

AI/ML for PHY in Rel-19

Status in Rel-18 SI: Framework

General framework to support ML model Life Cycle Management

- Data collection for training/updating and monitoring
- Model inference operation
- AI/ML functionality/model Identification and UE capability report: functionality-based LCM vs. model-ID-based LCM
- LCM for AI/ML functionality/model management: selection, activation, deactivation, switching and fallback operation.
- Model monitoring

Conclusion:

- Specify framework to support AI/ML for PHY, including: Data collection, model inference, LCM for AI/ML model/functionality management, model monitoring.

Status in Rel-18 SI: Two-sided model

Three types of two side models were identified

- Type 1: Joint training of the two-sided model at a single side/entity, e.g., UE-sided or Network-sided.
- Type 2: Joint training of the two-sided model at network side and UE side, respectively.
- Type 3: Separate training at network side and UE side, where the UE-side CSI generation part and the network-side CSI reconstruction part are trained by UE side and network side, respectively.
- Require share a set of information (e.g., dataset) between NW side and UE side

Observation

- Additional training efforts (multi-vendor collaboration) are required comparing to one-sided models.
- Additional testing efforts for two-sided models.
- Large specification effort for all working groups.
 - LCM for two-sided model.
 - RAN 4 need to study two-sided model test framework and study the interoperability, including defining reference decoder and encoder.
- Large signaling overhead is expected (e.g., for OTA Type 3 training) to support two-sided models.
- No significant gain has been observed so far for the use case that requires two-sided models.

Conclusion

- Two-sided model is not considered in Rel-19 AI/ML for PHY WI.

Status in Rel-18 SI: Use case for CSI feedback enh.

Sub use cases

- CSI compression with two-sided model
- Time-domain CSI prediction at UE side

Main observations

- Performance
 - CSI compression: Marginal gain in terms of UPT, performance impacted by training assumption
 - CSI prediction: Performance sensitive to UE speed, model LCM assistance may alleviate the problem
- Additional training effort for CSI compression
 - Two-sided models require complex training procedure that may necessitate offline multi-vendor collaboration.
- Life cycle management (LCM)
 - Data collection, model/functionality management, model monitoring
- Potential spec impact
 - CSI Compression: Specification impact for inference, training, monitoring, data collection and LCM for model/functionality management
 - CSI Prediction: focused on data collection, monitoring, model/functionality selection/switching and fine-tuning procedures.
 - Aspects which do not duplicate the work in Rel-18 MIMO WI.

Conclusion

- Considering the trade-off between potential gain and cost (training and overhead), CSI compression with two-sided model is not considered in Rel-19 AI/ML for PHY.
- Consider to support time-domain CSI prediction at UE side [if the performance gain is justified.]

Status in Rel-18 SI: Use case for Beam management

Sub use cases

- BMCASE-1: Spatial domain beam prediction
- BMCASE-2: Temporal domain beam prediction

Main observations

- Performance
 - Decent beam prediction accuracy with less measurements/RS overhead for at least for DL Tx beam prediction for spatial domain prediction.
 - Good generalization ability with mixing data training or finetune. Not sensitive to scenarios, but sensitive to antenna configuration.
- Life cycle management (LCM)
 - Data collection for training/finetune, performance monitoring.
- Potential spec impact
 - LCM for NW side model (data collection, inference, performance monitoring)
 - LCM for UE side model (data collection, inference, prediction result report, performance monitoring)

Conclusion

- Specify beam management related procedures including measurement and report, and signaling to facilitate AI/ML-based spatial domain and/or temporal domain beam prediction in Rel-19, considering NW and/or UE side model without model transfer.

Status in Rel-18 SI: Use case for Pos. accuracy enh.

Sub use cases

- Direct AI/ML positioning
- AI/ML assisted positioning

Main observations

- Performance
 - Direct AI/ML positioning can significantly improve the positioning accuracy compared to existing RAT-dependent positioning methods.
 - AI/ML assisted positioning can significantly improve the positioning accuracy compared to existing RAT-dependent positioning methods
 - Good generalization ability with mixing data training or finetune
- Life cycle management (LCM)
 - AI/ML model indication[and applicable conditions/configurations]
 - Data collection for training/inference/finetuning/monitoring
 - Model monitoring
- Potential spec impact
 - Assistance signaling for data collection, model training/finetuning/inference/monitoring/
 - Training data generation/collection including (new/existing) measurement and ground truth label
 - Model monitoring procedure including monitoring metric derivation etc

Conclusion

- Specify AI for direct AI/ML position and AI/ML assisted position in Rel-19, considering NW and-UE side model without model transfer.

New use cases for AI/ML in PHY

- Rel-18 SI only focused on the use cases with collaboration between NW and UE, however, AI/ML assisted receiver can improve system performance without or with limited collaboration (collaboration level x).
 - New use cases to explore the gain with AI/ML-assisted receiver can be considered in Rel-19.

Proposed Objectives

- **Specify necessary LCM operations, including (RAN2, RAN1)**
 - Data collection, model inference, model selection/activation/deactivation, switching and fallback operation, model monitoring.
- **Specify related procedures including measurement and report, and signaling to facilitate the following use cases with AI/ML (RAN1, RAN2, [RAN3])**
 - Time-domain CSI prediction at UE side
 - Beam management in spatial and temporal domain
 - Direct AI/ML position and AI/ML assisted position
- **Specify core and performance requirement for each use cases considering LCM operations (RAN4)**
- **Study, if identified, new use cases**
 - Study the use cases with AI/ML-assisted advance receiver (RAN4-led)
 - Note: FFS a joint WI, or a separate RAN4-led SI for RAN4 driven new use cases