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

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

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

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

**Agenda Item: 8.8.1.1 and 8.8.1.2**

**Document for: Information**

# Introduction

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

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

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

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

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

* 1st round (Initial collection of companies view) … 9/7 – 12:00 UTC of 9/10
* 2nd round (Provision of FL proposals and fine-tuning) … 9/11 - 9/16 …
	+ Please provide your views on FL proposals until 7pm UTC of 9/14
	+ **Please provide your views on updated FL proposals until 12:00 UTC of 9/16**
* 3rd round (Final proposal) … 9/17 at the latest

# Open issues

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

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

Agreements (for both FR1 & FR2):

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

Agreements:

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

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

Agreements:

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



Table A. antenna gain components for TDL option 1



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

**Remaining issue:**

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

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

Companies are invited provide your view on these issues.

|  |  |
| --- | --- |
| Company  | Comment |
| Ericsson | Since one total gain value is probably all that is needed for UE, suggest to follow what was done in the agreement for AGC 3+4: Antenna Gain = Antenna Element Gain + 10 \* log 10(N/k) - 3Where companies report 3.Also, I think N is captured in (1) transmit antennas and k is in (1bis) antenna ports.**Update**:Support Alt1 for UE Tx antenna gain with 5 dBi. It will be even harder to align results if a value for UE antenna gain can’t be agreed. |
| Nokia/NSB | Agree with Ericsson. |
| Samsung | Fine with Ericsson’s suggestion with following clarification:With reference to IMT-2020 self-evaluation template, N is captured in (1), k is captured in (1bis), and Antenna Element Gain is captured in (4) |
| vivo | We would like to clarify/understand some aspects for this proposal:Whether the UE array gain modeling in the proposal is common for both DL (Rx antenna) and UL (Tx antenna), and whether it is common for FR1 and FR2?In FR1, for DL channels, UE may have 4Rx, which means N=k=4, and for UL, only 1 Tx is used, and N=k=1 for UL. Is this understanding correct?Besides, we would like to clarify which non-ideal factors are supposed to be reflected by 3? According to the discussion in gNB side, 1 and 2 basically reflect the difference in antenna gain for broadcast and unicast, and antenna gain loss caused by tilt angle from the bore-sight direction of gNB panel. These factors are not applicable for FR1 UE, since it is less likely that a FR1 UE perform UL beamforming for UL transmission, and the antenna pattern in FR1 is usually omni-directional in FR1, according to ITU-M.2412. For FR2, the UE antenna is not omni-directional, then is 3 supposed to reflect the antenna gain loss caused by tilt angle from the bore-sight direction of UE panel, which means 3 at UE is similar to 2 at gNB side? |
| Qualcomm | Assuming the above proposal only applies to UE Tx.We are okay to go with Alt 1 for both array gain and antenna element gain. We prefer to clarify that for FR1, N = 1. For FR2, N can be based on agreements in sub-agenda 8.8.1.2. We are okay to report a single gain that combines antenna element gain and antenna array gain.Will there be an equivalent proposal for UE Rx? (It is not that important for FR1 but might matter for FR2) |
| Intel | We support Alt. 1 for UE antenna gain. In addition, we share similar view as other companies that k is captured in (1bis).For the second bullet, transmit antenna gain at the UE (dBi) is already included in the LB template, i.e., in (4). We do not need to add this in the template. For the specific value, we slightly prefer Alt. 1 to align the results among companies.  |
| ZTE | Regarding antenna array gain modeling for UE: We prefer Alt1, and the same modeling should apply to both transmitter side for UL, i.e., (1)/(1bis)/(4)/(5), and receiver side for DL, i.e., (10)/(10bis)/(11)/(11bis). But, as vivo mentioned, the detailed values for related components could be different.Regarding transmitter antenna gain at the UE (dBi): We prefer a value of 0dBi as used in IMT-2020 self-evaluation template. |
| Huawei, Hisilicon | In the proposal, *k* refers to the number of antenna portwhile *N* to the number of antenna elements. However, in the picture of Table A, they have different meaning, i.e. *k* referring to the number of RF chains while *N* to the number of antenna port and *M* to the number of antenna elements. The mismatch could make the proposal confusing.In the discussion of antenna gain at BS, the motivation to use k (with a small number) in LLS was to reduce the simulation workload and introduce to compensate the antenna array gain loss for the gain modeling 10\*log10(X) because the number of TxRU at BS can be as high as 64 and the number of antenna element can be as high as 192. However, at the UE side, the number of antenna N is much smaller, e.g. up to 4 for FR1 and up to 8 for FR2. Therefore, the simulation workload with N antenna elements or ports in LLS will be acceptable, i.e. k=N, resulting in no need of introducing additional gain modeling 10\*log10(X) nor 3 anymore.Therefore, we suggest that the antenna array gain at UE side (without antenna element gain) is directly included in the LLS results, i.e. required SNR.  |
| CATT | We prefer to Alt.1. We share same view with ZTE’s that 0dBi for transmitter antenna gain should be used as IMT-2020 self-evaluation template. |
| OPPO | We would like to clarify/understand some aspects for this proposal:image.pngIn the picture of Table A, the number of antenna elements is denoted by *M*, and the number of antenna port is denoted by *N*, the number of RF chains is denoted by *k*(*k*≤*N*) for reducing the simulation workload. However, in the proposal, *k* refers to the number of antenna portwhile *N* to the number of antenna elements, and the *k* is much smaller, thus may not need a smaller number of RF chains to reduce the simulation workload. Which means the number of RF chains = the number of antenna port. It seems to become the Table B:image.pngWe suggest make an update on the proposal:* + Let *~~k~~N* be the number of transmit antenna ports and *~~N~~M* be the number of AEs at UE. With reference to IMT-2020 self-evaluation template, *~~N~~M* is captured in (1) and *~~k~~N* in (2). Antenna array gain value (dB) is captured in (5) and:
		- Alt1: it is obtained as 10 \* log 10(*~~N/k~~**M/N*) -3. Companies report 3
		- Alt2: it is obtained as 10 \* log 10(*~~N/k~~**M/N* ).
		- Alt3: other [proposals are welcome]

