3GPP RAN 5G-ACIA Evaluations Week 2

December 14th – 18th 2020

Source: Moderator (Ericsson)

Title: Review of provided simulation results and needed updates

Document for: Discussion, Decision

# 1 Introduction

AT RAN#89, the following was agreed in [RP-202069](https://protect2.fireeye.com/v1/url?k=41a5db26-1f051960-41a59bbd-86fc6812c361-73f443258ff773bf&q=1&e=bc078f84-983d-45f3-ab31-19e60d911036&u=https%3A%2F%2Fwww.3gpp.org%2Fftp%2Ftsg_ran%2FTSG_RAN%2FTSGR_89e%2FDocs%2FRP-202069.zip) on providing evaluations for 5G-ACIA:

* Start an offline email-based activity to provide evaluation results for 5G-ACIA
* One company volunteers as moderator
	+ Proposes a work plan to follow
	+ Ericsson is willing do this
* Discussions are on the RAN1\_NR reflector
	+ Email activity only during short periods (< week) distributed across the time allocated to the activity
	+ No email activity in weeks before/during/after RAN1 meetings or RAN defined inactive periods
	+ All companies should strive to limit email activity as much as possible
	+ Outcome of the offline discussion will directly go to RAN without need for discussion in RAN1 nor need for LS from RAN1 to RAN
* Target completion by RAN#91
* At RAN#91, RAN will decide on a response LS to 5G-ACIA

The moderator made the following proposal on a timeline:

1. 12-16 October 2020
	* Discussion on which URLLC features to include in the evaluations and simulation assumptions
2. 14-18 December 2020
	* First round of simulation results
3. 22-26 February 2021
	* Second round of simulation results
4. 8-12 March 2021
	* Finalization of the report to RAN#91

During week 1, the simulation assumptions were agreed as captures in the document below:

[https://www.3gpp.org/ftp/tsg\_ran/TSG\_RAN/TSGR\_90e/Inbox/Drafts/5G-ACIA October/Agreements/Agreements week 1 5G-ACIA.docx](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_90e/Inbox/Drafts/5G-ACIA%20October/Agreements/Agreements%20week%201%205G-ACIA.docx)

For the second week, companies provided the first round of simulation results:

[https://www.3gpp.org/ftp/tsg\_ran/TSG\_RAN/TSGR\_91e/Inbox/Drafts/5G-ACIA December/Company Inputs/](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs)

The input contributions are also listed in the reference section.

In this contribution, review comments from other companies are collected for each input. Additionally, input on changes to simulations assumptions and need for additional simulations for round 2 are provided by companies.

# 2 Company Inputs

## 2.1 Huawei/HiSilicon

[Contribution link](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/HwHiSi%20-%20Simulation%20results%20for%205G-ACIA%20in%20the%20first%20round.docx).

Other companies can provide questions and comments in the table below:

|  |  |
| --- | --- |
| Company | Questions and comments |
| Nokia | For the MU-MIMO results, would it be possible to share more details on the assumed transmission scheme, e.g. details on the precoding, CSI acquisition and in general multiplexing of UEs?Is each BS limited to 2 Tx/Rx antenna ports?How was the scheduling done? I.e. was SPS/CG used, or was each TB scheduled independently? If SPS/CG was used, what are the modelling assumptions for the SPS/CG scheduling? E.g. is the FDRA fixed for each UE for the entire simulation? Is the MCS selected per UE or is it the same for all the UEs? Are there any adjustments of MCS/FDRA during the simulation? |
| Qualcomm | * On “distributed MIMO”: is it mTRP Tx only, or is it ICIC and other features as well?
* For the latency figure, are they identical for DL & UL?
* Please clarify how the MCS selection and radio link adaptation are used, especially in the context of “distributed MIMO”.
 |
| Ericsson | * + For the distributed MIMO, how was ‘the coordinated or coherent transmissions from different BSs’ done? Do the BSs coordinate to eliminate interference? Or they transmit coherently to improve SNR? Or both? But somehow the DL geometry shown in Figure 1 is worse than E/// plot, and E/// plot does not use any coordinated or coherent transmission.
	+ For blocked or failed packets, “E2E latency is set to 1ms“. Shouldn’t the E2E latency be set to infinity or at least some value >1ms?
	+ For the number of users in Table 2 and Table 3, it’s curious how the numbers come from. They don’t seem to based on real time scheduler that allocates different amount of PRB according to actual SNR of each UE. For example, 272, 544 and 1088 are simply multiples of 272 (PRB). Does this mean that each UE gets a fixed number of 1 or 2 or 4 PRBs?
 |
|  |  |

## 2.2 Intel

[Contribution link](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/INTEL%20-%205G-ACIA%20LS%20-%20Phase%202%20inputs.docx).

