3GPP RAN 5G-ACIA Evaluations Week 1

October 12th – 16th 2020

Source: Moderator (Ericsson)

Title: Updated proposals on URLLC features and simulation assumptions

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

A summary of the inputs provided by companies with first proposals for agreements was provided with companies adding their proposals[10].

In this contribution updated proposals are made based on companies’ comments to the initial proposals.

# 2 Simulation assumptions

## 2.1 Updated proposal

Based on the first round of discussions, the proposals for each parameter is listed in the table.

|  |  |  |
| --- | --- | --- |
| Parameters | 5G-ACIA LS | **Proposal for agreement** |
| Factory hall size | 120x50 m | As in 5G-ACIA LS |
| Room height | 10 m | As in 5G-ACIA LS |
| Inter-BS/TRP distance | Depending on the number of TRPs, which are evenly deployed in the factory hall. Simulation company should provide the number of BSs/TRPs used in the simulation. | According to proposed layout below |
| BS/TRP antenna height | 1.5 m for InF-SL and InF-DL 8m for InF-SH and InF-DH | As in 5G-ACIA LS |
| Layout – BS/TRP deployment | Depending on the number of TRPs | 12 TRPs within area with the same 2D placement as in TR 38.901 and TR 38.824. |
| Channel model | UC-2: InF-DH > InD-DL > InF-SH > InF-SL | Mandatory: InF-DH  Optional: InD-DL, InF-SH, InF-SL |
| Carrier frequency and simulation bandwidth | TDD 4 GHz: 100 MHz 30 GHz: 160 MHz | As in 5G-ACIA LS |
| TDD DL-UL configuration | Simulation company should report the used DL-UL configuration. | Companies should report the used DL-UL configuration. 1:1 DL-UL configuration is recommended. |
| Number of UEs per service area | Up to 50 per service area, e.g., 10, 20, 40, and 50 | As in 5G-ACIA LS |
| UE distribution | All UEs randomly distributed within the respective service area. | As in 5G-ACIA LS |
| Message size | 48 bytes | 48 bytes |
| DL traffic model | DL traffic arrival with option-1, option-2, and option-3. | 5G-ACIA Option 1 is mandatory |
| UL traffic model | UL traffic is symmetric with DL, and DL-UL traffic arrival time relationship with option-1 and option-2 | As in 5G-ACIA LS with Option 1 as mandatory |
| CSA requirements | UC-#2: 99.9999% | UC-#2: 99.9999% |
| Performance metrics | 1) CSA: single CDF of CSA distribution of all UEs in factory hall 2) Latency: single CDF of latency distribution of all UEs in factory hall 3) Percentage of UEs satisfying requirements  4) resource utilization | As in 5G-ACIA LS with 3) and 4) as low priority  Note: Clarification of metric 2) to be discussed |
| E2E latency & air interface latency | E2E latency: 1 ms for UC#2  Air interface latency: 1ms | As in 5G-ACIA LS |
| UE speed | Linear movement | Linear movement: 75 km/h  No explicit UE mobility (nor handovers) are modeled in the evaluations. |
| BS antenna mount |  | Option 1 (1 sector per BS) from 38.824 is used |
| Handover margin |  | 1 dB |

1. Agree on the proposals for simulation assumptions given in the table
2. Additional simulation parameters are taken from TR 38.824.

Intel raised a need for clarifying performance metric 2). The different alternatives are:

1. a packet transmission can be performed after the latency deadline. The collected statistics can exceed the latency requirement.
2. a packet transmission cannot be performed after the latency deadline. The collected statistics cannot exceed the latency requirement. The packets exceeding the deadline are visible in the UE packet error statistics

Companies are to give input on which alternative is preferred.

