3GPP TSG RAN WG1 #101 R1-20xxxxx

**e-Meeting, May 25th – June 5th, 2020**

**Agenda item: 8.4.1**

**Source: Moderator (China Telecom)**

**Title: [101-e-Post-NR-Cov-Enh] Email discussion/approval focusing on remaining evaluation assumptions**

**Document for: Discussion and Decision**

# Introduction

This contribution summarizes the email discussion/approval focusing on remaining evaluation assumptions for NR coverage enhancements.

[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

# Discussion

## 2.1 Discussion on proposals with high priority

### FR1

**Proposal:**

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

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| Parameters | Values |
| BLER for PUSCH | 10% iBLER for eMBB, 2% rBLER for voice. |
| Number of UE transmit chains for PUSCH | 1 or 2 |
| DMRS configuration for PUSCH | For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.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.FFS: PUSCH mapping Type B.FFS: DMRS position. |
| Waveform for PUSCH | DFT-s-OFDM, FFS: CP-OFDM |
| Repetitions for PUSCH | For eMBB, no repetition is assumed.For VoIP, the maximum number of repetitions is 8.FFS: Repetition type B |
| HARQ configuration for PUSCH | For eMBB, no retransmission is assumed.For VoIP, 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 |

Companies are invited to provide views on the above proposal.

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| **Companies** | **Comments** |
| Nokia/NSB | We propose to amend the proposal by adding that the actual number of PUSCH repetitions for VoIP should be reported by companies, and that the maximum number HARQ transmissions should be reported by companies (instead of “can be reported”). This would still not force any company to use a specific value (below the maximum allowed, of course, for the PUSCH repetitions), however it would allow an easier comparison of the results, in our view. |
| Sierra Wireless | For PUSCH, we propose HARQ and repetition can be considered at least optionally if companies find it increases coverage. We should start with the best performing baseline the specification can support so we recommend these changes:“10% iBLER for eMBB” change to “10% iBLER=rBLER for eMBB”  AND for repetitions“For eMBB, no repetition is assumed” change to “For eMBB, the maximum number of repetitions is [16] and is reported by company” AND for HARQ“For eMBB, no retransmission is assumed” change to “For eMBB, the maximum number of HARQ retransmissions is [2] and is reported by companies” WRT UE transmit chains for PUSCH: since 2 TX chains in the UE is so uncommon, we don’t see the point in evaluating this and if we evaluate, do we assume similar EIRP as one TX chain?  |
| vivo | For voip, we don’t think HARQ need to be considered in LLS, if repetition is considered. ‘can be reported by companies’ for max number of HARQ transmission can be 1? . We suggest to revise to ‘For VoIP, whether HARQ retransmission is assumed, and the maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies.’ |
| ZTE | Support the proposal. As for the open points, our preference is as follows:As for the FFS on DMRS configuration, different assumptions may be required under different assumptions on FH and UE speed. We think it can be leave up to companies reports. For waveform, DFT-s-OFDM is sufficient but open to further discuss.For repetition type, if we don’t consider collision handing in our evaluation, no see much difference between using repetition Type A and Type B.In addition, we think PUSCH without repetition should be the baseline for eMBB service. This is because, unlike VoIP, repetition for eMBB will consume the available resources for transmission and result in a higher TBS per transmission which would not make much performance improvement. We are open to consider re-transmission for eMBB. But if it is considered, the TBS should be scaled up based on the 10% iBLER.  |
| Intel | We are fine with the proposal. It is not clear to us why CP-OFDM waveform is used for PUSCH for coverage enhancement.  |
| Ericsson | * **LLS simulation with HARQ should be supported**, as we have commented repeatedly. rBler of 2% may be OK, but should be square bracketed. I will not object to simulations without HARQ as an option, but then it should be required that HARQ gains are justified with simulation results (just as they are for when HARQ is used).
* **Repetition and retransmission should be supported for eMBB**; supporting it for VoIP but not eMBB seems the opposite of normal operation.
* **The number of DMRS should either be square bracketed or left FFS.** The number of DMRS should be justified with simulation, including whether it is used for Msg3 vs. ‘normal’ PDSCH vs. CSI on PUSCH. If the concern is extra DMRS overhead, this is not consistent with e.g. the use of repetition. A conservative number is better than too few DMRS. Also, our understanding is that the default configuration for Msg3 is 3 DMRS. Lastly, the number of DMRS is adaptive in NR, and so LLS that optimize DMRS should not be preclude.
* **Support having DMRS type as FFS.** We would like to further discuss whether Type B DMRS is appropriate, or that this is left to the proponent. I expect this should not affect performance.
* **If 2 UE Tx chains are used, the transparent diversity mode used should be identified by proponents.**
 |
| Samsung | Regarding the number of UE transmit chains for PUSCH, we agree with Sierra Wireless that we can assume one TX chain.Regarding the waveform, we don’t think it is necessary to evaluate CP-OFDM for uplink in this SI. Although CP-OFDM can be configured to cell-edge UEs in some NR deployments, it is difficult to take into account all simulation assumptions. Especially, in our understanding, there is no concern about that DFT-s-OFDM is suitable waveform in cell-edge UEs compared to CP-OFDM. Therefore, we prefer to remove CP-OFDM waveform to reduce the simulation burden.Regarding the DMRS configuration, the 2 FFS for DMRS configuration, if not resolved, can be changed to “companies to report”. In addition, if we only consider DFT-s-OFDM waveform, we can remove the phrase “no multiplexing with data.”, since there is always no multiplexing with data when the precoding is enabled. |
| NTT DOCOMO | We are fine with the proposal. “DMRS additional position” is better to be clarified. (it seems pos0 and we are fine, but we prefer pos1 for 2 symbols, or pos3 for 1 symbol.) |
| InterDigital | We support to include both retransmission and HARQ in evaluation since in our contribution submitted in RAN1-101e, coverage can be enhanced by combining both HARQ and retransmission. As a starting point, we can set rLBER=10% for eMBB. Companies can report whether HARQ, retransmission and frequency hopping are included in evaluation or not. In evaluation, we support PUSCH mapping type B and DMRS locations shown in 6.4.1.1 in TS 38.211 can be used. Our preference is to have DMRS in the first symbol in a slot to minimize channel estimation error due to extrapolation.Regarding scope of UL CP-OFDM, we believe it is an issue that should be considered in coverage enhancement. Comparison of coverage between CP-OFDM and DFTsOFDM is not necessary in this study while whether coverage enhancement approach considered for DFTsOFDM can be applied to OFDM and yield coverage enhancement is a valid topic to study since there are attractive features in OFDM in practice such as multiplexing or multi-layer transmission. |
| Sharp | Single transmit chain for PUSCH should be mandatory. Dual transmit chains for PUSCH should be optional, or can be removed. |
| Panasonic | We are fine with the proposal. On DMRS configuration (PUSCH mapping type and DMRS position), if FFS is not resolved, it can be changed to “companies to report”. On waveform, we share same view as above companies that DFT-s-OFDM is sufficient. |
| Nomor Research GmbH | Nomor supports the proposal. Nomor believes that 2 UE transmit chains should be used, instead of 1, as up to 2 were allowed in IMT-2020 evaluations for rural with long distance. For VoIP, in case 8 PUSCH repetitions are considered, Nomor supports 2 HARQ transmissions.In terms of latency requirements, our suggestion is to stick to the regular packet delay budget for 5QI = 1, which is 100ms for conversational voice. Therefore, latency requirement for voice supported to be defined as 100ms one way, including at the rural scenario with long distance. |
| CATT | We are generally fine with the proposal. One comment for clarification:If the following assumptions are used in LLS* the frame structure is DDDSU(assuming 15 kHz)
* Latency requirement is 50 ms
* Retransmission and repetition are both enabled