We support Alt. 1 for UE antenna gain. In addition, the number of transmit antenna ports is denoted by N and captured in (2), the number of AEs at UE is denoted by M and captured in (1).In LB, (4) = (4a) – (4b), while (4a) = gain of antenna element + 10log((1)/(2)), we support a new row for transmitter antenna gain at the UE (dBi) is added to LB template. And prefer the Alt.1 : companies agree on a specific value, e.g., 5 dBi. |
| CMCC | Not quite understand this issue is relevant to FR1 or FR2 or both. Since the architecture of UE antennas could be different, the value of k and N should be different. For FR1, the k and N should be 1 for uplink. And in downlink, both k and N should be 4. And the port value k should be considered in the LLS and required SINR. If the LLS do not considered the k ports, the margin should be considered in the link budget. And the UE antenna gain should be 0 dBi in FR1. And Delta 3 should be 0 in FR1.For FR2, the k should be 1 and N could be 8 for uplink. And in downlink, k could be 2 and N is 8. Then antenna gain of UE in FR2 could be 3dBi or 5dBi. And none zero value of delta 3 should be considered. |

**FL perspective follows:**

* Antenna array gain: situation is complex and there might be misunderstandings between companies on the meaning of *k, N* and *M*. Maybe we could start from the basic definitions and build up the understanding. We are considering rank-1 transmission in the UL, i.e., 1 DMRS processed by baseband*.* From FL’s perspective the following situation occurs at both FR1 and FR2 at the UE:
	+ $k$ 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 AEs used both for transmission and reception, i.e., $\frac{M}{2}$ xpol AEs.

A formal definition of *N* is not given because from FL’s perspective it does not seem relevant for the definition of antenna array gain to be used for the LB at UE.

Concerning the values of $k$ and $M$, we have the following situation:

* + - FR1. According to FL’s understanding, in this case we have that
			* 1. $k=1$ for TX (optional *k* = 2)
				2. $k\in \{2,4\}$ for RX

However, it is not clear from the past agreements if this always implies that $k=M$.

* + - FR2. There are two possibilities for simulations:
			* 1. $k\in \{1,2\}$;
				2. $k=M$.

Let $Δ3\geq 0 [dB] $be a correction factor to account for various “non-idealities” impacting the the actual antenna array gain, if any. In this regard, we have the following situation:

* + FR1: Omnidirectional antennas are typically used by UE, hence $Δ3=0 $in FR1.
	+ FR2: UL beamforming can be used in FR2, and actual antenna array gain may depend on aspects such as the tilt angle from the bore-sight direction of UE panel, whether operations are performed in RRC\_connected at FR2 (i.e., whether requirements for beam correspondence exist or not) state and so on. Therefore,3 is channel procedure/dependent at FR2, e.g., larger prior to RRC connection, and should be reported by companies.

Given the above, the antenna array gain in transmission/reception to input in LB template is then given by

* + - $Antenna Element Gain+10\*log\_{10}\left(\frac{M}{k}\right)-Δ3$, if $k\in \{1,2\}$ and $k\ne M$
		- Antenna Element Gain, if $k=M$

Please note that:

* + - The above antenna array gain calculation would be valid in general for both FR1 and FR2, given that $10\*log\_{10}\left(\frac{M}{k}\right)=0$, when $M=k$
		- An additional gain up to 10log10(k) dB can be observed in LLS, due to baseband processing when only $k\in \{1,2\}$ SRS/CSI-RS ports are simulated. However, this would not impact EIRP.
		- If $k=M$ SRS/CSI-RS ports are simulated, then
			1. Properly calculating the EIRP may be less straightforward and a further discussion should be carried out.
			2. Properly capturing the difference between RRC\_connected state or not at FR2 may be less straightforward.
			3. TDL channel model may not be suitable.

Probably this may suggest not to consider the $k=M$ option for simulation at the UE, but proposals are welcome.

As a last element, FL observes that different preferences may exist among companies concerning the value to consider for the antenna element gain. This aspect does not seem to need an understanding but rather a simple agreement. More precisely, we have the following situation:

* + FR1: Omnidirectional antennas are typically used by UE at FR1, hence antenna element gain is 0dBi for FR1
	+ FR2: According to first round of comments, two options seem a viable way forward and companies are invited to add their names in the row corresponding to the preferred value and decision can be taken afterwards:

|  |  |
| --- | --- |
| Antenna element gain for FR2 | Supporting companies |
| 5 dBi | Ericsson, OPPO, CMCC, Intel, Samsung, Nokia/NSB, vivo, Huawei/HiSilicon |
| 0 dBi | ZTE, CATT |

Please provide your view on FL perspective. Also, please input your company name in the table above for antenna element gain for FR2.

|  |  |
| --- | --- |
| Company  | Comment |
| Huawei， Hisilicon | In the FL’s updated description, N is ignored and $Δ3$ accounts for all various non-ideal antenna array gain, which simplifies the antenna array gain in link budget template. We agree with FL’s following proposal for FR2* $Antenna Element Gain+10\*log\_{10}\left(\frac{M}{k}\right)-Δ3$, if $k\in \{1,2\}$ and $k\ne M$
* Antenna Element Gain, if $k=M$

and $Δ3$ is up to company’s report.Concerning the antenna element gain, we agree with FL’ proposal that 0dBi is used for omnidirectional antennas in FR1 and 5 dBi is used for FR2.  |
| * + 1. Samsung
 | * + 1. Given FL’s clarification on *k* and *M*, FL’s proposal is fine with us:
* $Antenna Element Gain+10\*log\_{10}\left(\frac{M}{k}\right)-Δ3$, if $k\in \{1,2\}$ and $k\ne M$
* Antenna Element Gain, if $k=M$

In addition, to make it more simple, we may combine above just one line:* $Antenna Element Gain+10\*log\_{10}\left(\frac{M}{k}\right)-Δ3$

(this includes the cases of *k = M* and Δ3 = 0)* + 1. Regarding antenna element gain for FR2, we want to keep a single agreed value and fine with 5dBi. (also updated in above table)
 |
| vivo | In FR1, k=M=1 can be assumed for UE Tx, and k=M=4 can be assumed for UE Rx.For FR2, UE Rx, the following antenna array gain can be assumed * + - $Antenna Element Gain+10\*log\_{10}\left(\frac{M}{k}\right)-Δ3$, if $k\in \{1,2\}$ and $k\ne M$

While for UE Tx in FR2, the ‘transmission power’ is agreed to be 23dBm in FR2, in RAN1#102e, as follows* 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.

