡪 FL perspective: For the values on which we have not agreed yet, some companies recommend employing the values used in IMT-2020 TR 37.910 and ITU-R M.2412-0, while one company has a concern to do so. Given this situation, it is not easy to achieve the consensus until the deadline of this email discussion. The comment can be captured in the spreadsheet for information, which will help our discussion in the future.
Similarly, other comments on the parameters and values are captured in the latest spreadsheet for information. FL thinks that achieving immediate agreement is not so easy given the diverse view / less interest from the companies. FL proposal is to keep open until RAN1#103-e.

* **(4-2 New) motivation & use case for (6)**
	+ **Agree to remove (6): ZTE, Intel, Ericsson, Qualcomm**

No negative comments, closed

* **(4-3 New) minor typos**
	+ **OPPO:** the values of (8) is incorectly refered from IMT-2020. Should be: values for IMT-2020 self evaluation (~~1~~3dB for DL and ~~3~~1dB for UL)"
* 🡪 FL perspective: OK with this proposal.
* **(4-4 New) handling of (24) Lognormal shadow fading std deviation (dB)**
	+ Some Company support the FL proposal
	+ Ericsson: OK with FL proposal but the value is for companies’ report
* 🡪 FL perspective: We can add a note saying this is for companies’ report
* **(4-5 New) EIRP limit for FR2**

🡪 FL perspective: There some more comment on this discussion, but it can be handled under another email thread, including the documentation.

Given the summary and FL perspective above, FL would like to propose the following for fine turning.

**FL proposal:**

* Agree the following link budget template

|  |
| --- |
| **Transmitter** |
| (1) Number of transmit antenna elements. |
| (2) Number of [(transmit TxRUs) or (modelled transmit chains)]Note: this row is void (left empty) for uplink |
| (2a) Number of transmit chains modelled in LLS |
| (3) Total transmit power (dBm) Note: total transmit power for system bandwidth  |
| (3a) System bandwidth for downlink, or occupied bandwidth for uplink (Hz) |
| (3b) Power Spectrum Density = (3) - 10 log( (3a) / 1000000 ) (dBm/MHz) Note: For FR1 downlink, (3b) should satisfy the following:  For 4GHz frequency, 24 and 33 For 2.6 GHz frequency, 33 For 700MH and 2GHz frequency, 36Note: For FR2 downlink, the following should be satisfied: 40 dBm for 100 MHz Urban scenario, 23 dBm for 100 MHz Indoor scenario.Note: no PSD constraint for uplink |
| (3c) Bandwidth used for the evaluated channel (Hz)Note: (3c) is identical to the number of PRBs assigned to the channel evaluated. For uplink, (3a) = (3c)  |
| (3bis) Total transmit power for occupied bandwidth = (3b) + 10 log ( (3c) / 1000000 ) (dBm) |
| (4) Total antenna gain at antenna gain component 3 & antenna gain component 4 of transmitter = (4a) – (4b) (dB) |
| (4a) Antenna gain at antenna gain component 3 & antenna gain component 4 of transmitter = (4c) + 10 log ( (1) / (2) ) (dB) for downlink, and = (4c) + 10 log ( (1) / (2a) ) (dB) for uplink |
| (4b) Antenna gain correction factor at antenna gain component 3 & antenna gain component 4 of transmitter (dB) |
| (4c) Gain of antenna element (dBi)  |
| (5) Total antenna gain at antenna gain component 2 of transmitter = (5a) - (5b) (dB)Note: zero for uplink |
| (5a) Antenna gain at antenna gain component 2 of transmitter = 10 log( (2)/(2a)) (dB)Note: zero for uplink |
| (5b) Antenna gain correction factor at antenna gain component 2 of transmitter (dB)Note: zero for uplink |
| (8) Cable, connector, combiner, body losses, etc. (enumerate sources) (dB) (feeder loss must be included for and only for downlink) |
| (9) EIRP = (3bis) + (4) + (5) – (8) dBm |
| **Receiver** |
| (10) Number of receive antenna elements |
| (10a) Number of receive [ (receive TxRUs) or (modelled receive chains)]Note: this row is void (empty) for downlink |
| (10b) Number of receive chains modelled in LLS |
| (11) Total antenna gain at antenna gain component 3 & antenna gain component 4 of receiver = (11a) - (11b) (dB)  |
| (11a) Antenna gain at antenna gain component 3 & antenna gain component 4 of receiver  = (11c) + 10 log ( (10)/(10a) ) (dB) for uplink = (11c) + 10 log ( (10)/(10b) ) (dB) for downlink |
| (11b) Antenna gain correction factor at antenna gain component 3 & antenna gain component 4 of receiver (dB) |
| (11c) Gain of antenna element (dBi) |
| (11bis) Total antenna gain at antenna gain component 2 of receiver = (11bis-a) - (11bis-b) (dB)Note: zero for downlink |
| (11bis-a) Antenna gain at antenna gain component 2 of receiver = 10 log( (10a)/(10b)) (dB)Note: zero for downlink |
| (11bis-b) Antenna gain correction factor at antenna gain component 2 of receiver (dB)Note: zero for downlink |
| (12) Cable, connector, combiner, body losses, etc. (enumerate sources) (dB) (feeder loss must be included for and only for uplink) |
| (13) Receiver noise figure (dB) |
| (14) Thermal noise density (dBm/Hz) |
| (15) Receiver interference density (dBm/Hz)  |
| (16) Total noise plus interference density = 10 log (10^(( (13) + (14))/10) + 10^((15)/10)) (dBm/Hz) |
| (18) Effective noise power = (16) + 10 log ((3c)) (dBm) |
| (19) Required SNR (dB) |
| (20) Receiver implementation margin (dB) |
| (21) H-ARQ gain (dB)Note: Only applicable if HARQ is not considered in LLS |
| (22) Receiver sensitivity = (18) + (19) + (20) – (21) (dBm) |
| (22bis) MCL = (3bis) – (22) + (5) + (11bis) (dB) |
| (23) Hardware link budget, a.k.a. MIL = (9) + (11) + (11bis) − (12) − (22) (dB)Note: MIL can also be derived by (22bis) + (4) – (8) + (11) − (12) |
| **Calculation of available pathloss** |
| (25) Shadow fading margin (function of the cell area reliability and lognormal shadow fading std deviation) (dB) |
| (26) BS selection/macro-diversity gain (dB) |
| (27) Penetration margin (dB) |
| (28) Other gains (dB) (if any please specify) |
| (29) Available path loss = (23) – (25) + (26) – (27) + (28) (dB) |
| **Range/coverage efficiency calculation** |
| (30) Maximum range (based on (29) and according to the system configuration section of the link budget) (m) |