One possible configuration would be 4 repetitions and 1 re-transmission. The problem would be the transmission period of a packet exceeds the periodicity of packet generation. It means the transmission of previous packet impacts a later coming packet. How should we handle it in the LLS? |
| Huawei, HiSilicon | Support.Regarding waveform, share same view as ZTE, Samsung, Panasonic that DFT-s-OFDM is necessary for coverage enhancement, and sufficient.Regarding DMRS, since DFT-s-OFDM is a must, the only applicable Type I DMRS must be adopted. We don’t feel it is worth much more time to debate on DMRS Type.Regarding number of DMRS symbols, since 2 symbols are adopted in IMT-2020 self-evaluation, 2-symbol DMRS is a reasonable starting point. Besides, the proposal has allowed companies to report 1 or 3 symbols of DMRS for different cases, therefore, we don’t feel it is worth much more discussion time on this issue.In our understanding, all proposals with high priority target at a starting point of assumptions to kick off the urgent simulation tasks as planned in SID. Therefore, our discussions should focus on only the additional text in red in these proposals. If any additional suggestions or requests, e.g. allowing reported repetition for eMBB, they are not the essential starting point but just complementary assumptions, we suggest they could be added in the list of low priority or medium priority for complementary discussions rather than slowing down the iterations of essentials here.A small suggestion, better to assign number to proposals, e.g. Proposal 2.1-1, Proposal 2.1-2, so that they can be referred in email text in case only short comment is sufficient. |
| Apple | On the waveform, we think DFT-s-OFDM is enough, but we are open to consider CP-OFDM as optional feature.  |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | DFT-s-OFDM only. Allow the usage of qam64lowSE MCS table for DFT-s-OFDM simulations to enable low code rates.  |
| BT | We support the proposal.Number of UE transmit chains for PUSCH: we believe this should be 1 and optionally 2. Agree with Ericsson that in case of 2 transmission scheme should be specified. |
| Qualcomm | On HARQ: If HARQ gains are going to be eventually accounted for in the link budget table, then we would prefer that these numbers come from a LLS. We need to accordingly select between rBLER and iBLER --- we are open to suggestions for target rBLER. This also impacts our considerations on PUSCH repetition for eMBB. For VoIP, we prefer to limit the set of allowed repetition + retransmission to what is possible within a 20 ms window. On DMRS: We want to make sure a minimum of 2 DMRS symbols are included for all UE velocities. Cell-edge UEs operate at extremely low SINRs, uplink channel estimation is challenging independent of doppler. Also, cell-edge UEs tend to have larger residual frequency errors due to poor downlink SINRs and having 2 DMRS symbols provides gNB with some ability to account for such issues. On Waveform: We think it is important for us to also evaluate CP-OFDM. CP-OFDM coverage is as important as coverage obtained through DFT-S-OFDM. Field logs also indicate cell-edge UEs being configured with CP-OFDM in some NR deployments. This is also useful to have when considering potential enhancements, where applicability to both waveforms may need to be studied. |
| SONY | The simulation assumptions should allow HARQ re-transmission for eMBB, in which case the initial BLER target is likely to be higher than 10% and the residual BLER target lower than 10%. Without LLS simulation of HARQ, it is not clear how we can account for any HARQ gain in the link budget.We are OK with considering a single transmit chain UE since this is a common configuration.We are OK considering either DFT-s-OFDM or CP-OFDM. In either case, the UE is assumed to be PC3. A main advantage of DFT-s-OFDM is that it allows for less PA backoff, but this affects the transmitter efficiency, rather than the coverage, assuming the same radiated transmit power. |

**Proposal:**

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

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| --- | --- |
| Parameters | Values |
| PUCCH format type | Format 1, 2bits UCIFormat 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%. |
| Number of PRBs for PUCCH | 1 PRB |
| Number of UE transmit chains for PUCCH | 1 |
| Number of repetitions for PUCCH | w/ and w/o repetition for PUCCH.The maximum number of repetitions is 8. |
| PUCCH duration  | 14 OS |

Companies are invited to provide views on the above proposal.

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| **Companies** | **Comments** |
| Nokia/NSB | We think PUCCH repetitions should be optional, i.e., between []. |
| Sierra Wireless | Support this proposal |
| vivo | We are generally fine with the proposal. Since both 4 bits and 11 bits UCI is encoded by RM encoder, we prefer to keep one UCI length, i.e. 11 bits. |
| ZTE | Support the proposal. |
| Intel | We are generally fine with the proposal. For the number of DMRS symbols, it is possible to configure 2 or 4 symbols for DMRS for PUCCH format 3 when the number of symbols for PUCCH is 14. Need to add one more row regarding DMRS configurations.  |
| Ericsson | Support |
| Samsung | As commented before, in our understanding, repetition is the most obvious method to enhance the coverage especially for PUCCH. We are not sure why we did not consider PUCCH repetition in coverage enhancement SI. Therefore, we support the proposal about PUCCH repetitions. |
| Sharp | We support the proposal. |
| Panasonic | We are fine with the proposal. |
| Nomor Research GmbH | Nomor supports the proposal. |
| CATT | We share the same view as VIVO. But would be OK if 4 bits is optional. |
| Huawei, HiSilicon | Support. We also OK to make repetition optional. |
| Apple | Intra-slot frequency hopping should be considered, inter-slot frequency is up to the repetition. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | Support.  |
| BT | We are generally fine with the proposal. For the number of UCI bits, we are concerned 11/22 bits may not be sufficient for if CSI report is carrier over PUCCH, and we would prefer that case to be considered. |
| Qualcomm | Agree with Nokia on the above statement. As explained by many companies in the earlier discussions, PUCCH repetitions have a lot of ramifications, especially in TDD systems. Given that a typical configuration may not allow repetitions, we think it is best to stick to this.We do not support the FFS. Impact of dropping CSI reliability to 10% is unclear without extensive studies. We prefer to stick to 1%. |
| SONY | Support |

**Proposal:**

* For link level simulation, adopt the following table for PUSCH and PUCCH for FR1.
	+ Note: Definition of TxRU refers to TR 36.897, 1 TXRU can be seen as 1 RF chain, which has a dedicated PA/LNA, and is associated with a set of antenna elements with the same polarization.

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| --- | --- |
| **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)Rural: 64 antenna elements for 4GHz and 2.6GHz(M,N,P,Mg,Ng) = (8,4,2,1,1)32 antenna elements for 2GHz and 700MHz(M,N,P,Mg,Ng) = (8,2,2,1,1) |
| Number of receive TxRUs for BS | TDL: 2 or 4 TxRUs, FFS: 64TxRUs for urban[CDL: urban: 64TxRUs, rural: 8 TxRUs for 4GHz and 2.6GHz, and 4TxRUs for 2GHz and 700MHz.] |
| Delay spread | Urban: 300ns~~, [240ns]~~Rural: 300nsRural with long distance: 30ns |
| PRBs/TBS/MCS for eMBB for PUSCH | ~~Reported by companies.~~[30PRBs] for 1Mbps, [4 PRBs] for 100kbps.Other values of PRBs can be reported by companies.TBS and MCS 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.QPSK |

Companies are invited to provide views on the above proposal.