However, in our opinion, 23dBm Tx EIRP, which corresponds to 22.4dBm MPE requirements in RAN4, is more reasonable than 23dBm Tx power. If 23dBm EIRP can be assumed for UE Tx in FR2, we can avoid the discussion for UE antenna gain components, at least for TDL option 1. Alternatively, antenna gain components can be clearly defined, and $Δ3$ can be determined such that the UE Tx EIRP is equal to 23dBm for FR2.For antenna element gain for FR2, we believe 5dBi should be assumed. |
| Ericsson | Agree in general with the FL perspective. Some comments/suggestions:* Support vivo that 23 dBm EIRP should be used for FR2. This is important to sort this out, given the high amount of antenna gain for UEs in FR2.
* It is important to use antenna element gain for FR2. Values such as 5 dBi are more realistic than 0 dBi for Rel-15/16/17.
* If antenna element gain is larger than 0, then Δ3 for the UE at FR2 will likely be greater than 0, since the UE will not point at the gNB. So Δ3 can be appropriate even when k=M.
* Regarding simulating with k=M as an option in addition to k=1 or k=2 at the UE for FR2, we do not have a strong view. However, such simulations should be reflective of analog beamforming for FR2.
* Minor comment: When k=2 and for UL MIMO simulation, Rel-15 UL MIMO power scaling assumes that each Tx chain has half power. So EIRP should be summed across UE Tx antenna ports.
 |
| Intel | We support FL’s proposal for UE antenna element gain in FR1 and FR2. We share similar view as Samsung that a unified equation for antenna array gain can be considered, where k = M and Δ3 = 0 are also covered by the equation.  |
| Nokia/NSB | Support the FL’s proposal that 0 dBi and 5 dBi are used for UE antenna element gain in FR1 and FR2, respectively.Concerning Δ3, we would like to add that from our perspective this correction factor does not only depend on gNB’s position w.r.t. UE, as mentioned above, but also on the considered channel/procedure. Assume a maximum theoretical antenna array gain of N dB for the sake of the argument. The share of these N dB that UE may enjoy at different stages/steps of the communication with gNB is not deterministic and depends on the BM procedures in place, if any, on whether UE is in RRC-connected state or not and, among other things, on the beam-width of the UE TX beam. In this sense, for instance, msg3 transmissions over PUSCH may not enjoy these N dBs, whereas “RRC-connected” PUSCH transmissions may enjoy at least part of those N dBs, depending on how finely aligned UE TX beam is with UE panel bore-sight. This will affect, for instance, how the actual UL EIRP values will vary during operations, even if TRP is constant (i.e., 23 dBm as per RAN1 agreements). We should make sure this understanding is properly considered in the antenna array gain modelling. Conversely, if these implications are not considered by RAN1, the UL part of the FR2 study would be relying on too simple assumptions on the actual antenna array gain an FR2 UE may enjoy in practice, in turn reducing the validity and relevance of the results. |
| Qualcomm | 0 dBi antenna element gain for FR1 and 5 dBi antenna element gain for FR2 makes sense. Please clarify the exact formula to be used for FR1 and FR2. For FR1, we think k=M makes sense and it suffices to only take antenna element gain into account.For FR2, we are okay to go with FL’s proposal:* $Antenna Element Gain+10\*log\_{10}\left(\frac{M}{k}\right)-Δ3$, if $k\in \{1,2\}$ and $k\ne M$
 |

**Summary of the discussion:**

7 companies joined the discussion, and their view is summarized as follows:

* **Definition of antenna gain for UE**
	+ All the companies are OK for the definition in principle. Small comments for clarification/refinement were made:
		- The equation for antenna gain can be unified
		- $Δ3$ may not be zero even when *k*=*M*, if AE gain is larger than 0 dBi
		- For FR1, *K=M* is assumed by two companies
* **Value for antenna element gain**
	+ During the 1st round email discussion, there were companies who supported 0 dBi for FR2.
	+ However at this round, all the companies who provided their views showed their preference on 5 dBi for FR2
	+ FL’s perspective is that we can go with the majority view, i.e. 5 dBi, because may companies think this is reasonable.
* **Transmit power / EIRP**
	+ Two companies proposed to use EIRP of 23dBm instead of 23 Tx power of 23dBm.
	+ FL's perspective is that no technical discussion was held so far about this topic in AI 8.8. It may be argued that this is the reason why comments were made and this would be a fair point. However, we should avoid mixing topics to avoid inefficiencies in the discussions.
	+ Current situation is that RAN1 agreed on FR2 UE TRP value, and a discussion on antenna array again modeling is currently ongoing. It may be advisable to ensure a proper modeling and understanding of the latter is achieved prior to discussing other aspects, if applicable/relevant, to ensure relevance and consistency of the results.

Given the analyses above, FL would like to propose the following:

**FL proposal:**

* 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:
			* $k\in \{1,2\}$;
			* $k=M$.
	+ 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

Please provide your view on the FL proposals above.

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| --- | --- |
| Company  | Comment |
| Ericsson | Support the FL proposal in general. The following should be clarified for the UE:* + - For FR2, there are two possibilities for simulations:
			* $k\in \{1,2\}$ for Tx and $k=2$ for Rx; or
			* $k=M$.

We also have continue to have a concern on FR2 UE Tx power and think it is essential to clarify. **Can we have a note in the agreement: ‘Note: Refinement of UE Tx power values for FR2 is to be further discussed’?**In more detail: Coverage with 23 dBm EIRP is dramatically different than having two 20 dBm PAs on Tx chains having 11 dBi maximum gain each. Therefore it is critical to reach common understanding on these values. The relevant agreement (copied below) says that ‘other values may be reported’, which leaves room for further refinement of the values. * 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.
 |
| ZTE | Fine with the proposal.It’s our understanding that, the uplink transmit power of 23dBm in FR2 was clarified as the value of total transmit power (3) in the ITM-2020 template rather than the EIRP during RAN1#102-e meeting. It seems no need further discussion on this.  |
| Samsung | Support FL proposal |
| Intel | We are fine with the FL proposal and the update from Ericsson on the number of Rx chains in FR2.  |
| CATT2 | We are fine with FL proposal. |
| vivo | Support the FL proposal.Since$Δ3$ can be reported by companies, $Δ3$ can be selected to make sure the Tx EIRP is 23dBm, which means $Δ3$ would also be different for UL and DL channels for FR2. |
| OPPO | Support the FL proposal. |
| Qualcomm | Support the FL proposal.  |
| Huawei, Hisilicon | Support FL’s proposal |
| Nokia/NSB | Support the FL’s proposal. |
| CMCC | Support FL’s proposal.For the issue of 23dBm transmit power, we share a similar view with Ericsson and vivo (in the last round). 23 dBm EIRP for UE transmission in FR2 is more appropriate, which is also aligned with RAN4 requirements. We propose to add a note for refinement or revisit agreement of the 23dBm Tx power in FR2 in a proper time. |

**FL perspective:**

First of all, both FLs would like to remind all companies that the earlier we manage to conclude the first phase of the discussion the easier will be for everyone to handle the subsequent two phases of the email discussion. In this context, adding notes which pave the way to revisiting/reversion of agreements may not be a good practice, nor desirable. Especially when the note does not pertain the object of the agreement as such. From FL’s perspective keeping clean and self-contained agreements is preferable to avoid ambiguities and maximize efficiency of present/future discussions.