* The values for following parameters are provided together with the link budget template
	+ The details how to provide the values (i.e. by introducing rows in the same/different tab, by different excel file, by different tabs, etc. ) is up to rapporteur and feature leads.

|  |
| --- |
| Scenarios |
| Carrier frequency (GHz) |
| BS antenna heights (m) |
| UT antenna heights (m) |
| Cell area reliability (%) |
| Lognormal shadow fading std deviation (dB) |
| Pathloss model (select from LoS or NLoS) |
| UE speed (km/h) |
| Channel for evaluation |
| UL-DL configuration for TDD |
| Subcarrier Spacing |
| Channel model for link level simulation |
| Frequency hopping |
| Number of PRBs, TBS and MCS |
| BWP size |
| DMRS configuration |
| Waveform |
| Repetition |
| HARQ configuration |
| Latency requirements for voice  |
| PUCCH format type |
| Tx Diversity |
| Target error rate (BLER, miss detection, false alarm, etc.) |
| ~~Number of SSB for broadcast PDCCH of Msg.2~~ |
| PRACH format  |
| Number of SSB  |
| Correlation for TxRU at BS |
| Description on how the value in antenna gain correction factor in (4b) is derived |
| Description on how the value in antenna gain correction factor in (5b) is derived |
| Description on how the value in antenna gain correction factor in (11b) is derived |
| Description on how the value in antenna gain correction factor in (11bis-b) is derived |
| Description on how the value in (8) is derived |
| Description on how the value in (12) is derived |
| Other parameters |