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| **Companies** | **Comments** |
| Nokia/NSB | The number PRBs has a strong impact on the code rate of the transmission, hence on the minimum SINR for 10% BLER. Thus, it should be considered as part of the study, similar to what is being proposed for FR2, and not agreed beforehand. We also observe that fixing a given number of PRBs irrespective of the number of DMRS symbols per slot is also a bit counterintuitive. In fact, when fewer DMRS are used a lower code rate can be achieved. Therefore, we prefer not to agree on any number of PRBs for both eMBB and VoIP for PUSCH, and we propose that each company reports the assumed value, similar to what is proposed for other parameters, e.g., number of PUSCH repetitions (if any).  |
| Sierra Wireless | Agree with Nokia – Number of PRBs and MCS can be reported by company and not be agreed beforehand – for both VoIP and eMBB |
| vivo | We are fine with the proposals. |
| ZTE | Support the proposal. As for the open points, our preference is as follows:* We support 64TxRUs for urban in TDL channel.
* For number of RBs for 100kbps eMBB service, we suggest considering 3PRBs for FDD and 4PRBs for TDD. Because, the MCS is already down to MCS#0 by using 3PRBs for FDD.
 |
| Intel | We prefer to align the simulation assumptions, especially the number of PRBs/MCS/TBS among companies for PUSCH simulation, in order to provide meaningful study for baseline coverage. Based on our calculation, 30 PRBs for 1Mbps and 4 PRBs for 100kbps and VoIP can be considered as a good starting point.  |
| Ericsson | * **For PRBs/TBS/MCS for PUSCH eMBB**: Agree with Nokia that some study of PRBs should be performed and that this can relate to other parameters. If we can show that 30 or 4 PRBs are the best values, that can be OK, but this should be checked. Would it be simpler to say here that proponent reports PRBs?
* **(M,N,P,Mg,Ng) = (12,8,2,1,1) is probably too large at least in Europe and US** where (M,N,P,Mg,Ng) = (8,8,2,1,1) is more likely. This may not affect bottlenecks, though. On the other hand, if absolute targets are used, then it is more important to use realistic antenna configurations.
* **An additional note is needed to clarify LLS simulation vs. TXRUs:** We should correct that 2 or 4 gNB antennas are used in the LLS with TDL based LLS, not 2 or 4 TXRUs at 4 GHz. A note like ‘*Note: At least for TDL models, link simulations may use 2 or 4 gNB Rx with suitable values of effective antenna and array gain*’ needs to be added.
* **The number of gNB TXRUs should be much more than 4 for at least Urban 4 GHz setups.** The number of TXRUs can be 32 in our view for 4 GHz, with 4 mandatory and 2 optional for 700 MHz.
* **The scenarios are unclear.** Channel models and parameters for the scenarios should be agreed. Please find proposals in R1-2005004 Appendices 4 & 5, for FR1 and FR2, respectively, that can be used as starting points.
 |
| Samsung | We have a concern about the variables assumed with company’s report. In order to make a constructive conclusion of this SI, we prefer to fix some values as a starting point and other values can be reported by companies, such as the number of PRBs for eMBB and VoIP. Therefore, we propose to remove the blanket regarding the number of PRBs and also we can add the following note for VoIP: “Other values of PRBs can be reported by companies.”. In addition, to reduce the amount of simulation work, our preference is to remove the CDL channel. However, we can agree to list is as optional in order to make progress.  |
| InterDigital | Regarding relationship between LLS and TXRU, we have some comments. Intention of the note about the definition of TXRU is not clear. Unlike CDL channel models, TDL channel models, agreed to be used in this evaluation, are not equipped with angle information in the model. Thus, how antenna element mapping onto TxRU or beamforming affect TDL-based simulation methodology is not clear. According to the agreement in RAN1-101e, it should be up to companies to decide whether to include antenna/beam characteristics (i.e., antenna gain) in link level simulation. If an additional note is to be added, we propose the following note “TDL: 2 or 4 RX at BS”. We support to keep the number of PRBs for both eMBB and VoIP in brackets since the optimum values need to be evaluated through evaluation. In addition, since pi/2 is another candidate for baseline modulation, we propose to keep square brackets around QPSK as well. |
| Sharp | For the number of receive antenna elements, we prefer 4 elements for 2 GHz and 700 MHz as optional.For the number of receive TxRUs for BS, CDL should be optional.The number of PRBs should be determined such that the data rate exceeds the target. For determination of the number of PRBs, the reference MCS can be MCS0 in Table 6.1.4.1-1. |
| Panasonic | We share the same view as Samsung. |
| Nomor Research GmbH | Nomor supports the proposals except:Antenna Elements: Nomor supports the earlier number of antenna elements proposed on BS for 700MHz Rural scenario, i.e. (M,N,P,Mg,Ng) = (8,4,2,1,1). TxRUs:We have already used 4TxRUs per polarization in our IMT-2020 evaluation for rural scenario, where we have 4 columns of antenna elements per polarization in our system-level simulations. This is also the assumption we have used in our contributions. Therefore, Nomor supports the idea that 8TxRUs (Mp,Np) = (1,4) should be used for the rural and rural with long distance scenarios. |
| CATT | On the TXRU issues, we share the same views as InterDigital, we oppose the use 64 TXRU for TDL model.  |
| Huawei, HiSilicon | OK. Share similar views with Intel, Samsung and Panasonic that it is beneficial to align the number of PRBs/MCS/TBS among companies for PUSCH simulation. UE Tx PSD is a very crucial factor for UL coverage evaluation. For better comparison of results, aligned number of PRBs for a given target throughput is preferred so that Tx PSD is aligned. Currently, some numbers in brackets provide good example for companies to check, thus better to be kept, which does not preclude companies to introduce different number of PRBs in the future and seems worth no further debate on this issue at this stage.Regarding CDL, we don’t feel it is necessary or mandatory for FR1. TDL is sufficient and has lower simulation time.Regarding TDL, TxRU and LLS, we feel antenna array gain and element gain can be involved in link budget evaluations but does not have to be involved in LLS with TDL, therefore, we may not fully understand proponent’s motivation but don’t feel a note for clarification on this is essential. |
| Apple | For the number of PRBs for eMBB and VoIP, we share the similar view with Intel and Samsung, 30 PRBs for 1Mbps and 4PRBs for 100kbps eMBB and VoIP can be the starting point, other values can be reported by interested companies. Otherwise it’s hard to compare the results with different assumptions. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | The benefits of pi/2 BPSK can be exploited for extreme coverage cases. Both pi/2BPSK and QPSK may be simulated.1 PRB for 30kbps option. |
| BT | We support 64TxRUs for urban scenario as mandatory, and would prefer to see 32TxRUs as optional. |
| Qualcomm | On antenna elements for 4 GHz:Why are we reducing the number of antenna elements for rural scenarios? I am assuming that rural scenarios have better cell sites to accommodate larger antenna arrays compared to urban scenarios? If so we should have more antenna elements for rural scenarios than urban scenarios. To keep things simple, I think it is best to assume a same panel for both urban and rural in this band. No need to consider a 64 antenna panel, 192 suffices for both scenarios in this band.On TXRUs for 4 GHz:We think it is important to include 64 TXRUs for both TDL and CDL. Digital beamforming/combining needs to be evaluated correctly.We believe typical deployments in the 4 GHz band will have gNBs with a large number of TXRUs. We will need this to support MU-MIMO via spatial multiplexing with 12 layers or even more. If this reflects the ground reality, it becomes all the more important to evaluate the case with 64 TXRUs. Operator input on their deployments and gNB vendor comments on commercial products can act as an important guideline. CMCC (noticed their comment in an earlier email discussion), BT, and ZTE seem to indicate support for such configurations. We want to make sure this doesn’t become an academic exercise that is not tied to reality.On antenna elements and TXRUs for 700 Mhz:I don’t think there is any deployment where we have 32 antennas in this band. 32 antennas in this band implies a 4x4 panel with dual-pol antennas. Considering that half-wavelength is around 0.5m, such an antenna panel would approximately be 3 meters x 3 meters in size. This is way too large to be practical. Wind loading would be a big issue; finding cell sites that accommodate such large panels would be extremely challenging. I think no more than 4 antennas ( 2 passive dual-pol antennas) are typical in these bands. There is a one-to-one mapping between antennas and TXRUs. If all of this is not convincing, we can check with at least one operator with spectrum in the sub-GHz band on what is the appropriate configuration.On PRB/TBS/MCS: Can we agree that the numbers in the brackets provide a baseline configuration that we can all use as a quick calibration checkpoint? Having a config for calibration is useful I think. We all have made 3 dB accounting errors at some point in our careers. Companies should aim to find other settings that yield better performance, but as a simple baseline can we agree to a set of numbers proposed by the moderator? |
| SONY | Number of PRBs should be reported by the proponent. It is unclear whether it is better to operate at a lower code rate (more PRBs, lower power spectral density, possibly worse channel estimation performance) or at a higher code rate (fewer PRBs, higher power spectral density, possibly better channel estimation).We would be supportive of Qualcomm’s proposal that “*the numbers in the brackets provide a baseline configuration that we can all use as a quick calibration checkpoint*” |

### FR2

**Proposal:**

* Adopt the following target data rates for eMBB performance evaluation for FR2.
* Indoor: DL: 25Mbps, UL:5Mbps
* Urban: DL: 25Mbps, UL: 5Mbps
* Suburban: DL: 1Mbps, UL: 50kbps
* FFS:
* Indoor: DL:100Mbps, UL: 10Mbps
* Urban: DL: 100Mbps, UL: 10Mbps
* Suburban: UL: 200kbps

Companies are invited to provide views on the above proposal.

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| **Companies** | **Comments** |
| Nokia/NSB | We do not see the need for including the FFS, since the target data rates have been discussed at large prior to the drafting of the SID. However, we would not object if this is what the majority prefers. |
| Sierra Wireless | Support this proposal |
| vivo | We prefer to stick to the target data rate given by the SID. |
| ZTE | Support the proposal and prefer not to consider the values in FFS. |
| Intel | We prefer the target data rate as identified in the SID. It is not clear to us why additional target data rate is needed.  |
| Ericsson | **What is the Suburban scenario, and why is it such low data rate?** While we acknowledge some kind of suburban scenario is agreed, we can’t agree to data rates without some common understanding of what the scenario is.The system bandwidth should be 400 MHz in our view, since the greater bandwidth of FR2 is a primary motivation for using FR2. **If we use 100 MHz system bandwidth for FR2, it is the same as we have agreed for 2.6 GHz, which is pretty counter-intuitive.** Since we have 100MHz, [400 MHz] now, we should at least have the 400 MHz values available here. However, for the UL, we think 10 Mbps is a better value for 400 MHz. Therefore, we propose the following, where Suburban rates can be added once the scenario is more clear.* Adopt the following target data rates for eMBB performance evaluation for FR2.

