3GPP TSG RAN WG1 email discussion [5G-ACIA]

e-Meeting, December 14th –18th, 2020

Source: vivo

Title: 5G-ACIA 1st round URLLC evaluation results

Agenda Item:

Document for: Discussion and Decision

1. Introduction

In the RAN #89e meeting, the following was agreed for 5G-ACIA URLLC features performance evaluation [1][2]:

* 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

In addition, the following work plan was made during email discussion:

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 email discussion, the following agreements on 5G-ACIA simulation assumptions were achieved in RAN1[3].

**Agreements:**

* The simulation assumptions given in the table are agreed
* Additional simulation parameters are taken from TR 38.824.

|  |  |  |
| --- | --- | --- |
| Parameters | 5G-ACIA LS | **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. Companies are also encouraged to provide results for option 3 |
| 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: For metric 2) it is clarified that 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 |
| E2E latency & air interface latency | E2E latency: 1 ms for UC#2 | E2E latency: 1 ms for UC#2  Air interface latency: 1ms |
| 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 |

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

* Rel-15 URLLC features included in the baseline are as follows, while it is up to each proponent to decide which Rel-15 features are used, and detail this when providing the results:
  + UE Processing capability 2
  + UL Configured grant
  + DL Semi-persistent scheduling

Regarding Rel-16 features, the following is agreed:

* It is up to each proponent 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.

In this contribution, we provide our 1st round 5G-ACIA URLLC evaluation results based on above simulation assumptions.

1. Evaluation assumptions

The detailed simulation assumptions for 5G-ACIA URLLC evaluation are shown in the below Table A-1 of Appendix. In addition, the following R15/R16 URLLC features and transmission strategies are applied.

* Low SE MCS and CQI table with 1e-5 target BLER
* One-shot transmission for each TB (without retransmission)
* DL SPS and CG PUSCH
  + 2 slots (1ms) period for FR1
  + Survival time aware scheduler, i.e.
    - The gNB will timely re-configure the resource allocation and MCS for the UE when the PDSCH or PUSCH is incorrectly received.
    - The gNB applies an offset (e.g. 2dB) to the reported DL CQI or the measured UL SINR to deduce a more conservative MCS for the UE with NACK packets.
* Physical layer processing delay (UL/DL latency) includes alignment delay, transmission duration, BS and UE processing delay (5 symbols).

1. Evaluation results for FR1

Based on above evaluation assumptions, the initial evaluation results for FR1 in InF-DH scenario are provided. The CDF of CSA and latency in InF-DH FR1 are given in Figure 1 and Figure 2, respectively. The percentage of UEs satisfying requirements and resource utilization are given in Table 1.



Figure 1 InF-DH FR1 CSA performance



Figure 2 InF-DH FR1 latency performance

Table 1 Percentage of UEs satisfying requirements in InF-DH FR1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE number per service area** | **Percentage of UEs satisfying requirements (%)** | | **Resource utilization (%)** | |
| **DL** | **UL** | **DL** | **UL** |
| 10 | 100 | 99.375 | 4.2 | 5.4 |
| 20 | 100 | 99.375 | 9.8 | 11.9 |
| 40 | 99.375 | 99.17 | 21.5 | 27.8 |
| 50 | 98.33 | 98.67 | 34.9 | 42.0 |

From above simulation results, we can get the following observation.

***Observation 1:***

* ***The CSA performance is degraded with increasing the number of UEs per service area.***
* ***There is neglectable impact on the latency performance with the increasing of the number of UEs per service area.***
* ***The percentage of UEs satisfying the requirement is decreased with the increasing the number of UEs per service area. In the case of 50 UEs for per service area, the percentage of UEs unsatisfying the requirement is less than 3%.***
* ***The utilization is growing rapidly with the increasing the number of UEs per service area.***

1. Conclusion

In this contribution, we provide our 1st round 5G-ACIA URLLC evaluation results with the following observation:

***Observation 1:***

* ***The CSA performance is degraded with increasing the number of UEs per service area.***
* ***There is neglectable impact on the latency performance with the increasing of the number of UEs per service area.***
* ***The percentage of UEs satisfying the requirement is decreased with the increasing the number of UEs per service area. In the case of 50 UEs for per service area, the percentage of UEs unsatisfying the requirement is less than 3%.***
* ***The utilization is growing rapidly with the increasing the number of UEs per service area.***

1. References
2. RP-202069, 3GPP TSG RAN Meeting #89e, September 14 - 18, 2020
3. RP-202097, 3GPP TSG RAN Meeting #89e, September 14 - 18, 2020
4. Agreements on URLLC features and simulation assumptions for 5G-ACIA, 3GPP RAN 5G-ACIA Evaluations Week 1, October 12th – 16th 2020

Appendix

**Table A-1. Simulation assumptions for FR1**

|  |  |
| --- | --- |
| Parameters | Values |
| Factory hall size | 120x50 m |
| Room height | 10 m |
| Inter-BS/TRP distance | 20 m |
| BS/TRP antenna height | 8 m InF-DH |
| Layout – BS/TRP deployment | 12 TRPs |
| Channel model | InF-DH |
| Cluster information | Clustter density: 0.6  Cluster height: 6 m  Cluster size: 2 m |
| Carrier frequency, simulation bandwidth and SCS | 4 GHz: 100 MHz, 30 KSCS |
| TDD DL-UL configuration | S (6D:2S:6U) |
| Number of UEs per service area | Up to 50 per service area  10, 20, 40, and 50 |
| UE distribution | All UEs randomly distributed within the respective service area. |
| Message size | 48 bytes |
| DL traffic model | DL traffic arrival with option-1 |
| UL traffic model | UL traffic is symmetric with DL, and DL-UL traffic arrival time relationship with option-1 |
| Simulation packets | 2E6 for DL  2E6 for UL |
| UE speed | Linear movement, 75 km/h |
| UE Tx power | 23 dBm |
| BS/TRP Tx power | 24 dBm per 20 MHz |
| BS antenna element gain + connector loss | 5 dBi |
| BS receiver noise figure | 5 dB |
| UE antenna gain | 0 dBi |
| UE receiver noise figure | 9 dB |
| BS antenna configurations | (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1; 1, 2)  dH = dV = 0.5 λ |
| UE antenna configuration | (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1; 1, 2)  dH = dV = 0.5 λ |
| Receiver | MMSE-IRC |