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3GPP TSG RAN Meeting#102 **RP-232974**
Edinburgh, Scotland, December 11-15, 2023

Agenda Item: 9.1.1.1

Source: Spreadtrum Communications

Title: AI/ML for Air interface in Rel-19

Document for: Discussion and decision

Background

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In Chair's summary for RAN Rel-19 Package (RP-232745), the following potential objectives are provided:

- Consider support single sided models for,
  - Positioning, further discuss whether to support all 5 sub use cases.
  - Beam management for DL Tx prediction in both UE-sided and NW sided model,
  - Consider support of single sided model for CSI prediction, if it is recommended to proceed with normative work taken all WG's outcome in Q4-23 into account
- Consider support two-sided model for CSI compression, if it is recommended to proceed with normative work taken all WG's outcome in Q4-23 into account
- Consider support the necessary/recommended LCM components for selected sub use cases
- RAN4 requirements and test cases for AI/ML enabled features

In the contribution, we will provide our views for AI/ML for Air interface in Rel-19

The summary of R18 AI/ML for Air Interface

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RAN1

- **RAN1 has studied the general framework of AI/ML for one-sided models and two-sided models. e.g., Model/functionality identification, Functionality-based/model-ID-based LCM, collaborative level, data collection, Model delivery/transfer**
- **Evaluations and spec impact on the 6 representative sub-use cases were completed.**

Aspects	Summary of R18	Initial views
Data collection	Data content and data size has been discussed by RAN1 and replied to RAN2	Further studied the normative work for data collection framework for different use cases.
Model/Functionality identification	a. For functionality identification, legacy 3GPP framework of feature is taken as a starting point. b. For model identification, type A/B1/B2 has been discussed. c. Additional conditions for model identification to achieve alignment has been discussed.	a. Further study/down-selection among identification types. b. Further study the association with additional conditions.
Performance monitoring	a. Performance monitoring for active model was studied for different use cases; b. Performance monitoring for inactive model was discussed but no conclusion.	Further study the performance monitoring for the performance on both active and inactive models/functionalities

The summary of R18 AI/ML for Air Interface

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Aspects	Summary of R18	Initial views
Functionality-based/model-ID-based LCM	a. Both functionality-based and model ID-based LCM frameworks were studied. b. Functionality-based LCM framework is considered as the basic framework; c. model ID-based LCM was still controversial	a. Functionality-based LCM can be a starting point for normative work in Rel-19; b. Further study the feasibility of model-ID-based LCM
Model delivery/transfer	RAN1 identified Case y/z1~z5 and provided some initial analysis on model delivery/transfer for difference cases.	Further study/down-selection among Case y/z1~z5

RAN2

- **Study the general AIML architecture and functionality mapping, the consideration and solutions for data collection and model transfer/delivery, and the general procedures for model management.**

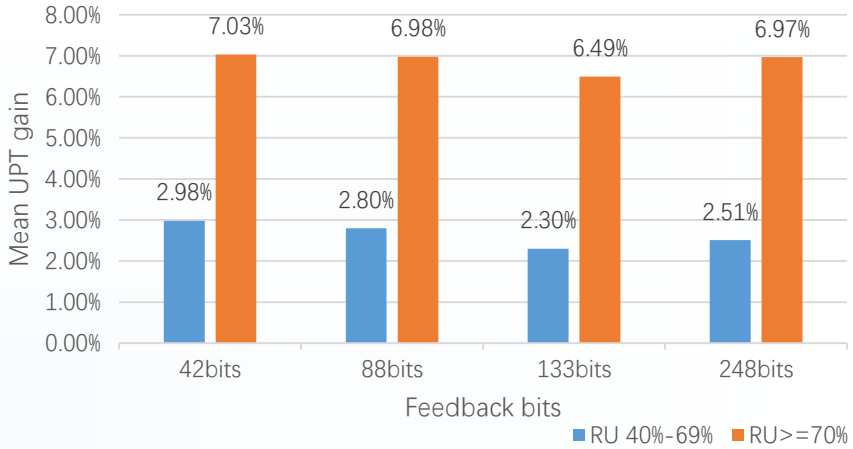
RAN4

- **Define data collection/generation for testing with high level principle.**
- **Define metrics for requirements/tests for inference for use case(s) with high level principle.**