-      Indoor: DL: 25, [100] Mbps, UL: 5, [10] Mbps-      Urban: DL: 25, [100] Mbps, UL: 5, [10] Mbps |
| Samsung | We agree with Nokia’s comment. |
| Panasonic | We are fine with the proposal. |
| CATT | We agree with the proposal except the FFS. |
| Huawei, HiSilicon | Because analogy BF employed in FR2 network may prevent UL FDM among UEs, 50kbps UE UL throughput could be also the network UL throughput, which sounds impractical and unattractive. Therefore, suburban with such low UL throughput seems lack of justification for practical 100MHz FR2 networks. Necessary to put it optional or put FFS on it at this stage. |
| Apple | We prefer only one set of target data rate in the simulation, otherwise, it’s hard to make conclusion on the coverage bottleneck due to different target data rates. |
| Qualcomm | We support the proposal. |
| SONY | We would prefer the proposal without the FFS (i.e. without the DL 100Mpbs / UL 10Mbps data rates). |

## 2.2 Discussion on proposals with medium priority

### FR1

**Proposal:**

Identify the target performance and coverage bottlenecks based on target performance metric for FR1.

* FFS: the target performance metric and potential down selection.
* Option 1: The target path loss is considered as the target performance.
	+ Derived from the target ISD.
* Option 2: The target MCL is considered as the target performance.
	+ Alt1: Derived from the target ISD, considering shadow fading margin, penetration loss, etc.
	+ Alt2: Fixed target MCL, e.g. 147dB for VoIP
	+ Alt3: Relative MCL
* If optional SLS is performed, the target performance for SLS is determined by the 5th percentile SINR value in CDF curve for different physical channels
* Other target performance metrics are not precluded.

Companies are invited to provide views on the above proposal.

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| --- | --- |
| **Companies** | **Comments** |
| Nokia/NSB | Would it be possible to include a second alternative to Option 1 as “Relative MPL”? This may help capturing relevant performance difference between channels while accounting for antenna+array gain differences, if any. |
| Sierra Wireless | OK with the proposal since it only lists options where other options are not precluded. However, we do not feel this is urgent so could be decided later i.e. no need for email discussion on this. |
| vivo | We are fine with the proposal. Our preference is option 1. |
| ZTE | Support the proposal. |
| Intel | We are fine with the proposal.  |
| Ericsson | The proposal implies an absolute metric, since we already have an agreement on how to perform evaluations, and bottlenecks can be determined by relative comparison of coverage performance. We can’t agree to setting absolute coverage requirements at this stage. Discussion of such requirements can be in parallel to evaluation, and so we see no need to conclude now. |
| SoftBank | We are OK with the proposal as log as it lists all the potential proposals without any bias while we don’t see strong necessity to make any decision on this aspect at this early stage. We have a comment on Alt 2 of Option 2. Our original intention is not absolute MCS value but relative MCS to UMTS. So, we would propose to rephrase Alt 2 is rephrased as “Fixed target MCL, e.g. 147dB for VoIP to achieve better performance than other RAT(s)”. Otherwise, some people may wonder where this value comes from.  |
| Samsung | Since this will make the discussion more complicated and definitely longer, we prefer to choose the target performance metric derived from target ISD but we would not object if this is what the majority prefers. Also, we should avoid adding more alternatives to the options. |
| InterDigital | We support Option 2. We can rephrase Option 2 as “~~The target MCL~~ An MCL or MCL based metric is considered as the target performance” since the original wording is more suitable for Alt1/2. We are also fine to postpone the discussion for the next meeting. |
| Sharp | Company can analyse coverage based on either or both. |
| Panasonic | We are fine with the proposal. |
| Nomor Research GmbH | Nomor supports option 1 and 5th percentile SINR value in CDF curve for optional SLSs. |
| CATT | Agree |
| Huawei, HiSilicon | One of objectives in SID is "Identify the performance target for coverage enhancement”. OK with this proposal, but with the FFS on the top, the proposal seems not to provide much progress. |
| Apple | We are fine with the proposal. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | Support the proposal.  |
| Qualcomm | The proposal is acceptable to us. We think we can finalize this in the next meeting.For down-selection, we prefer a relative comparison of MCL across various PHY channels (Option 2 Alt 3). MPL analysis gets to be too subjective due to the large number of parameters and we have not settled down on any common understanding on how to set these parameters. We are also uncomfortable to use any hard cutoffs on coverage characterization based on ISD. |
| SONY | We would prefer to consider relative metrics at the moment rather than specific target values. |

### FR2

**Proposal:**

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

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| BLER | 10% iBLER for eMBB, 2% rBLER for voice. |
| DMRS configuration | For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.For 30km/h~~, 120km/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.FFS: PUSCH mapping type.FFS: DMRS position. |
| Waveform | DFT-s-OFDM for PUSCH, CP-OFDM for PDSCHFFS: CP-OFDM for PUSCH |
| Number of repetitions for PUSCH | For eMBB, no repetition is assumed.For VoIP, the maximum number of repetitions is 8. |
| HARQ configuration for PUSCH | For eMBB, no retransmission is assumed.For VoIP, the maximum number of HARQ transmission is 8. |
| PUSCH/PDSCH duration | 14 OS for PUSCH, 12 OS for PDSCH |

Companies are invited to provide views on the above proposal.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| Nokia/NSB | We propose to amend the proposal by adding that the both actual number of PUSCH repetitions and HARQ transmissions should be reported by companies. This would allow an easier comparison of the results in our view, without forcing any company to use a specific value (below the maximum allowed, of course). |
| Sierra Wireless | Same view as for FR1. |
| vivo | Same as our opinion in FR1, HARQ retransmission is not considered in LLS as repetition is already considered. |
| ZTE | Support the proposal, and same view as for FR1.  |
| Intel | We are fine with the proposal. One minor comment is “FFS: PUSCH mapping type.” This should be for both PDSCH/PUSCH. Further, frequency hopping is only applied for PUSCH.  |
|  Ericsson | * **LLS simulation with HARQ should be supported**, as we have commented repeatedly. rBler of 2% may be OK, but should be square bracketed. I will not object to simulations without HARQ as an option, but then it should be required that HARQ gains are justified with simulation results (just as they are for when HARQ is used).
* **Repetition and retransmission should be supported for eMBB**; supporting it for VoIP but not eMBB seems the opposite of normal operation.
* **The number of DMRS should either be square bracketed or left FFS.** The number of DMRS should be justified with simulation, including whether it is used for Msg3 vs. ‘normal’ PDSCH vs. CSI on PUSCH. If the concern is extra DMRS overhead, this is not consistent with e.g. the use of repetition. A conservative number is better than too few DMRS. Also, our understanding is that the default configuration for Msg3 is 3 DMRS. Lastly, the number of DMRS is adaptive in NR, and so LLS that optimize DMRS should not be preclude.
* **Support having DMRS type as FFS.** We would like to further discuss whether Type B DMRS is appropriate, or that this is left to the proponent. I expect this should not affect performance.
 |
| Samsung | As commented in FR1, we don’t think it is necessary to evaluate CP-OFDM for uplink in this SI. Therefore, we prefer to remove CP-OFDM waveform to reduce the simulation burden.Regarding the DMRS configuration, The 2 FFS for DMRS configuration, if not resolved, can be changed to “companies to report”. In addition, if we only consider DFT-s-OFDM waveform, we can remove the phrase “no multiplexing with data.”, since there is always no multiplexing with data when the precoding is enabled. |
| InterDigital | Regarding retransmission and HARQ, DMRS mapping and treatment of OFDM, we have the same view as in FR1. |
| Panasonic | We are fine with the proposal. On DMRS configuration (PUSCH mapping type and DMRS position), if FFS is not resolved, it can be changed to “companies to report”. On waveform, we share same view as above companies that DFT-s-OFDM is sufficient. |
| CATT | We are fine with the proposal and same question as FR1. |
| Huawei, HiSilicon | OK. |
| Apple | Same view as FR1. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | DFT-s-OFDM only for PUSCH. |
| Qualcomm | Same view as FR1. |
| SONY | Same view as FR1. |