## 2.2 Companies comments to proposals

Companies can add comments on the proposals in the table.

|  |  |
| --- | --- |
| Company | View |
| Qualcomm | Regarding Proposal 1, companies should have the flexibility to choose what handover margin to use since this is implementation-dependent. Therefore, we suggest not to fix the value of the margin.  Regarding Proposal 2, we prefer Alternative 2. |
| Intel | Based on further clarifications, we are fine with most of the proposals.  Given that 5G-ACIA highlights that CN latency can be ignored, we can consider E2E latency = air interface latency. However, further agreement is needed here: 5G-ACIA indicates that E2E latency < Transmission Interval. Given that UC#2 uses 1ms TI and TS, then E2E needs to be taken less than 1 ms. We prefer to take either 0.9 ms value, or any other alternative < 1 ms.  We also confirm our own proposal on handover margin to be fixed. It is crucial to have aligned results between companies since it impacts basic geometry SINR distribution.  Between the mentioned latency options, we see reasonable Alt. 2, which however makes the metric #2 (latency CDF) less valuable.  The CDF of latency in this case still needs attention. For each point in the CDF, it could be either each packet latency, or a function of each UE packets latencies (max, avg, mean, X% tail, etc.). Given that it is just the first round of discussion, we suggest companies to comeback to this issue together with the initial results. |
| ZTE | For Proposal 1, we share with Qualcomm that the handover margin could leave to companies’ report based on their implementation.  In addition, we think the following aspects are important to be clarified.  **BLER requirement**  We support the proposed 99.9999%CSA requirement. But it is also important to clarify the packet BLER target used in air interface, which would make a big difference on the evaluation results. As discussed in the second round, there could be multiple options here.   * Option 1: Assume the same value for transfer interval and survival time, and packet errors are uncorrelated. In such case, we agree with Ericsson that 1e-3 BLER can be assumed. * Option 2: Assume the same value for transfer interval and survival time, and packet errors are correlated. In such case, a lower BLER target than 1e-3 BLER should be assumed. * Option 3: Assume zero survival time. In such case, the packet reliability is the same as CSA requirement, i.e., 1e-5 BLER. This is the same as the evaluation conducted in TR 38.824.   Clearly, Option 1 offers a much less stringent requirement than other options.  **DL traffic model**  If the traffic from different UEs is not coordinated, Option 1 should be taken, and the offset should be random to reflect the real traffic arrival. On the other hand, if the traffic arrival among different UEs could be synchronized in one or two groups, Option 3 is the more realistic model. Thus, we are fine to also consider Option 3 here. In such case, gNB can have a better arrangement on the traffic arrival based on TDD configuration and the number of UEs in the service area. Thus, we suggest to consider both Option 1 and Option 3, or leave this to companies report.  Regarding the performance metric, we prefer Alt 2. |
| vivo | Regarding proposal 1, for TDD DL-UL configuration, to make fair comparison across companies, we still think URLLC transmission schemes should be further clarified. According to the conclusions in TR 38.824, only a single-shot transmission can meet 1ms latency requirement for SCS=30KHz considering Rel-15 timing capability, re-transmission cannot be completed within 1ms. While if we adopt Rel-16 shorter periodicity DL SPS, and don’t consider PDCCH/PDSCH alignment delay, re-transmission can be completed within 1ms. Therefore, we would like to make the following modification.  *Companies should report the used DL-UL configuration and URLLC transmission schemes, i.e. HARQ-based retransmission or repetition-based transmission or one-shot transmission. If HARQ-based retransmission is used, what are the gNB’s/UE’s processing time and whether/how the DL/UL alignment delay is taken into account.*  In addition, for handover margin, we can leave it to company report.  Regarding proposal 2, Alt 2 is preferred. |
| HW/HiSi | **Layout – BS/TRP deployment**  We suggest to add the following note to the proposal:  *Note: If M-TRP or cooperation among ALL the 12 cells is considered, then also interference from an outdoor macro station shall be considered in the simulations.*  The reason is that, if interference would not be considered, the simulation is not meaningful, since it would always result into a very high SINR.  In our view, coherent cooperation among TRPs within a factory is realized by implementation.  **DL traffic model**  We do not agree to Option 1.  In our view Option 3 should be taken. It is more realistic for motion control applications and also makes it easier to compare results across companies. Also, we have not heard a justification why Option 1 should be preferred in case of coordinated traffic which according to our understanding will be used in the majority of motion control applications. Even for those motion control applications where the traffic would not be generated in a coordinated manner, the air-interface traffic can still be coordinated by using TSN. Therefore Option 3 is overall the better assumption for the possible use cases.  **Performance metric**  Regarding metric #2 from 5G-ACIA companies are asked by the moderator to clarify whether   |  | | --- | | 1. a packet transmission can be performed after the latency deadline. The collected statistics can exceed the latency requirement. 2. a packet transmission cannot be performed after the latency deadline. The collected statistics cannot exceed the latency requirement. The packets exceeding the deadline are visible in the UE packet error statistics |   In our view, alternative 2 should be used.  Given that alternative 2 from above is applied, however, metric #2 is not so useful in our view, because the latency will be cut after the deadline. In such case we think that Metric #4 should have higher priority than Metric #2.  **E2E latency and – BS/TRP deployment**  In the moderators summary, it is written that 5G-ACIA specified in the LS and “E2E latency: 1 ms for UC#2 and air interface latency: 1ms”  We do not see this observation from the LS. The only requirement that is spelled out in the LS is the E2E latency of 1ms. Then, according to understanding 5G-ACIA has not performed a breakdown into CN and air-interface latency.  Our understanding of the sentence below from the LS is that in this WI, only the air-interface latency performance will be studied. The reason is that the CN network performance is not impacted by the URLLC features that RAN1 has defined. It is not meant that the CN latency shall be assumed to be zero. According to our understanding, it was discussed in 5G-ACIA it how to split the E2E latency between CN and air-interface. From our understanding, the position of the verticals was that is part of the 5G solution design for motion control and should done within the communication companies and not in 5G-ACIA.  Some companies here within RAN1 interpret the sentence from the LS mentioned below differently. In their view, 5G-ACIA has already done the split and assumes CN latency is equal to zero.  **Since this decision has significant impact in the simulations, we would suggest to check back with 5G-ACIA about their intention. Maybe, this could be solved simply if companies check internally firstly with their 5G-ACIA represents, if possible.**    Sentence from the LS:  Regrading the following sentence rom the LS : “*Typically, end-to-end latency in service application level is affected by both core network latency and RAN part latency. It is assumed that the CN included latency can be negligible in this WI. As a result, this WI focuses on the latency performance of the RAN. The RAN latency performance is affected by multiple RAN system parameters, e.g. system capacity, user load,….,the wireless communication system is controlled to achieve different desired performance trade-offs*” |
| ITRI | Regarding Proposal 1, we are fine with most of simulation assumptions, except some of those should be clarified.  **TDD DL-UL configuration** The slot-based configuration options can be high priority, such as {SU}, S= {D12, G2} with FR1 SCS 30kHz and {DSUU}, S= {D12, G2} with FR2 SCS 120kHz in R4-1809555. The symbol-based configurations can be low priority, such as {S}, S = {D6, G2, U6}, to reduce complexity on mini-slot’s calibration.  **DL traffic model** We prefer options 1 and 2 should be both high priority because they give the extreme traffic condition and facilitate calibration. However, option 3 should also be mandatory in the second round because it is more realistic.  **Performance metrics**  We agree Intel’s comments on metrics’ CDF. The CDF points of latency needs clarification. It could be either each packet latency, or a function of each UE packets latencies (max, avg, mean, X% tail, etc.). We also expect to include the value of resource utilization per request in 5G-ACIA LS. In addition, the value of survival time, e.g. 0 or 1ms, should be also supplied with the CDF of CSA distribution.  Regarding Proposal 2, we prefer Alternative 2. |
| Nokia | Proposal 1: Agree with Qualcomm that this could be left up to the proponent.  Proposal 2: As long as the system is not heavily loaded the BLER vs. late delivery boil down to being the same. With BLER metric it may be interesting to see which packets were lost due to being late, and in this respect option #1 would provide more information. Due to this we prefer option #1.  Re Traffic model: We are not necessarily against companies using option #3, but in our view that would easily lead to more difficulties in aligning the assumptions and using option #1 has less of such issues. If some companies wish to use option #3 we would not be in opposition.  Re HW comment on Layout – BS/TRP deployment: We do not support the note on macro interference, as that would add another layer of deployment to discuss and agree. Where are the macro gNBs wrt. the factory? What are their Tx powers? What is the wall penetration loss?  Re HW on E2E latency: The LS states “*It is assumed that the CN included latency can be* ***negligible*** *in this WI.*”, negligible reads zero to us.  Re: ITRI on TDD DL-UL configuration: The proposals do not seem unreasonable, but we don’t see much value in trying to agree on priority cases in addition “up to the proponent” |
| Moderator’s comments | Here are comments and proposals from the moderator on how to resolve the comments.  **E2E latency & air interface latency**  I do not think we should get into a discussion on what 5G-ACIA really meant in their LS. This is an offline activity from 3GPP side with no mandate to write LS. Since most companies seem to be fine with the proposal, I suggest going with that. What I can do is move the air interface part from the 5G-ACIA LS column to the proposal column. On the E2E latency vs transmission interval, as commented by Intel, my understanding that there is precedence in RAN1/2 for having these the same.  **TDD DL-UL configuration**  Most companies are fine with leave this to each company. On vivo’s additional text, I do not see it as needed since the text just captures business as usual when it comes to presenting simulation results.  **DL traffic model**  My understanding is that we would not get an agreement on option 3 only. Hence, in order to have one set of simulation with the same assumption from all companies, I suggest keeping option 1 mandatory, but I can add text encouraging companies to also simulate option 3.    **Performance metrics**  Seems more companies prefer interpretation alternative 2 for metric 2). This will be added to the table.  **Layout – BS/TRP deployment**  On the addition of a note on interference from an outdoor macro, again, companies can bring simulation results for additional scenarios if they want.  **BLER requirement**  As clarified by Ericsson, they agree performance metric is CSA. What BLER needed to schive itr is up to companies to decide.  **Additional assumptions**  There does not seem to be an agreement on handover margin of 1 dB. Companies will report this. |