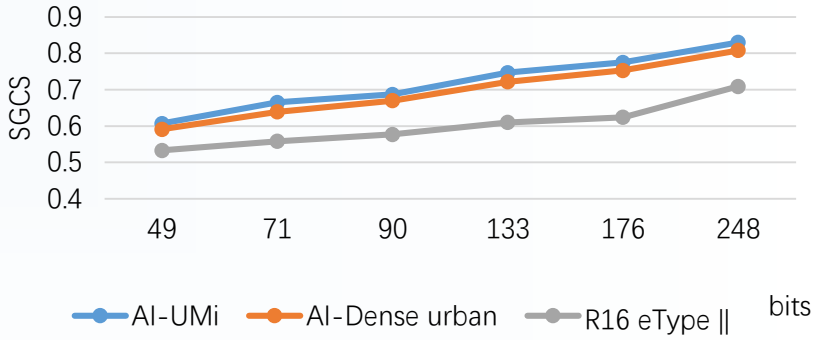
Use case – CSI compression and recovery

Observations

- In RAN, two-sided model for CSI compression was considered taken all WG's outcome in Q4-23 into account.
- In RAN1, there is no consensus for this use case, due to the trade-off between performance and complexity/overhead, and inter-vendor training collaboration in RAN1.
- In RAN4, the feasibility of any of the testing options has not concluded and more study is required for two-sided model.
- However, there is quite a big spread in reported gain from different companied.
- AI based CSI Compression can indeed achieve better SGCS performance and less overhead than legacy R16 eTypeII codebook .
- Time domain correlation can provide potential gains for CSI compression.



R16 eType II vs AI-transformer(Dense urban)



AI-transformer generalization verification(Umi)

Proposal

- Continue with normative work of CSI compression.
- Further study new use case (e.g., TSF-CSI compression) for CSI compression to achieve higher gain.

Use case – CSI prediction

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Observations

- In RAN, single sided model for CSI prediction was considered.
- In RAN1, there is no consensus for this use case, due to lacking of results on the performance gain in RAN1.
- AI based CSI prediction can achieve better SGCS performance than the nearest historical CSI w/o prediction.
- AI based CSI prediction can achieve good SGCS performance in generalization verification with various UE speeds
- The model for AI based CSI prediction is one-sided model, and could follow the high-level principle of other one-sided model sub-cases with less spec impact.

Table 1. The comparison of SGCS for AI based CSI prediction

	AI based CSI prediction	The nearest historical CSI w/o prediction
SGCS	0.9182	0.761

Table 2. The verification of generalization performance with various UE speeds

	Inference: 10km/h	Inference: 30km/h	Inference: 60km/h
Training: 10km/h	0.9939 (case1)	0.7465(case2)	0.6126(case2)
Training: 30km/h	0.9804(case2)	0.9484(case1)	0.6588(case2)
Training: 60km/h	0.9707(case2)	0.9144(case2)	0.8302(case1)
Training: 10, 30, 60km/h	0.9816(case3)	0.9079(case3)	0.8137(case3)

Proposal

- Continue with normative work of CSI prediction with less additional spec impact based on one-sided model and Rel-18 MIMO.

Use case - BM

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Observations

- **Tx prediction in both spatial and temporary domain with AI/ML enabled demonstrates gains over legacy beam measurement and reporting with the assumption that the scenarios/configures for training is consistent with that for inference;**
- **DL Tx beam prediction for both UE-sided model and NW-sided model are recommended for normative work in RAN1.**

Table 3. Evaluation results for BM-Case1 (Tx prediction)

Assumptions	Number of beams in Set A	64 beams	64 beams
	Number of beams in Set B	16 beams	8 beams
Prediction Accuracy [%]	AI Top-1	97.50%	93.80%
	AI Top-2	99.50%;	96.40%;
	AI Top-4	99.90%	98.20%
Prediction Accuracy with 1 dB L1-RSRP Margin [%]		99.20%	95.30%
Average L1-RSRP Diff [dB]		1.185dB	2.8877dB

Proposal

- **Continue with normative work of DL Tx beam prediction in both spatial and temporary domain for both UE-sided model and NW-sided model.**

Use case - Positioning

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Observations

- In RAN, support positioning use case and whether to support all 5 sub use cases needs further discuss.
- In RAN1, all five positioning cases (Case 1/2a/2b/3a/3b) are recommended to be further investigated in normative work without prioritization.
- Both direct AI/ML positioning and AI/ML assisted can significantly improve the positioning accuracy compared to existing RAT-dependent positioning methods;
- Given the analogous framework for 5 sub use cases, standardizing all or partial sub use cases has similar spec workload.

Proposal

- Continue with normative work in Rel-19 for all 5 positioning sub use cases.

Conclusion

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Motivations

- **Explore the benefits provided by AI/ML operation for air interface**
- **Establish the foundation - general framework of AI enabled air interface for nowadays and future air interface use cases leveraging AI/ML techniques**

Objectives

- **Specify general framework of AI/ML enabled air interface, and specify general protocol aspects, e.g., capability indication, configuration and control procedure . (RAN1, RAN2)**
- **Specify AI/ML related procedures/signallings, e.g., AI/ML Model lifecycle management, model/functionality identification, etc. (RAN1, RAN2)**
  - Continue normative work of CSI compression/CSI prediction/DL Tx beam prediction/Positioning.
  - Continue to study CSI compression with new use case.
- **Specify detailed test case/requirement. (RAN4)**

Thanks

紫光展锐
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