Other companies can provide questions and comments in the table below:

|  |  |
| --- | --- |
| Company | Questions and comments |
| ZTE | Do you assume one baseband for all 12 BSs or separate basebands for different BSs. Is there any coordination among different BSs?  |
| Nokia | How was the scheduling done? I.e. was SPS/CG used, or was each TB scheduled independently? If SPS/CG was used, what are the modelling assumptions for the SPS/CG scheduling? E.g. is the FDRA fixed for each UE for the entire simulation? Is the MCS selected per UE or is it the same for all the UEs? Are there any adjustments of MCS/FDRA during the simulation? |
| Qualcomm | What is the exact number for the % of Ues satisfying 10-4 PER for the DL simulation with 30 UE/cell? |
| Ericsson | * + In Table 1 evaluation assumptions, it has Handover margin of 1 dB. Is handover simulated? (But the agreement was ‘No explicit UE mobility (nor handovers) are modeled in the evaluations.’)
	+ In Table 1 evaluation assumptions, was there special reason to use BS transmit power of 30 dBm? The agreement was to follow 38.824: “24 dBm per 20 MHz”, which gives 31 dBm.
	+ For Figure 1(a), why was channel path gain presented? Other companies tend to show coupling loss. It’s easier for calibration if coupling loss is shown instead.
	+ For Figure 1(b), what configuration the geometry shown for? For example, BS antenna configuration is 4Tx/4Rx or 8Tx/8Rx?
	+ Regarding BLER target of 1e-5: is this a bit of overkill? With CSA=99.9999%, and survival time = 1ms, one packet error is acceptable. CSA is for two or more consecutive packet errors. BLER around 1e-3 should be adequate.
 |

## 2.3 ITRI

[Contribution link](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/ITRI_5G%20ACIA%20Simulation%20Result%20for%20InF-DH%204GHz.docx).

Other companies can provide questions and comments in the table below:

|  |  |
| --- | --- |
| Company | Questions and comments |
| ZTE | Do you assume one baseband for all 12 BSs or separate basebands for different BSs. Is there any coordination among different BSs?  |
| Nokia | What are the modelling assumptions for the SPS/CG scheduling? E.g. is the FDRA fixed for each UE for the entire simulation? Is the MCS selected per UE or is it the same for all the UEs? Are there any adjustments of MCS/FDRA during the simulation?The performance in terms of supported number of UEs seems significantly worse than what is reported by other companies. It was not immediately clear why this is the case, but it would be a good to understand the reasons before considering including these in the 5G-ACIA response LS. Would ITRI be able to indicate the potential reason for such low number of UEs supported? |
| Qualcomm | What is the exact PER requirement?  |
| Ericsson | For section 3 simulation results table, it’s puzzling why Percentage of UEs satisfying requirements is only at the level of 70+%, while other companies‘ results for 10 UE per service area show 99+%. Some explanation text was provided about the configuration, but not very easy to understand the details.  |

## 2.4 Nokia

[Contribution link](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/NOKIA%20-%205G-ACIA%20First%20round%20of%20simulation%20results.zip).

Other companies can provide questions and comments in the table below:

|  |  |
| --- | --- |
| Company | Questions and comments |
| ZTE | Do you assume one baseband for all 12 BSs or separate basebands for different BSs. Is there any coordination among different BSs? Nokia response: all 12 BS are separate and independent, there is no coordination among the BSs. |
| Qualcomm | * Please clarify the number of samples per UE (is it 2\*106)?
* Regarding the statement “This is because the latency performance is impacted not only by queuing delay and interference but also by limitations to user multiplexing imposed by beamforming operation itself. )”, is the difference between DL and UL in FR 2 due to beamforming capability, i.e. fewer opportunities for scheduling UEs?
* It would be great if the following quantities could be clarified: gNB processing delay, UE processing Delay, PUSCH preparation time
 |
| Ericsson | * + In Appendix B simulation assumption of FR1,
		- what’s the number of UE Tx antennas and configuration? Same as Rx antennas?
		- Any reason that BS Tx power is 27 dBm? The agreement was to follow 38.824 (24 dBm per 20 MHz), which gives 31 dBm.
	+ In Appendix B simulation assumption of FR2, UE antenna configuration mentions “2 UE panels facing opposite directions”. Was the panel selection static?
 |

## 2.5 Qualcomm

Contribution links for [FR1](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/QUALCOMM-5G-ACIA_URLLC_simulation_results_1st_round_FR1.docx) and [FR2](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/Qualcomm5G-ACIA_URLLCResultsRound1_FR2.docx).