# 3 Features to include in simulations

## 3.1 Updated proposals

Based on the initial discussion the proposals are updated.

For the Rel-15 baseline, the following is proposed:

1. Rel-15 URLLC features included in the baseline are

* UE Processing capability 2
* UL Configured grant
* DL Semi-persistent scheduling

Regarding Rel-16 features, it is proposed to leave it up to each individual company which features to include in addition to the baseline. This can be revisited after the first round of simulations have been provided in December.

1. It is up to each to decide on which Rel-16 features to provide simulations results for in addition to the Rel-15 baseline. This can be revisited after the first round of simulations have been provided in December.

Again, companies are as always free to submit additional results that they find relevant to the evaluations.

## 3.2 Companies comments to proposals

Companies can add comments on the proposals in the table.

|  |  |
| --- | --- |
| Company | View |
| ZTE | Fine with the proposals. |
| Vivo | Fine with the proposals. |
| HW/HiSi | Fine with the proposals |
| ITRI | Regarding Proposal 3, we prefer DL dynamic scheduling along with UE processing capability 2 to be included in the baseline instead of DL SPS. DL SPS shall be add-on in the first round or mandatory in the second round. Besides, the selection of PUSCH repetition type and update periodicity of UL CG/DL SPS also should be stated along with the simulation results. |
| Nokia | The proposals look good, but we would still see it important to further clarify the Rel-15 baseline to include the following:   * Type B PDSCH/PUSCH allocation with shortened symbol allocation (PDSCH: 2/4/7, PUSCH: any, proponent to declare) – this is critical for latency, and probably something everyone is assuming anyway. * High-reliability MCS and CQI tables – this would be useful for reliability.   Re ITRI on DL dynamic scheduling: We agree that dynamic scheduling should be allowed and did not read the list as something one MUST use if the performance is reachable without it. For us the main motivation why the Rel-15 list should be present is to convey the message that Rel-15 already has a large number of features useful for URLLC. |
| Moderator’s comments | My understanding is that Type B PDSCH/PUSCH would not be needed in general, but mainly for FR1 with 30 kHz and the larger number of users per cell. For high-reliability MCS and CSI, I understand not all companies think these are needed to meet the requirements.    I suggest sticking with the proposals as they are with the usual freedom to provide additional results. |