The current situation is as follows:

* An agreement on Tx UL power has been made during RAN1 #102-e. Therein a baseline value for UL Tx power is agreed, and possibility for companies to report other values is agreed as well.
* An agreement on UE antenna array gain modeling seems to be feasible, given the last round of comments to FL’s proposal. According to this likely agreement, companies would report their assumption on the correction factor.

With these two agreements in place, RAN1 would have agreed on a common framework which can be used by each company for the link budget study. This framework provides sufficient flexibility to companies to assume specific UE configurations which are considered (by said companies) as reasonable. This seems to be the most effective way forward, all differences of opinion considered.

Given the perspective above, FL would like to propose the following:

**FL updated proposal:**

* 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

Please provide your view on the FL proposals above, especially if you have a concern.

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

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

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

Agreements:

* For TDL Option 1
	+ Definition of MCL
		- Total transmit power – Receiver sensitivity + gNB antenna gain (component 2)
	+ Definition of MIL
		- Total transmit power – Receiver sensitivity + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain
	+ Definition of MPL
		- Further discussion offline the definition using below as a starting point:
			* Total transmit power – Receiver sensitivity + gNB antenna array gain (component 2+3+4 for TDL option 1) + UE antenna gain – (8) Cable, connector, combiner, body losses (Tx side) – (20) Receiver implementation margin + (21a/b) H-ARQ gain – (25a/b) Shadow fading margin + (26) BS selection/macro-diversity gain – (27) Penetration margin + (28) Other gains – (12) Cable, connector, combiner, body losses (Rx side)
	+ Note: whether/how to use the above definitions is to be discussed

Agreements:

For FR1 and FR2:

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

Agreements:

Definition of MPL for TDL option 1

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

**Remaining issues**

The following working assumption should be resolved:

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

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

|  |  |
| --- | --- |
| Company  | Comment |
| Ericsson | The working assumption should be modified to allow for 3 in UEs, as discussed in issue 1 of section 2.1**Update**:Agree (11) and (11bis) correspond to receive antennas, and support Nokia’s clarification.Regarding Samsung’s question, our understanding is that the correction factor is reported per channel per configuration. So transmit and receive as well as gNB and UE antenna gain correction factors can be different. That said, we can further check on if the antenna gain correction values can be set to be the same for transmit and receive for FR2 UE. |
| Nokia/NSB | Propose the following modification for this Issue* Issue 1
	+ (Working assumption for FR2) UE receive antenna gain corresponds to row No.(11)+No(11bis)

The working assumption should also be modified to allow account for the presence of 3 for the transmit antenna gain of UEs, [Row No. (4)], as discussed in issue 1 of section 2.1. |
| Samsung | Fine with modifying “UE receive antenna gain…”Since the corresponding agreement is for downlink case, antenna gain correction factor (3) should be for receive antenna not for transmit antenna. One clarification question – is the antenna gain correction factor the same or not between TX and RX? |
| Qualcomm | Same views as Nokia.  |
| Intel | We are fine to modify the proposal to “UE receive antenna gain…”.We think it is good to include the antenna gain correction factor only in Tx or Rx at gNB and UE side, but not both. |
| ZTE | Support the modification from Nokia. As commented in section 2.1, the same antenna array gain modeling for UE should be used for both transmitter side for UL and receiver side for DL. |
| Huawei, Hisilicon | As discussed in issue No. 1, the UE receive antenna gain can be directly included in LLS’s result “required SNR”. Hence, the value of No. (11bis) should be 0. We can accept that the table keep both No. (11) and No. (11bis) in the template, while leaving the actual antenna array gain included in the LLS results for both uplink and downlink. As a result, we suggest to confirm the working assumption with clarification that the value of No. (11bis) is 0 and antenna array gain included in LLS. |
| CATT | We are fine with Nokia’s modification |
| OPPO | Fine with Nokia’s modification |
| CMCC | The working assumption could be confirmed for FR2. For FR1, multiple port processing gains should have been considered in the LLS. We are open to the modification from Nokia.One more issue should be clarified. Will we have another round discussions for the uplink ? or is there any difference between uplink and downlink ? Uplink and downlink should be aligned from our understanding. |

**FL’s perspective**

For the moment the modification proposed by Nokia seems acceptable by all companies:

* Issue 1
	+ (Working assumption for FR2) UE receive antenna gain corresponds to row No.(11)+No(11bis)

However, there seem to be some doubts about UL and DL modelling and actual value of the receive antenna gain. FL would propose to wait until a high-level understanding for Issue 1 is achieved before debating this issues.

**Updated FL’s perspective:**

In addition to the proposal by Nokia, the introduction of correction factor ($Δ3$) seems agreeable to everyone as discussed in section 2.1. In addition, the additional questions raised by companies, i.e.

* unlink/downlink modelling for FR1 and FR2
* whether or not UE receiver gain is included in LLS

has also been covered by the discussion in section 2.1.

Given the analysis above, FL would like to make the final proposal on this issue:

**FL Proposal:**

* The working assumption for FR2 is updated as follows:
	+ UE receive antenna gain ~~corresponds to row~~ is given by row No.(11) + row No. (11bis) -$ Δ3$
* UE transmit antenna gain is given by row No. (4) -$ Δ3$

Please provide your view on the FL proposals above, especially if you have a concern.

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

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

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

**Open issues**

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

Companies are encouraged to provide their view on these issues above

|  |  |
| --- | --- |
| Company  | Comment |
| Ericsson | **Issue 3-1**:* H-ARQ gain should be included in MIL (as well as MCL), and therefore indirectly in MPL. If H-ARQ gain is in the link sims it is in MCL and MIL, and having it only in MPL if explicitly simulated does not make sense.
* No strong view on Shadow fading and penetration margin being separate, as long as how they are calculated is clear.
* Macro-diversity and ‘other’ gain can be provided by proponents if they wish, otherwise they should be zero.
* (21) on cable losses etc. can be included in MCL and MIL if values can be agreed.

