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On CSI feedback enhancements for URLLC/IIoT

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Outline

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- Summary of performance evaluation results for Case 2-3
- Proposals

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Introduction

- In RAN1#104b-e meeting, the Rel. 17 NR NR_IIOT_URLLC_enh WID was discussed and the group agreed to focus study on the following cases:
  - Case 1-1 (Statistical CSI/SINR)
  - Case 1-3 (Interference statistics)
  - Case 1-5 (CQI based on worst IMR occasion)
  - Case 1-6 (Worst-M CQI)
  - Case 1-8 (Increasing granularity of subband CQI)
  - Case 1-11 (Updating CQI-only)
  - Case 2-3 (delta-MCS/CQI)
- In RAN1#105-e meeting, a proposal was made to further investigate Case 1-8 and Case 2-3 only, but the group was not able to achieve an agreement on the proposal as there were strong concerns on the performance of Case 2-3

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Summary of performance evaluation results for Case 1-1 and Case 1-3

- In [1], performances of Case 1-1, 1-3, 1-5, 1-6 were evaluated through system level simulations and Case 1-3 and Case 1-1 were the two best performing schemes
  - Case 1-3 and 1-1 have performance gain of 88% and 77% over baseline, respectively
  - Case 1-3 has performance gain of 29% and 18% over Case 1-5 and 1-6, respectively
  - Case 1-1 has performance gain of 21% and 12% over Case 1-5 and 1-6, respectively
- In [2], FL provided a summary of performance evaluation results for Case 1-1 from multiple companies (please see next slide for more details)

[1] R1-2104199, “CSI feedback enhancements for URLLC”, Futurewei, RAN1#105-e
[2] R1-2106177, “Feature lead summary #4 on CSI feedback enhancements for enhanced URLLC/IIoT”, Moderator (InterDigital, Inc.), RAN1#105-e

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Summary of performance evaluation results for Case 1-1 and Case 1-3 (Cont'd)

- As summarized in [2], for Case 1-1, six companies have provided performance evaluation results: Futurewei, ZTE, InterDigital, Nokia, Ericsson, and Intel.
  - Futurewei: two cases simulated, both show significant performance gain
  - ZTE: one case simulated, results show performance loss, but the MCS was selected based on "MeanCQI – stdevCQI", which is inappropriate and should have a scaling factor for the "stdevCQI".
  - InterDigital: three cases simulated, two cases show large to significant performance gain, one show performance loss
  - Ericsson: two cases simulated, both show significant performance gain
  - Nokia: one case simulated, results show performance gain
  - Intel: two cases simulated, one shows significant performance gain, one shows no gain
- In summary, based on performance evaluation results from multiple companies, super-majority of the cases show that Case 1-1 provides large performance gain

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Summary of performance evaluation results for Case 1-8

- In [2], FL also provided summary of performance evaluation results for Case 1-8 from multiple companies.
- For Case 1-8, five companies have provided performance evaluation results: Intel, Samsung, InterDigital, Nokia, and MediaTek.
  - Intel: two cases simulated, one shows no performance gain, one shows performance loss
  - Samsung: two cases simulated, one shows performance gain, one shows little to no performance gain
  - InterDigital: five cases simulated, one shows little to no performance gain, four show performance loss
  - Nokia: one cases simulated, results show performance gain
  - MediaTek: three cases simulated and show some RU savings. However, there are no data showing gain on percentage of UEs satisfying reliability and latency requirements
- In summary, the performance evaluation results from multiple companies are mixed, with majority of the cases show that Case 1-8 provides little to no performance gain or have performance loss, and less than half of the cases show that Case 1-8 provides performance gain.

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Summary of performance evaluation results for Case 2-3

- In [2], FL also provided summary of performance evaluation results for Case 2-3 from multiple companies.
- For Case 2-3, four companies have provided performance evaluation results: Intel, InterDigital, Qualcomm, and ZTE.
  - Intel: two cases simulated, one shows no performance gain, one shows performance loss
  - InterDigital: nine cases simulated, six show little to no performance gain, three show performance loss
  - Qualcomm: two cases simulated, only RU savings in the 2nd TX are observed. But for URLLC, the chance of 2nd TX is very low and the RU savings in the 2nd TX will not translate to noticeable gains in satisfied UE ratio.
  - ZTE: three cases simulated and show performance gain. However, it seems the results are questionable. First, the RU level seems too low, which is just 1.9%-2.3% in many cases. Second, in one case, the results show that with 3-bit delta SINR for retransmission, the satisfied UE ratio is increased from 50% to 94%, which seems unrealistic.
- In summary, based on performance evaluation results from multiple companies, Case 2-3 provides little to no performance gain, and in some cases even results in performance loss

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Proposals

- To meet the WID objective, RAN1 has agreed on a performance metric and simulation assumptions [3] for performance evaluation of different schemes. The schemes for CSI feedback enhancements should be selected based on this agreed metric. Schemes with the best performance should be selected while schemes with no performance gain and/or with performance loss should not be considered for further investigation.
  - Case 1-1 and Case 1-3 are the two best performing schemes and should be selected for further investigation
  - Case 1-8 and Case 2-3 should not be considered for further investigation as they provide no performance gain, and in some cases even result in performance loss
- Therefore, we make the following proposal
- Proposal
  - RAN1 to further investigate the following for CSI enhancements for IIoT/URLLC:
    - Mean-CQI/SINR and stdev-CQI/SINR (Case 1-1)
    - Interference standard deviation (Case 1-3)

[3] 3GPP RAN1, RAN1#102-e, Chairman Notes

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