# 4 Conclusions

This document provided a summary of the input on 5G-ACIA simulation assumptions and features. The following proposals are made:

Proposal 1 Agree on the proposals for simulation assumptions given in the table

Proposal 2 Additional simulation parameters are taken from TR 38.824.

Proposal 3 Rel-15 URLLC features included in the baseline are

 UE Processing capability 2

 UL Configured grant

 DL Semi-persistent scheduling

Proposal 4 It is up to each to decide on which Rel-16 features to provide simulations results for in addition to the Rel-15 baseline. This can be revisited after the first round of simulations have been provided in December.

# References

1. [RP‑201279](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_88e/Docs/RP-201279.zip), “LS on 3GPP NR Rel-16 URLLC and IIoT performance evaluation”, 5G-ACIA
2. [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
3. “[Simulation Assumptions and URLLC Features for 5G-ACIA Performance Evaluation](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_90e/Inbox/Drafts/5G-ACIA%20October/Company%20Inputs/Ericsson%205G-ACIA%20URLLC%20simulation%20assumptions%20%26%20features.docx)”, Ericsson
4. “[Discussion on URLLC and IIoT features for performance evaluation in response to 5G-ACIA”,](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_90e/Inbox/Drafts/5G-ACIA%20October/Company%20Inputs/HWHiSi%20-%205G%20ACIA%20URLLC%20simulation%20assumptions%20and%20features.docx) Huawei, HiSilicon
5. “[5G-ACIA LS – Phase 1 input](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_90e/Inbox/Drafts/5G-ACIA%20October/Company%20Inputs/INTEL%20-%205G-ACIA%20LS%20-%20Phase%201%20inputs.docx)”, Intel Corporation
6. “[Features and simulation assumption for 5G ACIA URLLC LS response](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_90e/Inbox/Drafts/5G-ACIA%20October/Company%20Inputs/NOKIA%20-%205G-ACIA%20URLLC%20features%20and%20sim%20assumptions.zip)”, Nokia, Nokia Shanghai Bell
7. “[Features and simulation assumption for 5G ACIA URLLC LS response](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_90e/Inbox/Drafts/5G-ACIA%20October/Company%20Inputs/QUALCOMM-5G-ACIA%20URLLC%20features%20and%20simulation%20assumptions%20.docx)”, Qualcomm CDMA Technologies
8. “[Views on URLLC features and simulation assumptions for 5G-ACIA evaluations](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_90e/Inbox/Drafts/5G-ACIA%20October/Company%20Inputs/ZTE-Views%20on%20URLLC%20features%20and%20simulation%20assumptions%20for%205G-ACIA%20evaluations.docx)”, ZTE
9. “[5G-ACIA URLLC features and simulation assumptions](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_90e/Inbox/Drafts/5G-ACIA%20October/Company%20Inputs/vivo-5G-ACIA%20URLLC%20features%20and%20simulation%20assumptions.docx)”, vivo
10. “[Summary of company inputs on URLLC features and simulation assumptions v6](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_90e/Inbox/Drafts/5G-ACIA%20October/First%20summary%20and%20proposals/Summary%205G-ACIA%20evaluations%20v006_Nokia_Moderator.docx)”, Moderator(Ericsson)