3GPP TSG RAN Meeting #101
Bangalore, India, September 11 - 15, 2023
Agenda: 8A.2.15
Document for: Discussion
RP-232278

Views on Rel-19 AI/ML for air interface

China Telecom

September 2023

Outline

- Considerations on Rel-18 continuations
- Considerations for Rel-19 SI
- New use cases for Rel-19 SI

Considerations on Rel-18 continuation

General consideration

Rel-18 SI
AI/ML for NR air interface

- Use case 1: AI/ML for CSI feedback enhancement
- Use case 2: AI/ML for beam management
- Use case 3: AI/ML for positioning accuracy enhancement

Rel-19 WI
AI/ML for NR air interface

Rel-19 SI
AI/ML for NR air interface

- **New use case**, e.g., AI/ML based higher layer use cases

Proposal 1: Rel-18 SI can be transferred to Rel-19 WI, and all six sub-use cases should be considered in the Rel-19 WI.

Considerations for Rel-19 AI/ML SI

General consideration

Rel-18 SI
AI/ML for NR air interface

- Use case 1: AI/ML for CSI feedback enhancement
- Use case 2: AI/ML for beam management
- Use case 3: AI/ML for positioning accuracy enhancement

Rel-19 WI
AI/ML for NR air interface

Rel-19 SI
AI/ML for NR air interface

- **New use case**, e.g., AI/ML based higher layer use cases

» AI/ML for NR air-interface study item in Rel-18 focuses on the study of three typical **physical layer** use cases. Many AI/ML enabled use cases have been drawn a lot of interests in recent research and also were raised by many companies in former Rel-18 workshop.

» Based on the current working progress, more use cases should be initiated discussion to forward the AI/ML research for pre-6G research.

Considerations for Rel-19 AI/ML SI

- For making better preparation for 6G, the further study of AI/ML for NR air-interface in Rel-19 should consider following extended options:

Physical layer use case	→	**Higher layer use case**
Centralized learning based	→	**Distributed/Federated learning based**
Deep learning based	→	**Reinforcement learning based**
Uu interface	→	**Support by more interfaces, e.g., PC5**

New use cases for Rel-19 SI

- We recommend selecting representative new use cases to explore AI/ML for NR air interface following above extended options

	Higher layer	Federal learning	Reinforcement learning	More interface support
AI/ML based mobility enhancement	✓	✓	✓	✓
AI/ML based higher layer positioning enhancement	✓	✓		✓

Observation 1: Further study on new use case(s) in a separate SI can be considered based on the Rel-18 AI/ML air interface framework.

AI/ML based mobility enhancement

Background

- In Rel-18, the NR_AIML_Air SI would introduce the model life cycle management to enable the use cases at the air interface. Temporal beam prediction is studying and mainly focuses on **intra-cell beam prediction**, which is also helpful for improving mobility performance due to the UE trajectory prediction.
- In Rel-18, the NR_AIML_NGRAN-Core WI specifies the AI/ML based mobility optimization. The model inference functionality resides **within the RAN node only supporting cell-level mobility prediction**. Some location-related information of UE (e.g., coordinates) will be helpful as the input of AI/ML model to improve performance, which may introduce UE privacy concerns.

Motivation

- AI/ML based mobility management can be further studied and enhanced reusing the framework of NR air-interface.
- Mobility is mainly about user movement behavior and network coverage. AI/ML is expected to be used to **construct radio channel map/fingerprint** or **process UE trajectory prediction** and make better HO decisions or parameters configuration.
- The Model Inference functionality can reside on the UE side. Local model inference at UE side may utilize more detailed location information without privacy concerns and can reduce signaling overhead of input exchange.
- Besides, some **specific scenarios** can also be studied such as for high-speed mobility, high-speed train or V2X scenario mobility enhancement, heterogeneous deployment, and UE group mobility enhancement.