Other companies can provide questions and comments in the table below:

|  |  |
| --- | --- |
| Company | Questions and comments |
| ZTE | * For FR1 evaluation, is it a correct understanding that you allocated some time domain resources dedicated for re-transmission? To allow one re-transmission, do you assume 3 symbols or 4.5 symbols for processing SPS PDSCH and preparing HARQ-ACK?

Qualcomm response: 3 symbols are needed for processing SPS PDSCH. Also, 3 symbols are needed betwen receiving a PUSCH and sending a retransmission on PDSCH. They are all compliant with TR 37.910, TS 38.2124 and TS 38211 as explained below.* Do you assume one baseband for all 12 BSs or separate basebands for different BSs. Is there any coordination among different BSs?

Qualcomm response: All 12 BS are separate and independent, and there is no coordination among the BSs except for the orthogonal retransmission phase.In addition, it’s our understanding that assuming only 2.8 symbols for gNB processing especially for decoding PUCCH plus scheduling re-transmission is challenging. Qualcomm response: Our calculation is based on Table 5.7.1.1.1-1 and Table 5.7.1.1.2-1 in TR 37.910 and Table 6.4-2 in TS 38.214 (Note that $μ=1$ for 30 kHz SCS from TS 38.211 Table 4.2.1). Note that the retransmitted packet is already available in the buffer when the retransmission decision is made. Therefore, it seems practical to allow 2.8 symbols for gNB to process the PUCCH + retransmission.  |
| Nokia | FR1: * As also commented by ZTE, UE and gNB processing times seem more optimistic than what has been assumed by other companies. For instance, 2.8 symbols are assumed from PUCCH transmission (with HARQ) to PDSCH retransmission, whereas we assume 5.5 symbols (corresponding to N2). Also, minimum DL/UL latency in the CDF (Figs. 11 and 12) is ~80 us, which also doesn’t seem very realistic.

Qualcomm response: Our calculation is based on Table 5.7.1.1.1-1 and Table 5.7.1.1.2-1 in TR 37.910 and Table 6.4-2 in TS 38.214 (Note that $μ=1$ for 30 kHz SCS from TS 38.211 Table 4.2.1). The labels of the latency plot are indeed incorrect because the 2 SPS data symbols were not taken into account. The correct plot is attached here, where the DL and UL latencies are nearly identical:* Section 4.1: On the CSA distribution, does the reported ‘end-to-end error’ corresponds to single-error or two consecutive error case?

Qualcomm response: It’s the single-error case.* Are UEs dropped per service area or per BS? Section 4 and 5 seem to imply that there is a fixed amount of UEs in each BS.

Qualcomm response: Fixed number of UEs are dropped to each service area, while each BS may have different loads due to the pathloss association rule.* The proposed TDD configuration seems to require UE capability 5-1b of multiple DL/UL switches per slot. Should this be included in the feature list to be evaluated?

Qualcomm response: From Table 11.1.1-1 in TS 38.213, multiple DL/UL switches per slots are permitted. We think the multiple DL/UL switches per slot should be included in the feature list.FR2: * Is it correct that you assume up to 4 UEs FDM? Is this opportunistic, depending on how many UEs happen to be reachable with the same beam, or is there some sort of multi-beam transmission allowing this to happen always?
1. Qualcomm response: Multi-beam transmission is assumed so that 4 UEs FDM always happens - provided there is traffic available.