* For (13) Receiver noise figure, the following values are adopted
	+ For FR1: 7dB for UE and 5dB for BS
	+ For FR2: 10dB for UE and 7dB for BS
* For other parameters/values with FFS, square bracket or no agreement, interested companies are encouraged to continue their assessment aiming at the final resolution at RAN1#103-e.
	+ Detailed information can be find in the attached excel spreadsheet, i.e. link-budget-template-v011

Please note that link-budget-template-v011 is found from the following link:

<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/fine_tuning/link-budget-template-v011.xlsx>

Companies are invited to provide the view, especially the concerns.

|  |  |
| --- | --- |
| Company  | Comment |
| Huawei, HiSilicon | Regarding issue (3-4) “for uplink, (3a) = (3c)”, it is very confusing and misleading to say that the evaluated number of PUSCH/PUCCH PRBs (3c) should be equal to 20 MHz (3a). Please remove it. If its motivation is to make sure that the calculation (3bis) is equal to (3) for uplink, then please directly add a note under (3bis) or directly formulate it as (3bis) = (3) for uplink (i.e. no connection to (3b)) because the note under (3b) “no PSD constraint for uplink” has prevented (3b) from being an input for any uplink calculation.Regarding (2) and (10a) with change like “[ (receive TxRUs) or (modelled receive chains)]”, as commented before, we are OK with either no change or transmit/receive antenna ports as TR 37.910, but it is not helpful to introduce brackets which makes a previous agreement become open issue. In our understanding, with respect to a previous agreement, it should be either no change or some concrete revision. |
| Ericsson | Regarding Yosuke’s proposal below from email discussion, (2) and (10a) are worded inconsistently. Can we introduce ‘transmit’ to align them? Moreover, I think we’re getting stuck on terminology. While it is important to get terminology right because TRs become precedents for future work, we can resolve this later. Yosuke’s approach to leave a placeholder for further discussion seems appropriate then. We might have a note that the exact terminology is to be decided later. If we have possible alternatives in square brackets, I would prefer to list all of them rather than downselect now, and to clarify in the note that other terminology is not excluded. For me, it is OK to have only the note or both the note and square bracketed full list of alternatives. (2) Number of transmit [(transmit TxRUs) or (modelled transmit chains)]    Note:  this row is void (left empty) for uplink    (10a) Number of receive [(receive TxRUs) or (modelled receive chains)]    Note: this row is void (empty) for downlink    Regarding the note on (3a)=(3c), since (3a) is the occupied bandwidth when UL results are reported, I don’t think the note is incorrect. On the other hand, since (3a) is the system bandwidth for downlink, and since (3c) is the used bandwidth, I’m not sure that the note actually improves clarity, and so may not be needed. No strong view, though.For (15), a thermal noise density of -174 dBm/Hz should be non-controversial 😊.For the value of (20) receiver implementation margin, we think 0 dB may be appropriate for the purpose of evaluation in this study, especially since we already have noise figure. If non-zero values are used, what the losses represent should be explained. |
|  |  |
|  |  |

### Final proposal

Given the comment from the companies at the fine-tuning round, FL would like to propose the following:

**FL proposal 1:**

* Agree the following link budget template

|  |
| --- |
| **Transmitter** |
| (1) Number of transmit antenna elements. |
| (2) Number of [~~(~~transmit TxRUs~~) or (modelled transmit chains)~~]Note: this row is void (left empty) for uplink |
| (2a) Number of transmit chains modelled in LLS |
| (3) Total transmit power (dBm) Note: total transmit power for system bandwidth  |
| (3a) System bandwidth for downlink, or occupied bandwidth for uplink (Hz) |
| (3b) Power Spectrum Density = (3) - 10 log( (3a) / 1000000 ) (dBm/MHz) Note: For FR1 downlink, (3b) should satisfy the following:  For 4GHz frequency, 24 and 33 For 2.6 GHz frequency, 33 For 700MH and 2GHz frequency, 36Note: For FR2 downlink, the following should be satisfied: 40 dBm for 100 MHz Urban scenario, 23 dBm for 100 MHz Indoor scenario.Note: no PSD constraint for uplink |
| (3c) Bandwidth used for the evaluated channel (Hz)Note: (3c) is identical to the number of PRBs assigned to the channel evaluated. For uplink, (3a) = (3c)  |
| (3bis) Total transmit power for occupied bandwidth = (3b) + 10 log ( (3c) / 1000000 ) (dBm) |
| (4) Total antenna gain at antenna gain component 3 & antenna gain component 4 of transmitter = (4a) – (4b) (dB) |
| (4a) Antenna gain at antenna gain component 3 & antenna gain component 4 of transmitter = (4c) + 10 log ( (1) / (2) ) (dB) for downlink, and = (4c) + 10 log ( (1) / (2a) ) (dB) for uplink |
| (4b) Antenna gain correction factor at antenna gain component 3 & antenna gain component 4 of transmitter (dB) |
| (4c) Gain of antenna element (dBi)  |
| (5) Total antenna gain at antenna gain component 2 of transmitter = (5a) - (5b) (dB)Note: zero for uplink |
| (5a) Antenna gain at antenna gain component 2 of transmitter = 10 log( (2)/(2a)) (dB)Note: zero for uplink |
| (5b) Antenna gain correction factor at antenna gain component 2 of transmitter (dB)Note: zero for uplink |
| (8) Cable, connector, combiner, body losses, etc. (enumerate sources) (dB) (feeder loss must be included for and only for downlink) |
| (9) EIRP = (3bis) + (4) + (5) – (8) dBm |
| **Receiver** |
| (10) Number of receive antenna elements |
| (10a) Number of [ ~~(~~receive TxRUs~~) or (modelled receive chains)~~]Note: this row is void (empty) for downlink |
| (10b) Number of receive chains modelled in LLS |
| (11) Total antenna gain at antenna gain component 3 & antenna gain component 4 of receiver = (11a) - (11b) (dB)  |
| (11a) Antenna gain at antenna gain component 3 & antenna gain component 4 of receiver  = (11c) + 10 log ( (10)/(10a) ) (dB) for uplink = (11c) + 10 log ( (10)/(10b) ) (dB) for downlink |
| (11b) Antenna gain correction factor at antenna gain component 3 & antenna gain component 4 of receiver (dB) |
| (11c) Gain of antenna element (dBi) |
| (11bis) Total antenna gain at antenna gain component 2 of receiver = (11bis-a) - (11bis-b) (dB)Note: zero for downlink |
| (11bis-a) Antenna gain at antenna gain component 2 of receiver = 10 log( (10a)/(10b)) (dB)Note: zero for downlink |
| (11bis-b) Antenna gain correction factor at antenna gain component 2 of receiver (dB)Note: zero for downlink |
| (12) Cable, connector, combiner, body losses, etc. (enumerate sources) (dB) (feeder loss must be included for and only for uplink) |
| (13) Receiver noise figure (dB) |
| (14) Thermal noise density (dBm/Hz) |
| (15) Receiver interference density (dBm/Hz)  |
| (16) Total noise plus interference density = 10 log (10^(( (13) + (14))/10) + 10^((15)/10)) (dBm/Hz) |
| (18) Effective noise power = (16) + 10 log ((3c)) (dBm) |
| (19) Required SNR (dB) |
| (20) Receiver implementation margin (dB) |
| (21) H-ARQ gain (dB)Note: Only applicable if HARQ is not considered in LLS |
| (22) Receiver sensitivity = (18) + (19) + (20) – (21) (dBm) |
| (22bis) MCL = (3bis) – (22) + (5) + (11bis) (dB) |
| (23) Hardware link budget, a.k.a. MIL = (9) + (11) + (11bis) − (12) − (22) (dB)Note: MIL can also be derived by (22bis) + (4) – (8) + (11) − (12) |
| **Calculation of available pathloss** |
| (25) Shadow fading margin (function of the cell area reliability and lognormal shadow fading std deviation) (dB) |
| (26) BS selection/macro-diversity gain (dB) |
| (27) Penetration margin (dB) |
| (28) Other gains (dB) (if any please specify) |
| (29) Available path loss = (23) – (25) + (26) – (27) + (28) (dB) |
| **Range/coverage efficiency calculation** |
| (30) Maximum range (based on (29) and according to the system configuration section of the link budget) (m) |