**Issue 3-2**: Support FL proposal.**Issue 3-3**: Not sure what there is to discuss, so do not support the proposal. According to the agreement, it is clear that companies are allowed to select the appropriate value for each parameter, with IMT-2020 as a starting point.* + IMT-2020 values are as a starting point, but:
		- companies may use other values, and
		- for the parameters that companies think IMT-2020 self-evaluation does not clearly define the values for some scenarios, it is up to companies to report
 |
| Nokia/NSB | Agree with Ericsson on HARQ gain. Every other parameter contributing to MPL calculation should be reported by companies if not set to zero. |
| Samsung | Our preference on HARQ gain is Alt 1-2. As per agreed PUSCH/PDSCH eMBB evaluation assumptions, whether HARQ is adopted is reported by companies. If HARQ is not adopted in LLS result, the value of (21a/b) can be reported. Otherwise, it should be set to ‘0’For the others, we are fine to keep them to be aligned with IMT-2020 self-evaluation assumption as much as possibleFor Issue 3-2, we are OK to have the same definition. |
| vivo | We prefer keeping above parameters, which can be set to zero if not considered in evaluation. |
| Qualcomm | **Issue 3.1**HARQ gains must be reflected in MCL, MIL and MPL. It is absorbed as part of LLS. No need to include this separately.On shadow fading and penetration, prefer to have a single row --- they are two independent random variables and only their sum matters. If alignment with IMT is preferred, then okay to keep them as separate rows.On macro diversity, okay to keep as some companies prefer to align with IMT-2020 evaluation.On cable losses, okay to include this in MPL, but would like to leave it out of MCL/MIL calculation so that more divergence across companies does not emerge.On “Other gains” --- can be removed, but wont object if some companies prefer to keep.**Issue 3.2**Support **Issue 3.3**We are assuming no further discussion is needed on the other parameters. They are left to each company’s preference. |
| Intel | Issue 3.1/3.3Our view is that it is more appropriate to keep the rows as in IMT-2020 self-evaluation link budget template, i.e., do not remove or merge the rows. For MIL calculation, if some of the parameters are not needed, we can simply set to 0. This also includes HARQ gain, where company can report the value. Issue 3.2 We are fine with the proposal. |
| ZTE | On Issue 3-1: * HARQ gain is already included in Receiver sensitivity
* Prefer to keep (25a/b) Shadow fading margin and (27) Penetration margin separately.
* Prefer to keep the row for (26) BS selection/macro-diversity gain and (28) Other gains. Companies can report this value.
* ~~The cable loss at transmitter side has been included in Receiver sensitivity of MCL/MIL. The same should be applied to cable loss at receiver side.~~
* The cable loss at receiver side (12) should be included in MPL. In addition, it should also be included in MIL. Because, based on MIL definition, the cable loss at transmitter side (8) is included in MIL. Symmetrically, it’s reasonable to also include cable loss at receiver side (12) in MIL (by including in Receiver sensitivity).

On Issue 3-2: AgreeOn Issue 3-3: The parameters without explicit agreement on the values could leave to companies’ report. |
| InterDigital | For HARQ gain, we support Alt 1-2. If HARQ is not considered in LLS, companies can report the gain in the table for clarification. If HARQ is included in LLS, the gain can be set to zero in the table. |
| Xiaomi | Issue 3-1:Prefer keeping above mentioned parameters in the template, while it can be set to zero if it is not considered in the evaluation. Especially for HARQ gain, we have the same opinion with InterDigital.Issue 3-2:Agree. |
| Huawei, Hisilicon | For HARQ gain, we prefer Alt1-2 that keep HARQ gain in the link budget template as IMT-2020 self-evaluation does. If HARQ is included in LLS, then the HARQ gain value in link template can be reported as 0.Shadow fading and penetration margin should be kept separately. Shadow fading is closely related to the reliability requirement of channels, while penetration margin is closely related to channel model and scenarios. No need to combine two different parameters. (12) should be kept because it is necessary parameter for MPL. |
| CATT | On Issue 3-1,For (21a/b) H-ARQ gain: we prefer to Alt1-1 because this already is reflected in LLSFor the other parameters, we prefer to keep them as it is.On Issue 3-2we are fine with FL proposalOn Issue 3-3The same spirit of handling parameters for MPL should be adopted here as well. The parameters without agreements can be reported by companies. |
| OPPO | **Issue 3-1**:* For H-ARQ gain, we have the same opinion with InterDigital.
* For other parameters, we prefer keeping them as it is, which can be set to zero if not considered in evaluation.

**Issue 3-2**: Support FL proposal.**Issue 3-3**: The parameters without explicit agreement on the values could leave to companies’ report. |
| CMCC | On **Issue 3-1,**For (21a/b) HARQ gain: we prefer to Alt1-2. If the companies considered HARQ gains in the LLS, this value could be set to zero in the template. There is no need to merge (25a/b) Shadow fading margin and (27) Penetration margin, since the calculation procedure and the meaning are different.For the other parameters, we prefer to keep them to be aligned with IMT-2020 self-evaluation assumption as much as possibleOn **Issue 3-2**we are fine with FL proposalOn **Issue 3-3**As we proposed online and also captured in the agreements, IMT-2020 values could be a good starting point. Since RAN1 will not further discuss on specific values for the parameters related to MPL, to achieve a set of comparable results for the MPL, the IMT-2020 values are proposed to be used. Companies who have strong will to use other values could add notes for further clarifications. |

**Summary of the discussion**

* 13 companies joined the discussion
* Issue 3-1
	+ - **[(21a/b) H-ARQ gain]**
			* Alt 1-1: remove this assuming that HARQ-gain is included in LLS result
				+ CATT (it is included in LLS)
			* Alt 1-2: keep it, and companies can report the value if HARQ-gain is not included in LLS result
				+ Samsung, vivo, Intel, IDC, Xiaomi, Huawei, OPPO, CMCC
			* Other comments
				+ Ericsson, Nokia/NSB, Qualcomm (H-ARQ gain should be included as well as MIL and MCL (note, this can be solved by included in sensitivity) )
				+ Qualcomm (should be in LLS)
				+ ZTE (included in sensitivity)
			* FL Summary:
				+ H-ARQ gain (21a/b) can be removed from MPL definition because it is included in sensitivity
				+ H-ARQ gain should be included in LLS. Otherwise, this row can be used, and it is left to companies’ report
		- **[ (25a/b) Shadow fading margin – (27) Penetration margin ]**
			* Alt 2-1: they are merged and one row is preferred
				+ Qualcomm
			* Alt 2-2: keep both of them separate
				+ Samsung(IMT-2020 as baseline), vivo, Qualcomm (OK if alignment with IMT-2020 is preferred) , Intel, ZTE, Huawei, CATT, OPPO, CMCC
			* Other comments
				+ Ericsson(Either way is fine if the value is clear), Nokia/NSB (Can be reported by companies, otherwise it should be zero)
			* FL Summary:
				+ Majority of companies want to keep these rows (25a/b), (27) separate
				+ One company prefers to marge, but look OK go with majority view.
		- **[(26) BS selection/macro-diversity gain ]**
			* Alt 3-1: remove this row
			* Alt 3-2 keep this row
				+ Ericsson(should be zero if companies have no strong intention) , Nokia/NSB (Can be reported by companies, otherwise it should be zero), Samsung(IMT-2020 as baseline), vivo, Qualcomm (OK if alignment with IMT-2020 is preferred), Intel, ZTE, CATT, OPPO, CMCC
			* FL Summary:
				+ All the companies are OK to keep this row (26) .
		- **[(28) Other gains]**
			* Alt 4-1: remove this row
			* Alt 4-2 keep this row
				+ Ericsson(should be zero if companies have no strong intention) , Nokia/NSB (Can be reported by companies, otherwise it should be zero) ,Samsung(IMT-2020 as baseline), vivo, Qualcomm (OK if other companies want), Intel, ZTE, CATT, OPPO, CMCC
			* FL Summary:
				+ All the companies are OK to keep this row (28)
		- **[(12) Cable, connector, combiner, body losses (Rx side) ]**
			* Alt 5-1: remove this row, because this parameter is not used for MCL/MIL but MPL, which looks inconsistent
				+ Ericsson
			* Alt 5-2: keep this row
				+ Ericsson (if so, should be added to MCL and MIL as well) , Nokia/NSB (Can be reported by companies, otherwise it should be zero), Samsung(IMT-2020 as baseline), vivo, Qualcomm(should not be included in MIL/MCL), Intel, ZTE (should be included in MIL as well), Huawi/HiSilicon, CATT, OPPO, CMCC
			* FL Summary:
				+ Majority of companies are OK to keep this row for MPL
				+ The number of companies view was not sufficient to make the decision on the following issue:

2 companies supported to include (12) in MIL while 1 company does not prefer it

Tx loss is included in MIL while Rx loss is not included in MIL. This is contradicting

Inclusion in MIL may cause divergence across companies.

1 company supported to include (12) in MCL while 1 company does not prefer it

Inclusion in MCL may cause divergence across companies.

* Issue 3-2
	+ 8 companies supported the FL proposal, and no concern was raised for it.
* Issue 3-3
	+ 5 companies mentioned that this can be left to companies’ report as per the agreement
	+ 1 company mentioned values for IMT-2020 self-evaluation should be the baseline

Given the summary above, the following FL proposal is made:

**FL Proposal:**

* 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
* **Remaining issues**
	+ **Issue 3-A**. (12) Cable, connector, combiner, body losses (Rx side) is included in MIL or not
		- If yes, (12) can be removed from MPL definition
		- FL note: If yes, we may need to amend the agreement on MIL definition.
	+ **Issue 3-B**. (12) Cable, connector, combiner, body losses (Rx side) is included in MPL or not
	+ **Issue 3-C**. (12) Cable, connector, combiner, body losses (Rx side) is included in MCL or not
		- FL note: If yes, we may need to amend the agreement on MCL definition.
* The definition of MCL, MIL and MPL for TDL Option 2 & CDL is the same as that for TDL option 1

Please provide your views on FL proposal above, especially for the remaining issues 3-A, 3-B and 3-C.

|  |  |
| --- | --- |
| Company  | Comment |
| CATT | We think that Issue 3-A need be addressed and we prefer to body losses (Rx side) is included in MIL because Tx loss is already included in MIL. |
| Huawei, Hisilicon | Agree with FL’s proposal on MPL definition and prefer ‘(12) Cable, connector, combiner, body losses（Rx side）’ included in MPLAgree with FL’s proposal on H-ARQ gain that if H-ARQ gain is not included in LLS, (21a/b) can be reported by companies, if HARQ gain is included in LLS, (21a/b) can be reported as 0.Concerning issue 3-A, we prefer (12) to be included into MIL;Concerning issue 3-B, we prefer (12) to be included into MPL. |
| * + 1. Samsung
 | Agree with FL’s proposals on MPL definition and H-ARQ gain.* + 1. All YES for issues 3-A/3-B/3-C for consistency.
 |
| vivo | We are fine to include the (12) cable/connector/combiner/body losses (Rx side) in MIL, and amend the agreement on MIL and MPL definition accordingly.While for MCL, including (12) is not needed. |
| Ericsson | Support feature lead proposals.Similar comment to Samsung regarding 3A/3B/3C: For the transmitter, ‘(8) Cable, connector, combiner, body losses’ is accounted for in EIRP, and therefore with MCL, MIL, and MPL. For us it is unclear why we then would not take the same approach with ‘(12) Cable, connector, combiner, body losses’ in (22a/b) Receiver sensitivity.Perhaps it would be more clear what to do if companies can say what values they want, and what these values represent. Then depending on how significant the effect would be and the uses of the values, we might progress further.Looking at the IMT-2020 tables, it seems that (8) and (12) are commonly set to assume 3 dB loss at gNB (presumably cable loss) and 1 dB loss at UE (body loss?). AAS systems will in general not have the cable loss that non-beamformed systems will have, and so we think this 3 dB loss at gNB should be zero at 4 GHz. For 700 MHz, 3 dB cable loss is high in our understanding for cases where tower top electronics are used, and so this value should be revisited during this email discussion. For the UE loss(es): we anticipate that it will be difficult to reach common understanding on body losses and other implementation losses in the UE above and beyond those included in the UE noise figure, and prefer that these be assumed as zero. |
| Nokia/NSB | Support the FL’s proposal. For the remaining issues, we think that (12) can be included in MIL and MPL. For MCL, we share the same view as vivo and we would like to better understand why MCL should include these quantities, when it does not even include the entire antenna array gain (no impact due to analogue components is actually present in the MCL, AGC3 or AGC4). Could the proponents of this approach provide additional elements to substantiate the proposal? |
| Intel | We are fine with FL’s proposal. For the 3-A/B/C, we think that (12) Cable, connector, combiner, body losses (Rx side) can be included in MCL, MIL and MPL. Our view is that both Tx and Rx should consider the loss to reflect the true gain.  |
| QC | Pretty much same views as Nokia and vivo.We are okay to include (12) in MIL and MPL. It does not make any sense to add this term to MCL. Note that (8) is only added to MIL and not MCL as in one of the agreements in 102e and a similar treated is warranted for MIL and MPL. Some agreement on what value this parameter is expected to take will be helpful.  |

**Summary of the discussion**

8 companies joined the discussion, and their views are summarized as follows:

* All the companies are fine with the FL proposal
* For issues 3-A, 3-B and 3-C,
	+ 3-A (inclusion of (12) in MIL)
		- No concern was raised for the inclusion
	+ 3-B (inclusion of (12) in MPL)
		- No concern was raised for the inclusion
	+ 3-C (inclusion of (12) in MCL)
		- Should be included: 3 companies
			* Consistency among MIL, MPL and MCL
			* Alignment with Tx loss
			* Values should be checked together
		- Should not be included: 3 companies
			* Loss for Tx side (i.e. (8) ) is not included in MCL

