**October 12th – 16h, 2020**

**Source: Intel Corporation**

**Title: 5G-ACIA LS – Phase 1 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 is expected to collect and summarize evaluation assumptions including URLLC features to be included into the study.

In this document, our views on the evaluation assumptions are provided.

Features to include in the evaluation

In general, it is assumed that any advanced feature up to Release 16 can be included in the evaluation subject to limitations of the scenario. Note that in section 1 of 5G-ACIA LS [RP-201279] only Release 16 performance is mentioned, thus it is assumed Release 17 potential features are not required to be included. Furthermore, inclusion of Release 17 features may complicate work and discussions for this offline activity.

**Proposal 1**

* *A set of URLLC features for evaluation include any feature specified in NR Release 15 and 16.*
  + *Being studied and/or specified Release 17 features are not considered for this activity*

Evaluation Assumptions

Discussion on evaluation assumption is split on analysis of the table provided by 5G-ACIA, identification of additional assumptions, and miscellaneous considerations on methodology.

## Analysis of the assumptions provided by 5G-ACIA

Table 1. Comments on the assumptions provided by 5G-ACIA

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Comments |
| Factory hall size | 120x50m | Confirm 5G-ACIA proposal |
| Room height | 10m | Confirm 5G-ACIA proposal |
| Inter-BS/TRP distance | X = 20 m inter-TRP distance  Y = 20 m inter-TRP distance | See “Layout – BS/TRP deployment” |
| BS/TRP antenna height | 1.5 m for InF-SL and InF-DL, 8m for InF-SH and InF-DH | Confirm 5G-ACIA proposal |
| Layout – BS/TRP deployment | 12 single-sector TRPs | Reuse Rel.15-16 evaluation assumption.  As for 18 TRPs considered in InF channel model study, it seems more suitable for 120x60 m scenario while may provide excessive # of access nodes in 120x50 m |
| Channel model | Mandatory: InF-DH, InF-SL  Optional: InD-DL, InF-SH | Pick InF-DH as the most challenging as per geometry SINR, and InF-SL as the opposite in terms of clutter density and BS elevation |
| Carrier frequency and simulation bandwidth | TDD Mandatory: 4 GHz: 100 MHz Optional: 30 GHz: 160 MHz | Confirm 5G-ACIA proposal |
| TDD DL-UL configuration | ~1:1 UL-DL ratio  7 symbols for DL, 7 symbols for UL, necessary gap for switching | Confirm 5G-ACIA proposal |
| Number of UEs per service area | 10, 20, 40, 50 | Confirm 5G-ACIA proposal  Encourage companies to evaluate each density to show load dependency |
| UE distribution | All UEs randomly distributed within the respective service area. | Confirm 5G-ACIA proposal |
| Message size | 48 bytes | Confirm 5G-ACIA proposal |
| DL traffic model | TI, TS, E2E:  {0.5, 0.5, 0.45} ms  {1, 1, 0.9} ms  {2, 2, 1.8} ms  Burst model:  Mandatory: Option-1  Optional: Option-2, Option-3 | Consider all TI/TS times as from Table 1. E2E latency for simplicity is taken as 90% of TI/TS.  Prioritize Option-1 of burst modelling for simplicity. |
| UL traffic model | Same as DL.  Option-1 relationship with DL traffic, i.e. independent | Independent from DL for simplicity. |
| CSA requirements | 99.9999% | Confirm 5G-ACIA proposal |
| Performance metrics | 1) CSA: single CDF of CSA distribution of all UEs in factory hall | Confirm 5G-ACIA proposal |
| 2) Latency: single CDF of latency distribution of all UEs in factory hall | Confirm 5G-ACIA proposal.  Requires clarification how a given point in the CDF is obtained:   * + - A point is for each packet in the system     - A point is a function from all packets of a UE, e.g. average, maximum, etc. |
| 3) Percentage of UEs satisfying requirements and 4) resource utilization | Metric 3) and 4) are low priority. |

**Proposal 2**

* *Consider the clarification to the assumptions provided by 5G-ACIA in Section 3.1 of this document*