**Proposal:**

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

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Number of antenna elements for BS | Indoor scenario: 128Urban scenario: 256Suburban: 256FFS: (M, N, P, Mg, Ng) |
| Number of TxRUs for BS | 2 |
| Number of UE antennas | 8(M, N, P) = (1,4,2) / (2,2,2)[16(M, N, P) = (4,2,2)] |
| Number of UE TRXUs | 1 or 2 for PUSCH, 2 for PDSCH |
| Channel model for link-level simulation | CDL- A, TDL-A, [urban/suburban: TDL-C] |
| Delay spread | Indoor scenario: 30nsUrban scenario: 100nsSuburban scenario: 100ns |
| Latency requirements for voice | 50ms/100ms |
| PRBs/TBS/MCS | Reported by companies. |

Companies are invited to provide views on the above proposal.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| Nokia/NSB | We are ok with the proposal. |
| vivo | We are fine with the proposals. |
| ZTE | Support the proposal. As for the FFS on antenna configuration, our preference is:UE side: (2, 2, 2) is fine for us. But, to be clear, it’s better to say ‘(2, 2, 2, 1, 1)’. gNB side: (8,8,2,1,1) for indoor and (4, 8, 2, 2, 2) for urban/suburban scenario. |
| Intel | For channel model, we think it is good to clarify that company would provide simulation results based on one of the TDL or CDL model, not both. Similar to the comments for FR1, we prefer to align the simulation assumptions, especially the number of PRBs/MCS/TBS among companies in order to provide meaningful study for baseline coverage. |
|  Ericsson | * **For the gNB: Wonder why we have 192 elements for 4 GHz and then only 256 for 28 GHz (a 7x higher frequency)**. Suggest 512 antenna elements in 4 panels with (M,N,P,Mg,Ng) = (8,8,2,2,2). For analog BF, 2 TXRUs is fine, but other antenna configurations for mmwave may need to be considered.
* **For the UE antenna elements:** Prefer (M,N,P) = (4,2,2), with 2 panels in different directions.
* **For UE Tx & Rx chains:** ‘UE TXRUs’ needs to be changed to ‘UE Tx & Rx Chains’, since we can have 1T2R. Suggest ‘1T2R’ and ‘2T2R’.
* **The scenarios are unclear.** Channel models and parameters for the scenarios should be agreed. Please find proposals in R1-2005004 Appendices 4 & 5, for FR1 and FR2, respectively, that can be used as starting points.
 |
| Samsung | As commented in FR1, we can fix the number of PRBs as a starting point. Therefore, we prefer to determine the same number of PRBs in FR1 for PUSCH.  |
| InterDigital | We support to use CDL-A for evaluation in FR2 and radiation pattern for each element should also be agreed. The number of TXRUs assumed here should be specified as well. For companies wishing to use CDL, should the same note in FR1 be added here? |
| Panasonic | We share the same view as Samsung. |
| CATT | For PRB/MSC/TBS, one baseline combination should be provided as FR1. Other combinations can be reported by companies. |
| Huawei, HiSilicon | OK. CDL-A is superior over TDL-A for FR2 evaluations because of its angle spreads. Prefer to delete TDL-A.Share similar view as Samsung and Panasonic to fix the number of PRBs as a starting point. |
| Apple | Agree to fix the number of PRBs as the starting point, and other options can be reported. |
| Qualcomm | Support the proposal. |
| SONY | We agree with the UE antenna configuration that is proposed by Ericsson. We think it is important that the number of UE antennas need to be associated with UE/panel orientation and that single polarized panels can be also be an option. |

**Proposal:**

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

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| PUCCH format type | Format 1, 2bits UCIFormat 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: Block error probability: 1% |
| Number of PRBs for PUCCH | 1 PRB |
| Number of UE antennas for PUCCH | The same as PUSCH |
| Number of UE TRXUs for PUCCH | The same as PUSCH |
| Number of receive antenna elements for BS | The same as PUSCH |
| Number of receive TxRUs for BS | The same as PUSCH |
| Number of repetitions for PUCCH | w/ and w/o repetitionThe maximum number of repetitions is 8. |
| PUCCH duration | 14 OS |

Companies are invited to provide views on the above proposal.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| Nokia/NSB | We think that PUCCH w/ repetitions should be optional, i.e., between []. |
| vivo | Similar to our opinion in FR1. 4 bits is not necessary, 11 and 22 UCI bits are preferred. |
| ZTE | Support the proposal. |
| Intel | We are generally fine with the proposal. For the number of DMRS symbols, it is possible to configure 2 or 4 symbols for DMRS for PUCCH format 3 when the number of symbols for PUCCH is 14. Need to add one more row regarding DMRS configurations.  |
| Ericsson | PUCCH format 3 should include A/N+SR for the 4 bit case; should be aligned with the FR1 case.CSI BLER should be 10%Number of antennas for PUCCH should be clarified, since only one port is supported for PUCCH. If 2 Tx antennas are used, the virtualization method to map 2 Tx to one port should be given by proponents.Number of TXRUs should be number of Tx/Rx chains, but can be same as PUSCH.Frequency hopping should be used to align with FR1. |
| Samsung | As commented before, we support the proposal about PUCCH repetitions and others. |
| NTT DOCOMO | We would like to include short formats (format 0 and 2) for FR2. They can be optional as follows, but they need to be considered since FR2 supports beam sweeping with short duration (e.g. 2 OFDM symbols).- Format 1, 0 (optional), 2bits UCI- Format 3, 2 (optional), [4bits (3 bits A/N + 1 bit SR)]/11/22 bits UCI |
| Panasonic | We are fine with the proposal. In addition, the usage of frequency hopping should be clarified as in FR1.  |
| CATT | Same comments as FR1. |
| Huawei, HiSilicon | OK. |
| Apple  | Same view as FR1. |
| Qualcomm | Support the proposal |

**Proposal:**

Identify the target performance and coverage bottlenecks based on target performance metric for FR2.

* FFS: the target performance metric and potential down selection.
* Option 1: The target path loss is considered as the target performance.
	+ Derived from the target ISD.
* Option 2: The target MCL is considered as the target performance.
	+ Alt1: Derived from the target ISD, considering shadow fading margin, penetration loss, etc.
	+ Alt2: Fixed target MCL, e.g. 147dB for VoIP
	+ Alt3: Relative MCL
* Option 3: The target performance based on SLS is determined by the 5th percentile SINR value in CDF curve for different physical channels.
* Other target performance metrics are not precluded.

Companies are invited to provide views on the above proposal.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| Nokia/NSB | Would it be possible to include a second alternative to Option 1 as “Relative MPL”? This may help capturing relevant performance difference between channels while accounting for antenna+array gain differences, if any. |
| Sierra Wireless | Same view as FR1 |
| vivo | We are fine with the proposal. Our preference is option 1. |
| ZTE | To align with FR1, Option 3 can be changed to follows. ‘If optional SLS is performed, the target performance for SLS is determined by the 5th percentile SINR value in CDF curve for different physical channels’ |
| Intel | We are fine with the proposal.  |
| Ericsson | The proposal implies an absolute metric, since we already have an agreement on how to perform evaluations, and bottlenecks can be determined by relative comparison of coverage performance. We can’t agree to setting absolute coverage requirements at this stage. Discussion of such requirements can be in parallel to evaluation, and so we see no need to conclude now. |
| SoftBank | As discussed earlier, Alt 2 of option 2 comes from the comparison between NR and UMTS. So, we are not sure if this sentence is appropriate for FR2. But, we are of course OK to keep it if other companies are fine, e.g. companies want to have the same agreement as FR1. |
| Samsung | As commented in FR1, since this will make the discussion more complicated and definitely longer, we prefer to choose the target performance metric derived from target ISD but we would not object if this is what the majority prefers. Also, we should avoid adding more alternatives to the options. |
| InterDigital | We support Option 2, and we have same suggestion and comments as in FR1. |
| Panasonic | We are fine with the proposal. |
| CATT | We are fine with the proposal. |
| Huawei, HiSilicon | OK. |
| Apple | We are fine with the proposal. |
| Qualcomm | Same view as FR1. Support Option 2, Alt3. |
| SONY | Agree with Ericsson that improvements can be evaluated as relative. |