**FL perspective:**

As for the inclusion of Rx loss in MCL, it is not easy for FL to make a firm proposal because the companies’ view is equally split. However considering the comments from companies & and the discussion we had in the past, FL can make the following observation:

* If we consider the consistency between Tx side and Rx side, Rx loss cannot be included in MCL because we have agreed not to include Tx loss in MCL
* In RAN1#102e, we confirmed that the definition of MCL should be aligned with RAN4 definition, which is measured between antenna connectors. From this perspective, some of the components of (12), e.g. body loss are not appropriate for MCL

Given the analysis above, FL would like to update the proposal as follows, where the updated part is highlighted by red font:

**FL Proposal:**

* The agreement on the definition of MIL for downlink is updated by adding Rx loss as follows:
	+ Total transmit power – Receiver sensitivity – Rx loss + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain, where
		- Rx loss corresponds to row No. (12)
* MPL = MIL – (25a/b) Shadow fading margin + (26) BS selection/macro-diversity gain – (27) Penetration margin + (28) Other gains ~~[– (12) Cable, connector, combiner, body losses (Rx side) ]~~
* It is confirmed that H-ARQ gain is included in sensitivity
	+ H-ARQ gain should be included in LLS. In this case, “(21a/b) H-ARQ gain” is set to zero
	+ If not, “(21a/b) H-ARQ gain” can be used for companies report
* Note: as per the former agreement, the values for rows (25a/b) (26) (27) (28) and (12) are left to companies’ report, which includes the values for IMT-2020 self evaluation and/or using 0 dB
* Note: (12) Cable, connector, combiner, body losses (Rx side) is not included in MCL, but included in MIL and MPL
* The definition of MCL, MIL and MPL for TDL Option 2 & CDL is the same as that for TDL option 1

Please provide your views on the FL proposal above.

|  |  |
| --- | --- |
| Company  | Comment |
| Ericsson | **Support the FL proposal.** As was pointed out, it is consistent with the RAN1#102e agreement on Tx loss (8) to have Rx loss (12) in MIL. Also, since any channel received at either gNB or UE should have the same Rx loss (12) as any other channel, it is not so crucial whether Rx loss (12) is in MCL or MIL.**After some internal checking we think ~1 dB feeder loss is appropriate for gNB at 700 MHz. So for gNB, (8) and (12) can be 1 dB at 700 MHz and (with AAS) at 4 GHz they can be 0 dB.**  Also, we think UE losses for (8) and (12) can be zero for this study. Are these UE and gNB values acceptable to the group? |
| CATT | We are fine with FL proposal. |
| ZTE  | Support the FL proposal.  |
| Samsung | Fine with FL proposal. Regarding Ericsson’s question, with reference to IMT-2020 self-evaluation, e.g., for 700MHz Rural & 4GHz DU scenarios, * (8) is 3dB (DL) and 1dB (UL), and
* (12) is 1 dB (DL) and 3dB (UL)

Therefore, our suggestion is to take the assumption of IMT-2020 self-evaluation. For FR2, we are open to company’s view. The same for FR1? |
| Intel | Although we initially supported to include (12) in the MCL, we are fine with the FL proposal to make progress.  |
| vivo | Support the FL proposal. |
| OPPO | Fine with the FL proposal. |
| Qualcomm | Support the FL proposal. |
| Huawei, Hisilicon | For the definition of MIL, we agree that Rx loss correspond to row No.(12) can be included, then as a result the *‘(12) Cable, connector, combiner, body losses (Rx side)*’ can be removed from MPL. But three issues are needed to be clarified:1. Since *(8) Cable loss* is removed from MPL and the definition of MIL is refined at the same time, it is unclear whether *(8) Cable loss* is included into MIL as well. It should be explicitly clarified by either adding a note to confirm the agreement “*Total transmit power + gNB antenna gain (component 2 + 3 + 4) corresponds to row No.(9a/9b)*”, or explicitly adding Tx loss into MIL definition as “Total transmit power - Receiver sensitivity - Tx loss - Rx loss + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain”. We prefer the latter because it completes the MIL definition without any confusion and has a good form to be captured in the TR, it is also helpful to make clear the difference between MCL and MIL.
2. In the updated link budget template, (16a)(16b) have been revised as follows:

10 log (10^((((12)+(13) + (14))/10) + 10^((15b)/10)),where (12) is included in (16a) and (16b). However, (12) is not part of “Total noise plus interference density”, and the addition of (12) in (16a/b) is unreasonable and non-linear. We suggest that the definitions of (16a) and (16b) in IMT-2020 self-evaluation should be reused as: (16a) Total noise plus interference density for control channel = 10 log (10^(((13) + (14))/10) + 10^((15a)/10)) dBm/Hz(16b) Total noise plus interference density for data channel = 10 log (10^(((13) + (14))/10) + 10^((15b)/10)) dBm/Hz1. For MIL definition in current link budget template (23a) and (23b), (12) can be included in directly:

(23a) Hardware link budget for control channel, a.k.a MIL = (9a) + (11) + (11bis) − (12) − (22a) dB(23b) Hardware link budget for data channel, a.k.a MIL = (9b) + (11) + (11bis) − (12) − (22b) dB**We propose the following updated agreement:** **Option1:**The agreement on the definition of MIL for downlink is updated by adding Rx loss as follows:* 1. Total transmit power - Receiver sensitivity - Tx loss - Rx loss + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain, where
		1. Rx loss corresponds to row No. (12)
		2. Tx loss refers to *(8) Cable, connector, combiner, body losses (Tx side)* in the template.
		3. (16a/b) are updated as:
			1. (16a) Total noise plus interference density for control channel = 10 log (10^((~~(12)+~~ (13) + (14))/10) + 10^((15a)/10)) dBm/Hz
			2. (16b) Total noise plus interference density for data channel = 10 log (10^((~~(12)+~~ (13) + (14))/10) + 10^((15b)/10)) dBm/Hz
		4. (23a/b) are updated as:
			1. (23a) Hardware link budget for control channel, a.k.a MIL = (9a) + (11) + (11bis) − (12) − (22a) dB
			2. (23b) Hardware link budget for data channel, a.k.a MIL = (9b) + (11) + (11bis) − (12) − (22b) dB