AI/ML based mobility enhancement

Feasibility analysis with field test – Highway

Carrier Frequency: FR1, 3.5GHz UE speed: 80~120km/h

Figure 1: Map of deployment

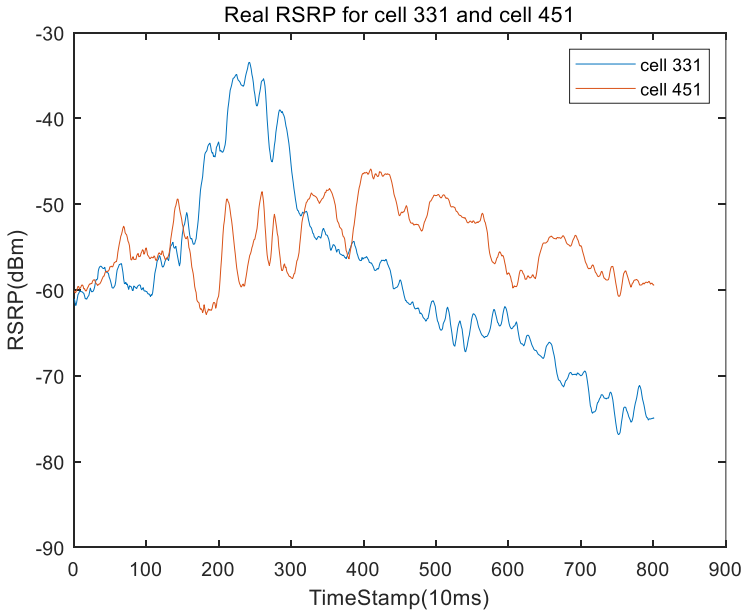

Figure 2: Field test RSRP

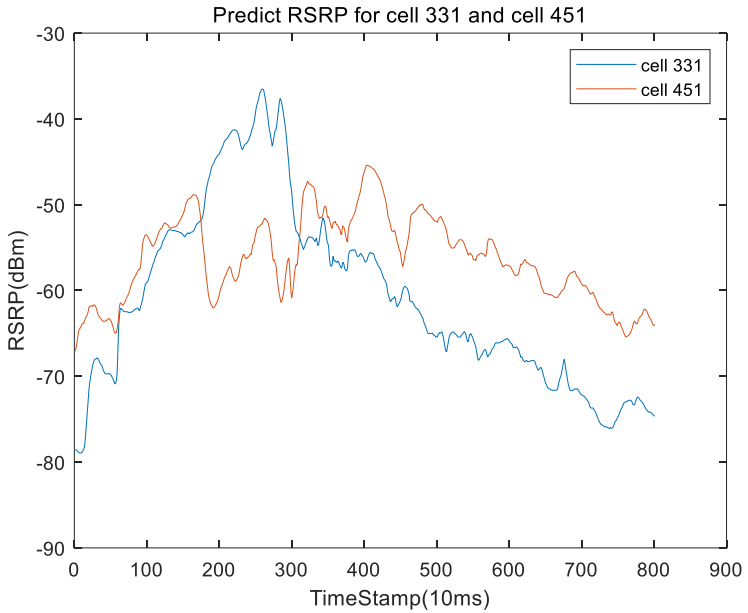

Figure 3: Predict RSRP

- During UE high-speed movement, the RSRP of the neighbor may becomes better than the serving cell in a short period of time. UE will handover to the neighbor cell and handover back quickly to the last serving cell, i.e., ping-pong handover occurs.
- Field test results show that the predicted RSRP has 0.8 dB RMSE. AI/ML based predict RSRP is basically consistent with the filed test RSRP on highway field scenario

Note: More information can be found in RP-230273: “Motivations on AI/ML-based mobility enhancement”, China Telecom, vivo.

AI/ML based mobility enhancement

Potential objective

Study and finalize the sub use cases from the following for evaluation and specification impact analysis for AI/ML based mobility optimization: [RAN2]

- E.g., RRM measurement (e.g., RSRP, SINR) prediction, target Cell prediction, unintended events prediction.
- UE sided model [network sided model and two sided model]

For the selected sub-use case for evaluation, evaluate performance benefits of AI/ML based algorithms [RAN2]

- Methodology based on statistical models (from [TR 38.901]), for system level simulations.
- KPIs: Determine the common KPIs and corresponding requirements for the AI/ML operations.