What are the modelling assumptions for the SPS/CG scheduling? E.g. is the FDRA fixed for each UE for the entire simulation? Is the MCS selected per UE or is it the same for all the UEs? Are there any adjustments of MCS/FDRA during the simulation? Qualcomm response: FDRA and MCS for a UE could be modified by the SPS/CG overriding symbol in each slot. More precisely, FDRA can be updated upon need for radio link adaptation. MCS is selected per UE. There are adjustments of both MCS and FDRA when the radio link adaptation indicates MCS or FDRA change-upon NACK reception. Given that not many UEs need FDRA or MCS update per slot under our SPS/CG scheme, the resources provided for SPS overriding should be sufficient. Our preliminary investigation indicated that the difference between SPS/CG and dynamic schedulings are minimal for 20 UE/cell under our SPS/CG strategy. More detailed investigation on the overhead required for effective SPS/CG is ongoing. |
| Ericsson | FR1:* + For simulation parameters in section 2, why was the periodicity=2ms? Use case #2 has transfer interval of 1ms, which means periodicity=1ms in our understanding.
	+ Could you please explain why retx BLER target is 10-4/6? How to ensure orthogonal **retx** throughout the network? No orthogonal tx if initial transmission?

FR2:* + For FR1 study, the timing was worked out to allow 1 retx, hence a high BLER target of 1e-2 could be used for initial tx. For FR2, presumably the latency requirement is easier to achieve than FR1. Isn’t it more feasible to use HARQ retx in FR2 (hence higher BLER target than 1e-4)? What’s the considerations for the setup of FR2 as compared to FR1?
	+ In Section 2.1.5, UE Tx power is set to 11 dBm. Any special reason to use such low value? 38.824 used 23 dBm.
 |

## 2.6 vivo

[Contribution link](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/vivo-5G-ACIA%201st%20round%20URLLC%20evaluation%20results.DOCX).

Other companies can provide questions and comments in the table below:

|  |  |
| --- | --- |
| Company | Questions and comments |
| ZTE | Do you assume one baseband for all 12 BSs or separate basebands for different BSs. Is there any coordination among different BSs?  |
| Nokia | How was the scheduling done? I.e. was SPS/CG used, or was each TB scheduled independently? If SPS/CG was used, what are the modelling assumptions for the SPS/CG scheduling? E.g. is the FDRA fixed for each UE for the entire simulation? Is the MCS selected per UE or is it the same for all the UEs? Are there any adjustments of MCS/FDRA during the simulation? |
| Qualcomm | What is the CSA assumption? |

## 2.7 Ericsson

[Contribution link](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/Ericsson%205G-ACIA%20Simulation%20Results%20Round1.zip).

Other companies can provide questions and comments in the table below:

|  |  |
| --- | --- |
| Company | Questions and comments |
| ZTE | Do you assume one baseband for all 12 BSs or separate basebands for different BSs. Is there any coordination among different BSs?  |
| Nokia | * What are the modelling assumptions for the SPS/CG scheduling? E.g. is the FDRA fixed for each UE for the entire simulation? Is the MCS selected per UE or is it the same for all the UEs? Are there any adjustments of MCS/FDRA during the simulation?
* Minimum latency is ~100 us, which is a bit too low for 2 OS TTI and 30 kHz SCS. Are realistic processing times taken into account?
 |
| Qualcomm | * Please elaborate the sentence “Since packet arrival is known by gNB, allocation in time and periodicity is optimized so that the alignment delay is minimized.” What quantities are optimized to minimize alignment delay?
 |

## 2.8 ZTE

[Contribution link](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/ZTE-5G-ACIA%20evaluations%20-%201st%20round%20of%20simulation%20results.docx).

Other companies can provide questions and comments in the table below:

|  |  |
| --- | --- |
| Company | Questions and comments |
| Nokia | * What are the modelling assumptions for the SPS/CG scheduling? E.g. is the FDRA fixed for each UE for the entire simulation? Is the MCS selected per UE or is it the same for all the UEs? Are there any adjustments done to the MCS/FDRA during the simulation?
* Minimum latency is ~250 us, which is a bit too low for 5 OS TTI and 30 kHZ SCS. Are realistic processing times taken into account?
 |
| Qualcomm | * How do the base stations coordinate together? What are the technologies involved, such as mTRP, ICIC or other features as well?
 |
| Ericsson | * + For latency figures (Fig 3 and 4), why are the CDF curves in staircase shape? Is it related to packet arrival being generated with symbol granularity?
	+ For Table 1 RU results, it is puzzling why RU is so low. Our back of envelope estimate is, using RU=10.08% for 50 UEs per service area as in ZTE Table 1, most UEs are allocated with 1 PRB. This seems very low. For example, as a reference point, Intel’s RU results (Table 2 and Table 3) are approximately 4 times as high as ZTE’s for both DL and UL.
 |

