

3GPP TSG RAN Meeting #102

RP-232868

Edinburgh, Scotland, December 11-15, 2023

Agenda item: 9.1.1.1 AI (Artificial Intelligence)/ML (Machine Learning) for Air Interface

AI/ML for NR air interface

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Content

- ◆ Current status on AI/ML for NR air interface
- ◆ Rel-18 SI outcome
- ◆ Rel-19 WI overview and proposals

Current Status on AI/ML for NR Air Interface

◆ In RAN#101, according to the Chair's Guidance (RP-231540), for RAN1-led item AI (Artificial Intelligence)/ML (Machine Learning) for Air interface, the estimate #TUs are as follows

■ [4] RAN1 TUs and [2] RAN2 TUs

◆ In RAN#101, the following observation was captured in the summary (RP-232611)

- 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

◆ Based on Rel-18 study, the final TR38.843 is endorsed

Rel-18 SI Outcome

◆ Rel-18 SI has the following recommendations for general framework

The following aspects have been studied for the general framework of AI/ML over air interface for one-sided models and two-sided models:

- Various Network-UE Collaboration Levels
- Functionality-based LCM and model-ID-based LCM
- Functionality/model selection, activation, deactivation, switching, fallback
- Functionality identification and model identification
- Data collection
- Performance monitoring
- Various model identification Types and their use cases
- Reporting of applicable functionalities/models
- Method(s) to ensure consistency between training and inference regarding NW-side additional conditions (if identified) for inference at UE
- Model delivery/transfer and analysis of various model delivery/transfer Cases

The above studied aspects for General Framework can be considered for developing/specifying AI/ML use cases and common framework (if needed for some aspects) across AI/ML use cases.

Rel-18 SI Outcome

◆ In Rel-18 SI there is no consensus on recommendations for two CSI sub use cases

From RAN1 perspective, there is no consensus on the recommendation of CSI compression for normative work.

At least the following aspects are the reasons for the lack of RAN1 consensus on the recommendation of CSI compression for normative work:

- Trade-off between performance and complexity/overhead.
- Issues related to inter-vendor training collaboration.

Other aspects that require further study/conclusion are captured in the summary

From RAN1 perspective, there is no consensus on the recommendation of CSI prediction for normative work.

The reason for the lack of RAN1 consensus on the recommendation of CSI prediction for normative work:

- Lack of results on the performance gain over non-AI/ML based approach and associated complexity.

Other aspects that require further study/conclusion are captured in the summary

Rel-18 SI Outcome

◆ Rel-18 SI has the following recommendations for two beam management sub use cases

For AI-based beam management, from RAN1 perspective, at least the following are recommended for normative work:

- Both BM-Case1 and BM-Case2:
 - BM-Case1: Spatial-domain DL Tx beam prediction for Set A of beams based on measurement results of Set B of beams
 - BM-Case2: Temporal DL Tx beam prediction for Set A of beams based on the historic measurement results of Set B of beams
- DL Tx beam prediction for both UE-sided model and NW-sided model
- Necessary signalling/mechanism(s) to facilitate data collection, model inference, and performance monitoring for both UE-sided model and NW-sided model
- Signalling/mechanism(s) to facilitate necessary LCM operations via 3GPP signalling for UE-sided model