Option2 is not our preference because it is not in a good form to be captured in the TR, but acceptable to us.**Option2:**The agreement on the definition of MIL for downlink is updated by adding Rx loss as follows:* 1. Total transmit power - Receiver sensitivity - Rx loss + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain, where
		1. Rx loss corresponds to row No. (12)
		2. Note: Total transmit power + gNB antenna gain (component 2 + 3 + 4) corresponds to row No.(9a/9b) where *(8) Cable, connector, combiner, body losses (Tx side)* is included.
		3. (16a/b) are updated as:
			1. (16a) Total noise plus interference density for control channel = 10 log (10^((~~(12)+~~ (13) + (14))/10) + 10^((15a)/10)) dBm/Hz
			2. (16b) Total noise plus interference density for data channel = 10 log (10^((~~(12)+~~ (13) + (14))/10) + 10^((15b)/10)) dBm/Hz
		4. (23a/b) are updated as:
			1. (23a) Hardware link budget for control channel, a.k.a MIL = (9a) + (11) + (11bis) − (12) − (22a) dB
			2. (23b) Hardware link budget for data channel, a.k.a MIL = (9b) + (11) + (11bis) − (12) − (22b) dB

Regarding the values proposed by Ericsson for cable loss, we share similar view as Samsung to take the assumption of IMT-2020 self-evaluation.We support row (12) is not included in MCL. |
| Nokia/NSB | We agree with the FL’s proposal in principle. Concerning the comment from Huawei/Hisilicon, we would like to share the following views:* We are fine to further clarify the definition of MIL by including “-Tx loss” and refer it to (8) as Option 1 from HW, for completeness. However, we would like to note that according to the agreement from RAN1#102-e, (8) is already included in “Total transmit power + gNB antenna gain (component 2 + 3 + 4)”. Therefore, if the Option 1 is adopted then some clarifications/modifications to the following agreement is needed. The related part of the agreement is copied below for your reference.

“Agreements: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”.
* Regarding the question where to capture (12), similar to our comments in the FL’s template during RAN1#102-e meeting (in [this link](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.8.1.1/4th_round/update-link-budget-template-v004-FL2-Nokia.xlsx)), we agree that (12) can be included in (23a/b) but should not be included in (16a/b).

In overall, we share the same preference as Huawei/Hisilicon on Option 1 for cleaner expressions in view of the TR and we think discussion should be about this and not about whether the parameter should be included or not. |
| CMCC | Agree with FL’s proposal in principle. The option 1 proposed by Huawei for the cleaner expressions is preferred.For the undetermined values, the assumption of IMT-2020 self-evaluation are proposed to be used. |

**Summary of the discussion**

* 9 companies are OK for FL proposal (in principle)
* 3 companies discussed about the exact values for Rx losses (12)
	+ feeder loss at gNB (1dB for 700MHz, 0dB for 4GHz with AAS), and 0dB for the loss at UE
	+ use of the values for IMT-2020 self-evaluation
* 3 companies mentioned that cleaner expression is preferred
	+ i.e. where/how (8) and (12) are captured

As mentioned in section 2.1, the most important thing for us is to finish the discussion within the given time period. “Determination of values” is quite difficult for email discussion, and hence FL doesn’t recommend to spend time on this issue right now given the fact that “companies to report” manner is always allowed.

The cleaner expression of MCL/MIL/MPL is very important to avoid the misunderstanding among companies. Also, I will contribute to improve the readability of TR. However, it is clear that we are going to have the same discussion very soon by using the draft link budget template. FL foresees that moderate number of issues will be found even when we do it now. The goal of this email discussion should be high level, which can help drafting the link budget template for the next round of discussion. Hence, FL would like to suggest leaving the clean-expression discussion for the next round, i.e. [102-e-Post-NR-CovEnh-02].

Given the analysis above, FL would like to propose the same contents with some notes:

**FL Proposal:**

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

Please provide your views on the FL proposal above, especially if you have a concern.

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

# Agreements after this email discussion

To be incorporated

# References

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

# Annex 1 – Agreements at RAN1#101e

Update on 6/1: to check 6/2

Update from 6/4 GTW:

Agreements:

* Adopt the following target data rates for eMBB performance evaluation for FR1.
* Urban scenario: DL 10Mbps, UL 1Mbps
* Rural scenario: DL 1Mbps, UL 100kbps
* Rural with long distance scenario: DL 1Mbps, UL 100kbps, ~~[~~30kbps~~]~~ (optional)

**Agreements:**

* For VoIP performance evaluation based on link-level simulation for FR1.
* A packet size of [320] bits with 20ms data arriving interval is adopted.
* ~~FFS~~TBD: TBS for SIP invite message. Payload of 1500 bytes can be a starting point.

Agreements:

* The basic evaluation methodology is based on link-level simulation for FR1.
* Step 1: Obtain the required SINR for the physical channels under target scenarios and service/reliability requirements.
* Step 2: Obtain the baseline performance based on required SINR and link budget template.
* Note: asepcts related to identifying target performance and coverage bottlenecks based on target performance metric is to be handled separately
* ~~FFS:~~ The evaluation methodology based on system-level simulation is optional for FR1.
* Note: The simulation assumptions for SLS are up to companies’ reports.

Agreements:

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

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Scenario and frequency | Urban: 4GHz (TDD), 2.6GHz (TDD) Rural: 4GHz (TDD), 2.6GHz (TDD), 2GHz (FDD), 700MHz (FDD)Rural with long distance: 700MHz (FDD), 4GHz (TDD)  |
| Frame structure for TDD | DDDSU (S: 10D:2G:2U) only for 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#101e

Agreements:

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

Agreements (for both FR1 & FR2):

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

Agreements:

* For TDL Option 1
	+ Definition of MCL
		- Total transmit power - Receiver sensitivity + gNB antenna gain (component 2)
	+ Definition of MIL
		- Total transmit power - Receiver sensitivity + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain
	+ Definition of MPL
		- Further discussion offline the definition using below as a starting point:
			* Total transmit power - Receiver sensitivity + gNB antenna array gain (component 2+3+4 for TDL option 1) + UE antenna gain - (8) Cable, connector, combiner, body losses (Tx side) - (20) Receiver implementation margin + (21a/b) H-ARQ gain - (25a/b) Shadow fading margin + (26) BS selection/macro-diversity gain - (27) Penetration margin + (28) Other gains – (12) Cable, connector, combiner, body losses (Rx side)
	+ Note: whether/how to use the above definitions is to be discussed

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

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

Update from GTW on 8/24

Agreements:

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

Agreements:

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

Agreements:

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

Agreements:

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

Update on 8/27:

Agreements:

* for SIP invite message
	+ Payload of 1500 bytes can be a starting point.
	+ The assumptions (TB size, time period etc.) are reported by companies.
	+ Contributions R1-2003464 and [R1-2005259](file:///C%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.