Assess potential specification impact, specifically for the selected sub-use cases, including [RAN2, RAN1, RAN4]

- Identify AI/ML framework applicable for the selected sub-use case.
  - Identify applicable levels of collaboration between UE and NW.
  - Characterize lifecycle management of AI/ML based mobility optimization: e.g., model training, model deployment, model inference, model monitoring, model updating.
  - Data collection aspects
  - Note: Federated learning can be considered for model training.
- PHY layer aspects and protocol aspects of the identified framework
  - E.g, identify impacts of different collaboration levels, the input and output for model training and model inference purpose, the performance metrics for model monitoring purpose.
- Interoperability and testability aspects

Proposal 2: New use case(s) in a separate SI should be considered based on the AI/ML air interface general framework.

AI/ML based higher layer positioning enhancement

Motivation

» In practice, **high-quality labeled data samples are relatively small** compared with the present evaluation assumptions. Many data samples without high-quality label may be used. **Data security and personal privacy** are crucial issues with public concern.

» Frequent exchange of the input between network and UE will introduce massive signaling overhead and latency

Scope

» Study higher layer scenarios and sub use cases of AI/ML based positioning enhancement.

» Study **distributed learning (e.g., federal learning)** based positioning enhancement to satisfy data security and personal privacy requirements, which model transfer via Uu or PC5.

- Such as centralized/distributed learning mode selection and configuration, model monitoring of LCM etc.

Proposal 2: New use case(s) in a separate SI should be considered based on the AI/ML air interface general framework.

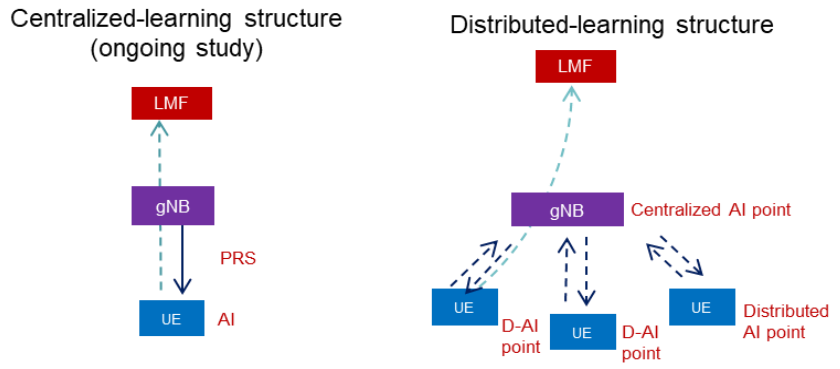

Figure 1. Examples of use case

Simulation results

Simulation results show that federal learning based positioning enhancement can achieve faster convergence and comparable positioning accuracy.

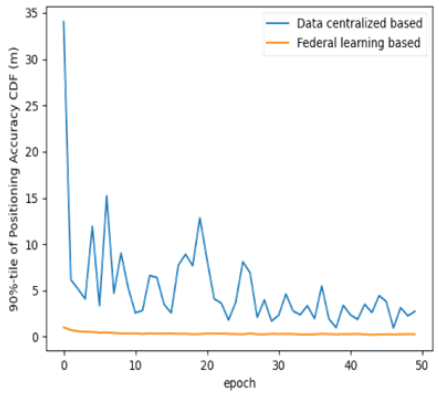

Figure 2. Performance of federal learning @InF-DH

Summary

In this contribution, we have following proposals:

- **Rel-18 SI can be transferred to Rel-19 WI, and all six sub-use cases should be considered in the Rel-19 WI.**
  - » **E.g., WI on AI/ML for NR air interface (RAN1-led)**
- **New use case(s) in a separate SI should be considered based on the AI/ML air interface general framework.**
  - » **E.g., AI/ML-based mobility enhancement (RAN2-led).**
- **Start discussions on the Rel-19 AI/ML for NR air interface.**
  - » **E.g., separate subtopics for Rel-19 WI and new use case(s) for SI.**

Thanks!