**FL proposal 2:**

* The values for following parameters are provided together with the link budget template
	+ The details how to provide the values (i.e. by introducing rows in the same/different tab, by different excel file, by different tabs, etc. ) is up to rapporteur and feature leads.

|  |
| --- |
| Scenarios |
| Carrier frequency (GHz) |
| BS antenna heights (m) |
| UT antenna heights (m) |
| Cell area reliability (%) |
| Lognormal shadow fading std deviation (dB) |
| Pathloss model (select from LoS or NLoS) |
| UE speed (km/h) |
| Channel for evaluation |
| UL-DL configuration for TDD |
| Subcarrier Spacing |
| Channel model for link level simulation |
| Frequency hopping |
| Number of PRBs, TBS and MCS |
| BWP size |
| DMRS configuration |
| Waveform |
| Repetition |
| HARQ configuration |
| Latency requirements for voice  |
| PUCCH format type |
| Tx Diversity |
| Target error rate (BLER, miss detection, false alarm, etc.) |
| PRACH format  |
| Number of SSB  |
| Correlation for TxRU at BS |
| Description on how the value in antenna gain correction factor in (4b) is derived |
| Description on how the value in antenna gain correction factor in (5b) is derived |
| Description on how the value in antenna gain correction factor in (11b) is derived |
| Description on how the value in antenna gain correction factor in (11bis-b) is derived |
| Description on how the value in (8) is derived |
| Description on how the value in (12) is derived |
| Other parameters |

**FL proposal 3:**

* ~~For (13) Receiver noise figure, the following values are adopted~~
	+ ~~For FR1: 7dB for UE and 5dB for BS~~
	+ ~~For FR2: 10dB for UE and 7dB for BS~~
* For ~~other~~ parameters/values with FFS, square bracket or no agreement, interested companies are encouraged to continue their assessment aiming at the final resolution at RAN1#103-e.
	+ Detailed information can be find in the attached excel spreadsheet, i.e. link-budget-template-v013
	+ Note: link-budget-template-v013 is found from the following link:
	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/fine\_tuning/link-budget-template-v013.xlsx

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

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

Update on 6/5:

Agreement:

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

Agreement:

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

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

Agreement:

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

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

Agreements:

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

Agreements:

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

Agreements:

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

Agreements:

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

Agreements:

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

Agreements:

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

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

Final summary in R1-2005004.

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

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

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

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

Update on 6/12:

Agreements

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

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

Agreements

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

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

Agreements:

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

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

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

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

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

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

Agreements:

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

Other proposals?

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

Update on 6/17

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

Agreements:

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

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

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

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

Other proposals 6/18

Update on 6/18:

Agreements:

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

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

Agreements:

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

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

Agreements:

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

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

Agreements:

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

Agreements:

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

Agreements:

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

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

Agreements:

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

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

Agreements:

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

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

Agreements:

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

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

Agreements:

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

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

Agreements:

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

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

Agreements:

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

Final summary in R1-2005192.

# 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%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_102%5CDocs%5CR1-2005259.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

**Agreement:**

* Antenna array gain at a UE for FR1 and FR2 is clarified as follows:
	+ The meaning of *k, N* and *M:*
		- $k$ is the number of Tx/Rx chains, e.g., number of SRS/CSI-RS ports to be simulated in LLS.
		- $M$ is the number of antenna elements used both for transmission and reception, i.e., $\frac{M}{2}$ 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
			* $k=1$ for Tx (optional *k* = 2)
			* $k\in \{2,4\}$ for Rx
		- For FR2, there are two possibilities for simulations:
			* $k\in \{1,2\}$; for Tx and $k=2$ for Rx; or
			* $k=M$.
	+ Antenna array gain in transmission/reception to input in link budget template is given by
		- $Antenna Element Gain+10\*log\_{10}\left(\frac{M}{k}\right)-Δ3$, where
			* $Δ3(\geq 0 \left[dB\right]) $is a correction factor to account for various non-idealities impacting the actual antenna array gain, if any
				+ For FR1, $Δ3=0$.
				+ 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

**Agreement:**

* 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) -$ Δ3$
* UE transmit antenna gain is given by row No. (4) + row No. (5) -$ Δ3$

**Agreement**

* 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~~