## Additional assumptions

Table 2. Additional evaluation assumptions

|  |  |  |
| --- | --- | --- |
| Parameters | Value | Comments |
| Numerology | FR1: 30 kHz or 60 kHz  FR2: 120 kHz |  |
| Handover margin | 1 dB |  |
| BS Tx power | FR1: 24 dBm per 20 MHz  FR2: 23 dBm per 80 MHz | As per TS 38.824 for Factory Automation |
| BS antenna element gain + connector loss | 5 dBi | As per TS 38.824 for Factory Automation |
| BS noise figure | FR1: 5 dB  FR2: 7 dB | As per TS 38.824 for Factory Automation |
| BS antenna configurations | FR1:  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  FR2:  2 Tx/2 Rx antenna ports  (M, N, P, Mg, Ng; Mp, Np) = (4, 4, 2, 1, 1; 1, 1)  dH = dV = 0.5 λ | As per TS 38.824 for Factory Automation |
| UE maximum TX power | 23 dBm | As per TS 38.824 for Factory Automation |
| UE antenna configuration | FR1:  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;  FR2:  2 Tx/Rx antenna ports  (M, N, P, Mg, Ng; Mp, Np) = (2, 4, 2, 1, 2; 1, 1)  (dH, dV) = (0.5, 0.5) λ  Static panel selection | As per TS 38.824 for Factory Automation |
| UE antenna height | 1.5 m |  |
| UE antenna gain | FR1: 0 dBi  FR2: 5 dBi | As per TS 38.824 for Factory Automation |
| UE receiver noise figure | FR1: 9 dB  FR2: 10 dB | As per TS 38.824 for Factory Automation |
| UE mobility | Uniformly distributed between choices {3, 30, 75} kmph  Movement is not explicitly modelled. The speed is applied in channel modelling only | Motion control use case assumes <= 75 kmph speeds |
| Scheduling and link adaptation | Reported by evaluating company |  |
| UE TX power control | Reported by evaluating company |  |
| TX MIMO modes | Reported by evaluating company |  |
| PDCCH | Modelled at least as an overhead. If not explicitly modelled, evaluating company should ensure no impact on presented performance. |  |
| PUCCH | Modelled at least as an overhead. If not explicitly modelled, evaluating company should ensure no impact on presented performance. |  |
| PDSCH DMRS | Reported by evaluating company |  |
| PUSCH DMRS | Reported by evaluating company |  |
| CSI-RS and SRS | Reported by evaluating company |  |
| Other traffic presence | Assume no other traffic is present, i.e. no mix with eMBB |  |

**Proposal 3**

* *Consider the additional assumptions in Section 3.2 of this document*

Latency aspects

* The proposed values of E2E latency need to be converted to the radio access latency
  + In Release 16, 3GPP RAN1 assumed 1 ms air interface latency for the case of 2 ms E2E budget. For the presented 0.45, 0.9, 1.8 ms E2E budgets it would be logical to consider ~half of the budget is given to the air interface. Note, it may not be possible to apply the same network latency contribution for all cases due to either too tight or too loose values in some of these three cases.
    - Air interface latency = 0.5 \* E2E latency
* There could be different approaches how the latency bound is treated in scheduling. In order to efficiently utilize resources, a smart scheduler may not allocate retransmissions if the deadline is passed. However, 5G-ACIA specifically requests to investigate a CDF of packet delays, which may not be representative for such scheduling approach. If the latency bound is ignored by the scheduler, then the latency CDF can also include the tails exceeding the bound. We therefore propose to look into the following options:
  + Option 1: a packet transmission can be performed after the latency deadline. The collected statistics can exceed the latency requirement.
  + Option 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

**Proposal 4**

* *For evaluation purpose, air interface latency budget is assumed to be 1/2 of the end-to-end latency budget*
* *Down-select between one of the following options for latency deadline modeling*
  + *Option 1: a packet (re-)transmission can be performed after the latency deadline. The collected statistics can exceed the latency requirement.*
  + *Option 2: a packet (re-)transmission cannot be performed after the latency deadline. The collected statistics cannot exceed the latency requirement.*

Conclusion

This document provides inputs to the first 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. The following proposals are made:

**Proposal 1**

* *A set of URLLC features for evaluation include any feature specified in NR Release 15 and 16.*
  + *Being studied and/or specified Release 17 features are not considered for this activity*

**Proposal 2**

* *Consider the clarification to the assumptions provided by 5G-ACIA in Section 3.1 of this document*

**Proposal 3**

* *Consider the additional assumptions in Section 3.2 of this document*

**Proposal 4**

* *For evaluation purpose, air interface latency budget is assumed to be 1/2 of the end-to-end latency budget*
* *Down-select between one of the following options for latency deadline modeling*
  + *Option 1: a packet (re-)transmission can be performed after the latency deadline. The collected statistics can exceed the latency requirement.*
  + *Option 2: a packet (re-)transmission cannot be performed after the latency deadline. The collected statistics cannot exceed the latency requirement.*