## 2.3 Discussion on proposals with low priority

### FR1

**Proposal:**

* 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 |
| ~~CCE-to-REG mapping type~~ | ~~Non-interleaved mapping~~ |
| Tx Diversity | With Tx Diversity, optional: without Tx Diversity |

Companies are invited to provide views on the above proposal.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| Nokia/NSB | Can we have further clarification on which “Tx Diversity” scheme is considered?  |
| vivo | What is exact meaning of the ‘Tx diversity’? Is there any specific scheme any mind or reported by companies?We prefer to keep the aggregation level, payload, CORESET size, other parameters, e.g. precoding cycling, BF gain (broadcast or unicast), interleave size, can be reported by companies. |
| ZTE | Similar question as Nokia and vivo, it’s better to have a further clarification on Tx diversity (is it one port precoder cycling which is used in Rel-15 evaluation?) |
| Intel | We share similar view as Nokia. It is good to clarify that this is for precoder cycling for PDCCH transmission.  |
| Ericsson | 10% and 1% BLER should be reported.Regarding Nokia’s question: we think (transparent) precoder cycling should be used for PDCCH.  |
| Samsung | We agree with Nokia’s comment that “TX diversity” for PDCCH needs to be clarified. |
| Sharp | REG bundle configuration should be determined for Tx diversity (i.e., precoder cycling). We propose 6 REGs in one REG bundle. |
| Panasonic | Performance target (e.g., 1% BLER) should be included. We share the same view with above companies that clarification of Tx diversity is necessary. |
| Nomor Research GmbH | Nomor supports the proposal. |
| CATT | Similar views as Nokia |
| Huawei, HiSilicon | As a clarification, “e.g. precoding cycling” can be added after Tx diversity. |
| Apple | Similar views as Nokia |
| Qualcomm | We are okay with this proposal. The only major aspect that remains is modeling the broadcast PDCCH. This is particularly important in the 4 GHz band. |

### FR2

**Proposal:**

* 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 FFS: 1symbol |
| The number of SSB for broadcast PDCCH | FFS |
|  |  |

Companies are invited to provide views on the above proposal.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| Nokia/NSB | Support the proposal. |
| vivo | Same as in FR1. |
| ZTE | Support the proposal. |
| Intel | We are generally fine with the proposal. We suggest to remove “FFS: 1 symbol” as 2 symbols would provide better performance than 1 symbol.  |
| Ericsson | 10% and 1% BLER should be reported.Tx diversity is needed; can align with FR1. Suggest precoder cycling is used.  |
| Samsung | We are fine with the proposal. |
| CATT | Support |
| Huawei, HiSilicon | OK. |
| Apple | We are fine with the proposal. |
| Qualcomm | Clear assumption on the number of SSB beams is important for the performance of broadcast PDCCH (e.g. Msg2 PDCCH) which is, based on our evaluation, one of the main coverage bottlenecks. |

**Proposal:**

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

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Format type | Format B4, (Optional: Format C2) |
| Scheduled PRBs | 12 PRBs |
| Performance metric | 0.1% false alarm, 1% miss-detection |

Companies are invited to provide views on the above proposal.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| Nokia/NSB | C2 is the format with the largest CP size, and possibly the longest coverage. This seems particularly interesting when longer delay spreads need to be accommodated for. From our perspective we should consider it along with B4 (both without brackets). |
| vivo | We are fine with the proposal. |
| ZTE | Support the proposal. |
| Intel | We are fine with the proposal.  |
| Ericsson | Format B4 with 12 symbols10% or 1% missed detection at 0.1% false alarm probability, with maximum timing estimation error 50% of the normal CP length64 preambles per cellInitial timing offset uniformly distributed in [0, 0.77 µs] for an ISD of 200m |
| Samsung | C2 indeed has larger CP length than B4, however, with the CP length of B4, it can already support the RTT for 1km in FR2; so for delay budget, B4 is enough. C2 only has 4 repetitions while B4 has 12 repetitions, so B4 has obvious advantage to C2 in terms of link budget. From our point of view, B4 should be selected for FR2 simulation, but we are open to other companies to simulate C2, thus, optional for C2 should be fine. |
| Huawei, HiSilicon | OK. |
| Qualcomm | Clear assumption on the number of SSB beams is important for the performance of PRACH. |

## 2.4 Others

### FR1

Companies are invited to provide views on the evaluation assumptions not covered by agreements or the above proposals.

|  |  |  |
| --- | --- | --- |
| **Channel** | **Companies** | **Comments** |
| PRACH | Intel | For PRACH in FR1, suggest to use PRACH format 0 for baseline coverage analysis.  |
| Ericsson | **700 MHz:**Format 010% and 1% missed detection at 0.1% false alarm probability, with maximum timing estimation error 50% of the normal CP length and 64 preambles per cellInitial timing offset uniformly distributed in [0, 23 µs] corresponding to 6 km intersite distance (ISD).Sector beamwidth **4 GHZ:**Format B4 (12 symbols)10% and 1% missed detection at 0.1% false alarm probability, with maximum timing estimation error 50% of the normal CP length and 64 preambles per cellInitial timing offset uniformly distributed in [0, 1.9 µs] for 500 m ISD and [0, 6.7 µs] 1732 m ISDGoB over four horizontal directions  |
| Samsung | We prefer to be lower SCS, i.e., 60kHz, for PRACH in FR2.  |
| Msg2 | Ericsson | PDSCH with 8 bytes payload, MCS 0 with transport block scale factor 0.25, 12 PRBs, 3 DMRS symbol, 9 symbols with PDSCH (and 2 symbols reserved for PDCCH)precoder cyclingSector beamwidth for 700 MHz GoB over four horizontal directions for 4 GHz |
| Qualcomm | We are not concerned about the broadcast PDSCH (very small payload), but we are concerned about the broadcast PDCCH associated with msg2. We prefer to reuse the parameters for PDCCH assumed above and study it under a broadcast setting. |
|  |  |
| Msg3 | Ericsson | PUSCH with 7 bytes payload,MCS 0, 2 PRBs, 3 DMRS symbols 11 symbols with PUSCH, With 7 re-transmissions (8 attempts), using different frequency for different attempts. No PDCCH errors.Sector beamwidth for 700 MHz MRC for 4 GHz |
| Samsung | We prefer 2 PRBs for msg3 with TBS 56bits. |
| Qualcomm | Preferred slot format and waveform: Transform precoding enabled, 3 symbol DMRS, 11 PUSCH data symbols, 2 RB allocation. No repetitions. |
| Msg4 | Qualcomm | This is a broadcast PDSCH message with a payload size of up to 3000 bits. This needs to be evaluated as part of studying the coverage and reliability of the RACH procedure. It remains to be seen whether this or broadcast PDCCH is the primary bottleneck in downlink. |
|  |  |
|  |  |
| SSB | vivo | The PBCH performance is based on combination of 4 SSB transmissions.Broadcast BF/array gain should be different from unicast channels, and companies can report the broadcast BF/array gain. |
| ZTE | A combination of 4 SSBs in 80 ms is assumed |
| Intel | Accumulation of 4 SSBs in 80ms in the simulation.  |
| Ericsson | SSB transmitted with 20ms periodicity10% and 1% residual BLER after 4 retransmissions within MIB TTI of 80ms, UE is not assumed to know the SS/PBCH block index, wideband precoder, cycled for different transmissionsSector beamwidth for 700 MHz GoB over four horizontal directions for 4 GHz |
| PDSCH | Ericsson | **700 MHz:**Link and rank adaption based on 20 slot wideband CSI feedback periodicity and HARQ with up to three retransmissions. 52 PRBs, 2 symbols with DMRS, PDSCH and DMRS mapped to 12 symbols (2 symbols reserved for PDCCH), overhead due to CSI-RS and TRS with 20ms period Sector beamwidth **4 GHz:**Link and rank adaption based on 20 slot wideband CSI feedback periodicity and HARQ with up to three retransmissions. 273 PRBs, 2 symbols with DMRS, PDSCH and DMRS mapped to 12 symbols (2 symbols reserved for PDCCH), overhead due to CSI-RS and TRS with 20ms period GoB over four horizontal directions for 4 GHz |
|  |  |
|  |  |
| Others | Ericsson | **CSI on PUSCH: 700 MHz**5+2 bits for wideband CSI feedback for 2Tx1 PRB, no HARQ ACK/NACKsPUSCH without multiplexing with data on PUSCH and no frequency hopping**CSI on PUSCH: 4 GHZ**6 bits CSI part 1 (RI+CQI), 10 bits CSI part 2 (PMI1+PMI2) wideband reporting for type I feedback for an 8x2 port layout and up to rank four 1 PRB, no HARQ ACK/NACKsPUSCH without multiplexing with data on PUSCH and no frequency hoppingSector beamwidth for 700 MHz MRC for 4 GHz 1% and 10% error rate |
| InterDigital | For SIP invite message, latency requirement needs to be studied and agreed. In R1-2003464, time constraints are mentioned, but latency requirements at physical layer are not clear. |
|  |  |