Rel-18 SI Outcome

◆ Rel-18 SI has the following recommendations for positioning sub use cases

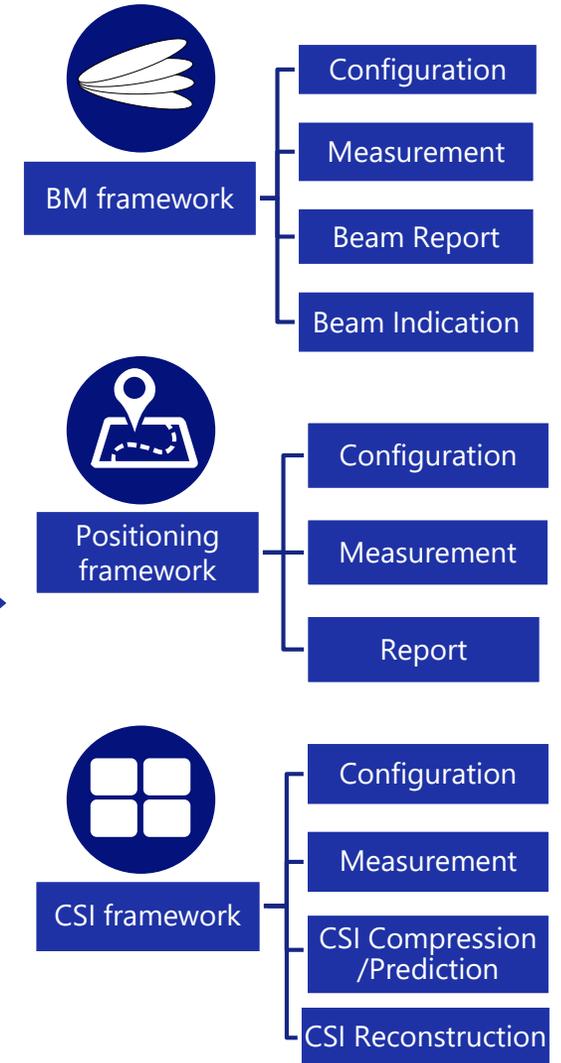
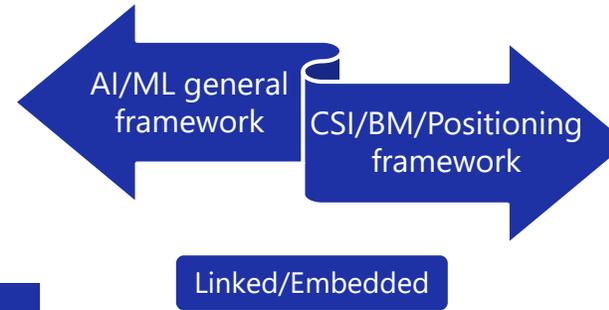
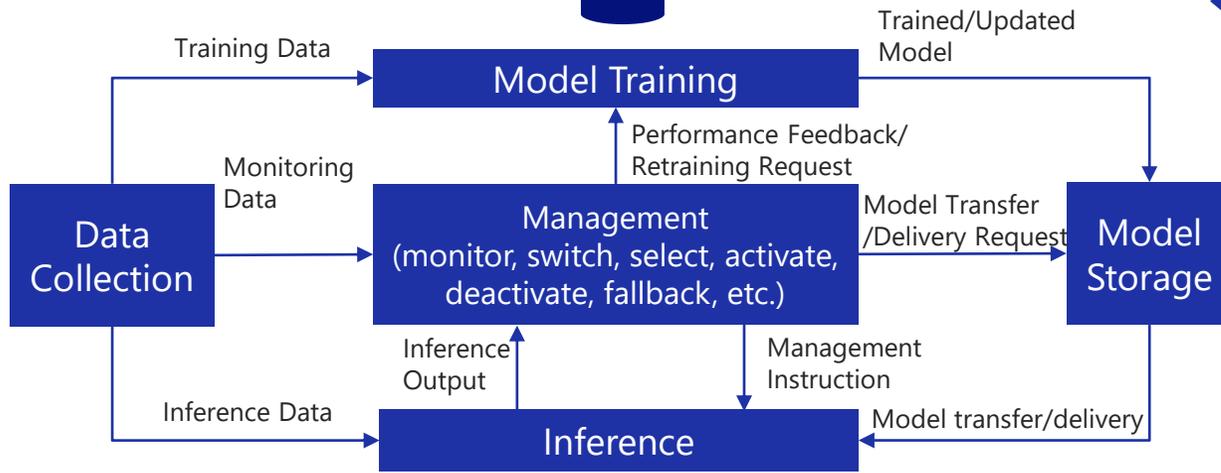
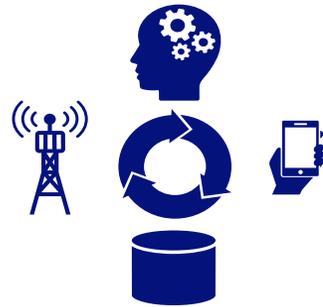
It is recommended to specify necessary measurement, signalling and procedure to facilitate training, inference, monitoring and/or other LCM operations for both direct AI/ML positioning and AI/ML assisted positioning, specifically:

- specify necessary signalling of data collection; investigate the necessity of other information for supporting data collection, and if needed, specify during normative work
- investigate on the necessity and signalling details of measurement enhancements, and if needed, specify during normative work
- investigate on the necessity and signalling details of monitoring method(s), and if needed, specify during normative work

A variety of enhancements for measurements (e.g., based on extensions to current positioning measurements or with new measurements) were also identified as potentially beneficial (e.g., trade-off positioning accuracy requirement and signalling overhead) and are recommended to be investigated further and if needed, specified during normative work.

Overview of the New WI

- ◆ Rel-19 AI/ML WI is expected to
 - Introduce a general AI/ML framework for NR air interface
 - Enable AI/ML operations for each use case to embrace the AI/ML gain



Motivation for AI/ML for NR Air Interface

- ◆ In the Rel-18 SI phase,
 - Various aspects of the general framework of lifecycle management (LCM) were studied, for both one-sided model and two-sided model, for various NW-UE collaboration levels, for various model identification types, for various model delivery/transfer cases, and can be considered across AI/ML use cases
 - Evaluation showed measureable gains of using AI/ML models for all selected representative sub use cases including CSI feedback, beam management and positioning
 - Spec impacts were also identified to support the selected representative sub use cases
 - Even though RAN1 has no consensus on recommendations for two CSI sub use cases, we see some benefits to have CSI use case in the normative work
 - For example, CSI compression is the only representative case of two-sided model. The aspects that were studied for this are useful to have a general and common framework
- ◆ Considering the above, our proposals for Rel-19 WI are provided on next pages

Proposals for the New WI

- ◆ **Proposal 1:** New WI is approved for Rel-19, with the following aspects of general lifecycle management (LCM) framework
 - Specify the necessary procedures and signaling for data collection, model training, model update, model inference, performance monitoring, functionality/model identification, functionality/model switching/selection, functionality/model activation/deactivation, and fallback
 - Consider both one-sided model and two-sided model
 - Consider both functionality based LCM and model-ID based LCM
 - Consider various model delivery/transfer cases studied in the Rel-18 SI

Proposals for the New WI

- ◆ **Proposal 2:** New WI is approved for Rel-19, with the following aspects for respective AI/ML use cases
 - Specify necessary enhancements on beam management related procedures including measurement and report, and signaling to enable:
 - spatial-domain DL Tx beam prediction for Set A of beams based on measurement results of Set B of beams
 - temporal DL Tx beam prediction for Set A of beams based on the historic measurement results of Set B of beams
 - Specify necessary enhancements on positioning related procedures including measurement and report, and signaling to enable, for all five studied cases in the Rel-18:
 - direct AI/ML positioning
 - AI/ML assisted positioning
 - Specify, if justified, necessary enhancements on CSI related procedures including measurement and report, and signaling to enable:
 - spatial-frequency domain CSI compression using two-sided AI/ML model
 - time domain CSI prediction using UE sided model
 - Note: The enhancements can be at least based on Rel-18 positioning and MIMO, respectively

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