**December 14th – 18h, 2020**

**Source: Intel Corporation**

**Title: 5G-ACIA LS – Phase 2 input**

Introduction

RAN#89-e agreed to conduct evaluation and prepare a response to 5G-ACIA LS [RP-201279, RP-202069] by offline activity. The first phase of the activity resulted in initial agreements on evaluation assumptions including URLLC features to be included into the study. The second phase is expected to collect initial evaluation results.

In this document, initial results on DL and UL performance in FR1 according to the agreed assumptions are provided.

Initial Evaluation for FR1

In this section, initial evaluation results for FR1 downlink and uplink are provided. The assumptions for DL and UL are summarized in Table 1.

Table 1. Evaluation assumptions

|  |  |
| --- | --- |
| Parameters | **Values** |
| Factory hall size | As per agreement |
| Room height | As per agreement |
| Inter-BS/TRP distance | As per agreement |
| BS/TRP antenna height | 8 m for InF-DH |
| Layout – BS/TRP deployment | As per agreement |
| Channel model | InF-DH |
| Carrier frequency and simulation bandwidth | As per agreement |
| TDD DL-UL configuration | 1:1 DL-to-UL  7 OS DL - 7 OS UL |
| Number of UEs per service area | 10, 20, 30, 40 per service area  (120, 240, 360, 480 per factory hall) |
| UE distribution | As per agreement |
| Message size | As per agreement |
| DL traffic model | Periodic traffic every 1 ms  Option-1: all UEs’ DL messages arriving at NG-RAN node in the first transfer interval are  uniformly random distributed within the TI time window |
| UL traffic model | Periodic traffic every 1 ms  Option-1: DL and UL traffic arrival time instants are independent |
| CSA requirements | Output of simulation |
| E2E latency & air interface latency | As per agreement |
| UE speed | As per agreement |
| BS antenna mount | As per agreement |
| Handover margin | 1 dB |
| UE antenna configuration | 2 Tx/4 Rx antenna ports  Panel model 1: Mg=1, Ng=1, P=2, dH=0.5  (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1; 1, 2) for 4 Rx;  (M, N, P, Mg, Ng; Mp, Np) = (1, 1, 2, 1, 1; 1, 1) for 2 Tx; |
| UE maximum TX power | 23 dBm |
| UE noise figure | 9 dB |
| BS antenna configuration | 4 Tx/4 Rx antenna ports and 8 Tx/8 Rx antenna ports  (M, N, P, Mg, Ng; Mp, Np) = (1, 2, 2, 1, 1; 1, 2) for 4 Tx/4 Rx antenna ports;  (M, N, P, Mg, Ng; Mp, Np) = (2, 2, 2, 1, 1; 2, 2) for 8 Tx/8 Rx antenna ports;  dH = dV = 0.5 λ |
| BS antenna element gain + connector loss | 5 dBi |
| BS transmit power | 30 dBm |
| BS noise figure | 5 dB |
| Sub-carrier spacing | 30 kHz |
| PDSCH | 7 symbols, 2 of which are OH for PDCCH and RS  RA type 0, 8 PRB granularity |
| PUSCH | 7 symbols, 2 of which are OH for PUCCH and RS  RA type 1, 8 PRB granularity |
| UL power control | P0 to achieve 20 dB SNR, alpha = 0.8 |
| DL scheduling | Randomization of PDSCH allocation - changing frequency position over time per UE.  MCS (low SE 64QAM table) and resource allocation size is selected to achieve 1e-5 target BLER |
| UL scheduling | Randomization of PUSCH allocation - changing frequency position over time per UE.  MCS (low SE 64QAM table) and resource allocation size is selected to achieve 1e-5 target BLER |
| Channel estimation | Ideal |
| Receiver | MMSE IRC |

Further, common geometry parameters are shown in Figure 1.

 

Figure 1. Channel path-gain CDF and geometry SINR CDF

For both DL and UL, the simulation time is equivalent to 100 seconds, i.e. each UE receives 100 000 packets throughout the simulation. This may provide PER and CSA calculation accuracy down to 1e-4~1e5. The number of evaluation trials is selected to achieve 720 simulated UEs in total.

## Downlink

For DL, for different UE densities the distribution of PER per UE and CSA per UE is presented in Figure 2. Resource utilization for UL is presented in Table 2.



Figure 2. DL packet error rate CDF and communication service availability CDF

Table 2. DL resource utilization

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| UE density | 10 UE/area | 20 UE/area | 30 UE/area | 40 UE/area |
| Resource utilization | 7.33 % | 14.66 % | 22.02 % | 29.45 % |

Since evaluation only generates 100k packets per UE, in low density scenarios 10-30 UEs there is no situation observed when consecutive packet drop happens, and the CDF appears as a vertical line in 1.

**Observation 1**

* *Under the considered assumptions, in FR1 in DL, the PER and CSA requirement could be met for up to 40 UEs per service area*

## Uplink

For UL, for different UE densities the distribution of PER per UE and CSA per UE is presented in Figure 3. Resource utilization for UL is presented in Table 3.

 

Figure 3. UL packet error rate CDF and communication service availability CDF

Table 3. UL resource utilization

|  |  |  |  |
| --- | --- | --- | --- |
| UE density | 10 UE/area | 20 UE/area | 30 UE/area |
| Resource utilization | 14.71 % | 29.41 % | 44.12 % |

Since evaluation only generates 100k packets per UE, in low density scenarios 10-20 UEs there is no situation observed when consecutive packet drop happens, and the CDF appears as a vertical line in 1.

**Observation 2**

* *Under the considered assumptions, in FR1 in UL, the PER and CSA requirement could be met for up to 30 UEs per service area*

Conclusion

This document provides inputs to the second phase of the offline activity related to 5G-ACIA LS [RP-201279, RP-202069] regarding evaluation assumptions including URLLC features to be included into the study.

**Observation 1**

* *Under the considered assumptions, in FR1 in DL, the PER and CSA requirement could be met for up to 40 UEs per service area*

**Observation 2**

* *Under the considered assumptions, in FR1 in UL, the PER and CSA requirement could be met for up to 30 UEs per service area*