### FR2

Companies are invited to provide views on the evaluation assumptions not covered by agreements or the above proposals.

|  |  |  |
| --- | --- | --- |
| **Channel** | **Companies** | **Comments** |
| PRACH | Ericsson | Format B4 with 12 symbols10% or 1% missed detection at 0.1% false alarm probability, with maximum timing estimation error 50% of the normal CP length64 preambles per cellInitial timing offset uniformly distributed in [0, 0.77 µs] for an ISD of 200mGoB 4x16 |
| Qualcomm | Clear assumption on the number of SSB beams is important for the performance of PRACH. |
|  |  |
| Msg2 | Ericsson | PDSCH with 8 bytes payload, MCS 0 with transport block scale factor 0.25, 12 PRBs, 3 DMRS symbol, 9 symbols with PDSCH (and 2 symbols reserved for PDCCH)precoder cyclingGoB 4x16 |
| Qualcomm | Clear assumption on the number of SSB beams is important for the performance of Msg2. It is important to include the performance evaluation of Msg2 PDCCH, as it has more coverage vulnerability, compared to Msg2 PDSCH. |
|  |  |
| Msg3 | Ericsson | PUSCH with 7 bytes payload,MCS 0, 2 PRBs, 3 DMRS symbols 11 symbols with PUSCH, With 7 re-transmissions (8 attempts), using different frequency for different attempts. No PDCCH errorsGoB 4x16 |
| Qualcomm | Clear assumption on the number of SSB beams is important for the performance of Msg3. The payload size for Msg3 needs to be specified (we suggest 56 bits). |
|  |  |
| Msg4 | Qualcomm | Clear assumption on the number of SSB beams is important for the performance of Msg4. The payload size for Msg4 PDSCH needs to be specified. |
|  |  |
|  |  |
| SSB | vivo | Same as in FR1. |
| ZTE | A combination of 4 SSBs in 80 ms is assumed |
| Ericsson | SSBs are transmitted with 20ms periodicityresidual BLER after 4 retransmissions within MIB TTI of 80ms, UE is not assumed to know the SS/PBCH block index10%, 1% error rateGoB 4x16 |
| SONY | We think it is important to include assumption regarding the SSB polarization. |
| PDSCH | Ericsson | Link and rank adaption based on 20 slot 2 port wideband CSI feedback periodicity and HARQ with up to three retransmissions. 66 PRBs, 2 symbols with DMRS, PDSCH and DMRS mapped to 13 symbols (1 symbol reserved for PDCCH), overhead due to CSI-RS and TRS with 20ms periodGoB 4x16 |
|  |  |
|  |  |
| Others | Ericsson | **CSI on PUSCH:** Type I wideband CSI feedback* 8+2=10 bits for 2 port feedback + 3bit CRI

1 PRB, no HARQ ACK/NACKsPUSCH without multiplexing with data on PUSCH and no frequency hopping |
|  |  |
|  |  |

# Summary

## 3.1 Summary of proposals with high priority

**Proposal 1:**

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

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameters** | **Values** | **Summary of Comments** | **Revised Values** |
| BLER for PUSCH | 10% iBLER for eMBB, 2% rBLER for voice. | * **Support or Accept**:

ZTE, Intel, Nomor, CATT, HW, BT, Panasonic, NTT DOCOMO, Nokia, vivo, Samsung, Sharp, Apple, IITH, IITM, CEWIT, Reliance Jio, Tejas Networks, Qualcomm* Sierra Wireless:

10% iBLER=rBLER for eMBB* InterDigital:

rBLER=10% for eMBB* Ericsson:

[2%] rBLER. | For eMBB, w/ HARQ, 10% rBLER; w/o HARQ, 10% iBLER.For VoIP, 2% rBLER. |
| Number of UE transmit chains for PUSCH | 1 or 2 | * **Support or Accept**:

Nokia, vivo, ZTE, Intel, Ericsson, NTT DOCOMO, InterDigital, Panasonic, CATT, HW, Apple, IITH, IITM, CEWIT, Reliance Jio, Tejas Networks, Qualcomm* **2 Tx chains**:

**Support**: Nomor**Optional**: Sharp, BT**Concerns**: Sierra Wireless, Samsung* Ericsson:

If 2, transparent diversity mode used should be identified by proponents. | 1，2 (optional)  |
| DMRS configuration for PUSCH | For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.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.FFS: PUSCH mapping Type B.FFS: DMRS position. | * **Support or Accept**:

Nokia, Sierra Wireless, vivo, ZTE, Intel, Samsung, NTT DOCOMO, InterDigital, Sharp, Nomor, CATT, HW, Apple, IITH, IITM, CEWIT, Reliance Jio, Tejas Networks, BT, Sony* InterDigital:

We support PUSCH mapping type B and DMRS locations shown in 6.4.1.1 in TS 38.211 can be used.* Qualcomm:

A minimum of 2 DMRS symbols.* Ericsson:

The number of DMRS should either be square bracketed or left FFS.* Samsung, ZTE, Panasonic:

As for the FFSs, report by companies.  | For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.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. |
| Waveform for PUSCH | DFT-s-OFDM, FFS: CP-OFDM | * **DFT-s-OFDM**:

**Support**: All companies.* **CP-OFDM**:

**Support**: Qualcomm, Sony, InterDigital**Optional**: Apple**Concerns**: Intel, Samsung | DFT-s-OFDM, CP-OFDM (optional) |
| Repetitions for PUSCH | For eMBB, no repetition is assumed.For VoIP, the maximum number of repetitions is 8.FFS: Repetition type B | * **w/ or w/o repetition**

**For eMBB**,**w/**: Ericsson, Sierra Wireless (optional)**w/o**: ZTE (baseline)**Report by companies**: HW* **Number of repetitions**

**For VoIP**,**Report by companies**: Nokia | 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, no retransmission is assumed.For VoIP, the maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies.  | * **w/ or w/o HARQ**

**For VoIP**,**Report by companies**: vivo**For eMBB**,**w/**: Sierra Wireless (optional), Ericsson, Sony**Report by companies**: InterDigital* **Number of HARQ transmission**

**For VoIP**,**Report by companies**: Nokia, vivo**For eMBB**,**Report by companies**: Ericsson, InterDigital* Qualcomm:

For VoIP, we prefer to limit the set of allowed repetition + retransmission to what is possible within a 20 ms window. | 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 | * **Support or Accept**:

most companies* Nomor:

Only 100ms | 50ms/100ms |
| PUSCH duration  | 14 OS | No concerns. | 14 OS |

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| **Companies** | **Comments** |
| Ericsson | **The proposal needs to be clarified a bit** **with respect to what type of data on PUSCH is considered**, since Msg3 etc. will may have different parameters: ‘For link level simulation, adopt the following table for PUSCH for eMBB data or VoIP on FR1.’**On BLER for PUSCH:** 10% rBLER for HARQ implies a very high initial BLER, so this value is confusing for us, especially since companies can report HARQ for eMBB according to the proposal . 10% iBLER is a common value used in simulations with HARQ, so we would instead ask for the following which leaves rBLER unspecified, and so a free parameter according to the number of HARQ transmissions: For eMBB: 10% iBLER**For DMRS configuration for PUSCH**: the number of DMRS symbols may be OK, but this has not been really studied. Can we square bracket the numbers, or at the very least make the number of DMRS symbols a working assumption, just so companies can check? This may ultimately lead to fewer DMRS configurations and less simulation effort overall.**For VoIP repetition & HARQ**: can we clarify that at least one, but not both, repetition and HARQ are required? |
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**Proposal 2:**

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

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| --- | --- | --- | --- |
| **Parameters** | **Values** | **Comments** | **Revised Values** |
| PUCCH format type | Format 1, 2bits UCIFormat 3, [4bits (3 bits A/N + 1 bit SR)]/11/22 bits UCI | * **Support or Accept**:

Nokia, Sierra Wireless, ZTE, Intel, Ericsson, Samsung, Sharp, Panasonic, Nomor, HW, Apple, IITH, IITM, CEWIT, Reliance Jio, Tejas Networks, Qualcomm, Sony* Vivo:

Format 3, only keep 11 bits.* CATT:

Format 3, 4bit (optional).* BT:

11/22 bits may not be sufficient for if CSI report is carrier over PUCCH. | 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%. | * **Support or Accept**:

Most companies.* Ericsson:

BLER for CSI: 10%.* Qualcomm:

BLER for CSI: 1%. | 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 | No comments. | 1 PRB |
| Number of UE transmit chains for PUCCH | 1 | No comments. | 1 |
| Number of repetitions for PUCCH | w/ and w/o repetition for PUCCH.The maximum number of repetitions is 8. | * **Support or Accept**:

Most companies.* Qualcomm, Nokia:

PUCCH repetition is optional. | w/ and w/o repetition for PUCCH.The maximum number of repetitions is 8. |
| PUCCH duration  | 14 OS | No comments. | 14 OS |
| DMRS configuration for PUCCH | Configure 2 or 4 symbols for DMRS for PUCCH format 3 | Intel | FFS: number of DMRS symbols for PUCCH Format 3. |

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| **Companies** | **Comments** |
| Ericsson | **On UE Tx chains**: A bit late comment, my apologies: if we have 2 Tx chains as optional for PUSCH, why should 2 not be optional for PUCCH? Transparent TxD is being discussed in RAN4 for NR at present.  |
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**Proposal 3:**

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

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| --- | --- | --- | --- |
| **Parameters** | **Values** | **comments** | **Revised 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)Rural: 64 antenna elements for 4GHz and 2.6GHz(M,N,P,Mg,Ng) = (8,4,2,1,1)32 antenna elements for 2GHz and 700MHz(M,N,P,Mg,Ng) = (8,2,2,1,1) | * **Support or Accept**:

Most companies.* Nomor:

 (8, 4, 2, 1, 1) for 700MHz Rural * CMCC:

32 antenna elements for 700MHz (R1-2005004) * Qualcomm:

no more than 4 antennas ( 2 passive dual-pol antennas) for 700MHz. 192 antenna elements for 4GHz.* Ericsson:

(8,8,2,1,1) is more likely in Europe and US. * Sharp:

4 elements for 2GHz and 700MHz is optional. | 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 and 700MHz(M,N,P,Mg,Ng) = (8,2,2,1,1) |
| Number of receive TxRUs for BS | TDL: 2 or 4 TxRUs, FFS: 64TxRUs for urban[CDL: urban: 64TxRUs, rural: 8 TxRUs for 4GHz and 2.6GHz, and 4TxRUs for 2GHz and 700MHz.] | * ZTE:

64TxRUs for urban in TDL* BT:

64, 32(optional) TxRUs for urban in TDL* Qualcomm :

64 for 4GHz both TDL and CDL, <=4 TxRU for 700MHz* CATT:

Opposed to 64 TxRU for TDL* Ericsson:

32 TXRU for 4GHz; 4, 2(optional) for 700MHz. We should correct that 2 or 4 gNB antennas are used in the LLS with TDL based LLS, not 2 or 4 TXRUs at 4 GHz.* Nomor:

8 TxRU (1,4) for rural and rural with long distance* IntelDigital:

TDL:2 or 4 RX at BS | TDL: 2 or 4 TxRUs, FFS: 64TxRUs for urban[CDL: urban: 64TxRUs, rural: 8 TxRUs for 4GHz and 2.6GHz, and 4TxRUs for 2GHz and 700MHz.] |
| Delay spread | Urban: 300ns~~, [240ns]~~Rural: 300nsRural with long distance: 30ns | No comments. | Urban: 300ns~~, [240ns]~~Rural: 300nsRural with long distance: 30ns |
| PRBs/TBS/MCS for eMBB for PUSCH | ~~Reported by companies.~~[30PRBs] for 1Mbps, [4 PRBs] for 100kbps.Other values of PRBs can be reported by companies.TBS and MCS can be calculated based on e.g. the number of PRBS, target data rate, frame structure and overhead. | * **Number of PRBs**

**Specific values as starting point/baseline**: Samsung, Intel, vivo, Apple, Panasonic, HW, Qualcomm, Nomor, CATT.**Report by companies**: Sony, Nokia, Sierra Wireless, Ericsson* IITH, IITM, CEWIT, Reliance Jio, Tejas Networks:

1 PRB for 30kbps (optional) | [30PRBs] for 1Mbps, [4 PRBs] for 100kbps, [1 PRB] for 30kbps as starting point.Other values of PRBs can be reported by companies.TBS and MCS 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.QPSK | * IITH, IITM, CEWIT, Reliance Jio, Tejas Networks, InterDigital:

pi/2 BPSK | [4 PRBs] for VoIP as starting point. Other values of PRBs can be reported by companies.QPSK, pi/2 BPSK (optional) |

As for antenna elements, TxRUs and antennas, there seem different understandings among companies.

* Opt.1 One level mapping
* A set of antenna elements map to one TxRU
* The number of TxRUs, corresponding to Tx/Rx, is used in LLS.
* Opt.2 Two level mapping
* A set of antenna elements map to one TxRU
* A set of TxRUs map to one antenna
* The number of antennas, corresponding to Tx/Rx, is used in LLS.

For option 1, to alleviate the burden of simulation, the number of TxRUs assumed in LLS (e.g., 2 or 4) is smaller than the practical network (e.g., 64).

For option 2, the number of TxRUs comes from the practical network, e.g., 64. The number of antennas used in LLS (e.g., 2 or 4) is smaller than the number of TxRUs.

From LLS perspective, for either option 1 or option 2, there seems little difference. The only difference is how to consider the array gain.

It seems that most companies’ understandings are based on option 1.

So proposal 3 is based on the understanding of option 1.

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| **Companies** | **Comments** |
| Ericsson | The option 1 and 2 explanation helps quite a bit, but the use of the term TXRU can still lead to confusion, since the intention of option 1 is to model more TXRUs than are actually used in the link simulation. Since there seems to be majority support for 32 or 64 TXRUs at 4 GHz, we can compromise to 64. To ensure that there is no ambiguity on the number of TXRUs, then we would prefer the following, which is hopefully in line with the intention of option 1:TDL: 2 or 4 TxRUs in LLS; 64 TXRUs modeled for urban. TBD: array gain calculation method  |
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**Proposal 4:**

* Adopt the following target data rates for eMBB performance evaluation for FR2.
* Indoor: DL: 25Mbps, UL:5Mbps
* Urban: DL: 25Mbps, UL: 5Mbps
* Suburban: DL: 1Mbps, UL: 50kbps
* FFS:
* Indoor: DL:100Mbps, UL: 10Mbps
* Urban: DL: 100Mbps, UL: 10Mbps
* Suburban: UL: 200kbps

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| --- | --- | --- |
| **Original proposal** | **Comments** | **Revised proposal** |
| **Proposal:*** Adopt the following target data rates for eMBB performance evaluation for FR2.
* Indoor: DL: 25Mbps, UL:5Mbps
* Urban: DL: 25Mbps, UL: 5Mbps
* Suburban: DL: 1Mbps, UL: 50kbps
* FFS:
* Indoor: DL:100Mbps, UL: 10Mbps
* Urban: DL: 100Mbps, UL: 10Mbps
* Suburban: UL: 200kbps
 | * **No additional data rate**

**Support**: Nokia, vivo, ZTE, Intel, Samsung, CATT, Apple, Sony* HW:

50kbps optional or FFS.* Ericsson:

the data rate of Suburban is too low.Adopt the following target data rates for eMBB performance evaluation for FR2.- Indoor: DL: 25, [100] Mbps, UL: 5, [10] Mbps- Urban: DL: 25, [100] Mbps, UL: 5, [10] Mbps | **Proposal:*** 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)
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| **Companies** | **Comments** |
| Ericsson | We do not expect the 100 MHz system bandwidth associated with the numbers shown is reflective of FR2 deployments: why at 28 GHz would you have the same bandwidth as 4 GHz? However, it can be noted in the TR later that 100 MHz was chosen solely for the purpose of evaluation and so the DL data rates shown are expected to be less than those in expected FR2 deployments. Given that, we will not object. |
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# References

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2. R1-2005004, Moderator (China Telecom), [101-e-NR-Cov-Enh] Email discussion on evaluation methodology and simulation assumptions for NR coverage enhancements, e-Meeting, May 25th – June 5th, 2020.