# 3 Updates of simulations assumptions and missing simulations

In the table below, companies can provide inputs on need for changes in simulation assumptions and what additional simulations that should be performed for the second round of simulations.

|  |  |
| --- | --- |
| Company | Input |
| Nokia | The antenna assumption for FR2 may be too restrictive, with only 2 Tx/Rx antenna ports in the BS. When analogue BF is used, this limits the multiplexing capability and leads to starvation of slots to transmit while a lot of PRBs are unused. We should consider an antenna system that allows for larger number of UEs to be multiplexed to transmit/receive at the same time. Not exactly related to further simulation needs, but realizing that some companies are simulating a single gNB with 12 RRUs having some sort of joint scheduler, while others are simulating 12 independent gNBs without coordination it would seem important to categorize the results in the final output so that it is possible to understand that different network setups lead to different performance. |
| Qualcomm | Our proposed scheme assumes the following: CSA metric with no consecutive errors; gNBs do not coordinate except for orthogonalized retransmissions, which is a special form of mTRP; Multiple uplink/downlink switchings in a slot; Processing delays compliant with TR 37.910, TS 38.2124 and TS 38211 are used for our HARQ strategy.Most companies use the same CSA metric where no consecutive errors are permitted. It seems appropriate to make this CSA assumption mandatory in the 2nd round.Also, the set of permitted coordination strategies among gNBs should be made more specific. The companies that assume gNB coordination should elaborate the coordination strategies being used because different coordination strategies have different processing requirements.  |
| Ericsson | There is a need to calibrate the simulator among companies. We noticed at least two sets of DL geometry curves for 4GHz:1. E/// and QC have very similar DL geometry curves;
2. HW and Intel have very similar DL geometry curves;

But (b) are significantly worse than (a), for example, about 4 dB worse at CDF=50% and 80%. It would be good to align this basic setup first. |

# 4 Conclusions

# References

1. [RP-202069](https://protect2.fireeye.com/v1/url?k=41a5db26-1f051960-41a59bbd-86fc6812c361-73f443258ff773bf&q=1&e=bc078f84-983d-45f3-ab31-19e60d911036&u=https%3A%2F%2Fwww.3gpp.org%2Fftp%2Ftsg_ran%2FTSG_RAN%2FTSGR_89e%2FDocs%2FRP-202069.zip), “Way forward on RAN work for 5G ACIA requested simulations“, Ericsson
2. “[Simulation results for 5G-ACIA in the first round](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/HwHiSi%20-%20Simulation%20results%20for%205G-ACIA%20in%20the%20first%20round.docx) Huawei, HiSilicon
3. “[5G-ACIA LS – Phase 2 input](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/INTEL%20-%205G-ACIA%20LS%20-%20Phase%202%20inputs.docx)”, Intel Corporation
4. “[Simulation Assumptions and URLLC Performance Evaluations for 5G-ACIA Performance Evaluation Round 1](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/ITRI_5G%20ACIA%20Simulation%20Result%20for%20InF-DH%204GHz.docx)”, ITRI
5. “[First round of simulation results for 5G-ACIA evaluation](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/NOKIA%20-%205G-ACIA%20First%20round%20of%20simulation%20results.zip)”, Nokia, Nokia Shanghai Bell
6. “[First round of FR1 simulation results for 5G ACIA URLLC LS response](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/QUALCOMM-5G-ACIA_URLLC_simulation_results_1st_round_FR1.docx) ”, Qualcomm CDMA Technologies
7. “[Simulation Assumptions and URLLC Performance Evaluations for 5G-ACIA Performance Evaluation Round 1](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/Qualcomm5G-ACIA_URLLCResultsRound1_FR2.docx)”, Qualcomm CDMA Technologies
8. “[5G-ACIA 1st round URLLC evaluation results](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/vivo-5G-ACIA%201st%20round%20URLLC%20evaluation%20results.DOCX)”, vivo
9. “[Simulation Results for 5G-ACIA (First round)](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/Ericsson%205G-ACIA%20Simulation%20Results%20Round1.zip)”, Ericsson
10. “[ZTE-5G-ACIA evaluations - 1st round of simulation results](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_91e/Inbox/Drafts/5G-ACIA%20December/Company%20Inputs/ZTE-5G-ACIA%20evaluations%20-%201st%20round%20of%20simulation%20results.docx)”, ZTE