

3GPP TSG RAN Rel-19 workshop

Taipei, June 15 - 16, 2023

Agenda: 5

Document for: Discussion

RWS-230241



# Views on Rel-19 AI/ML for air interface

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China Telecom

June 2023

- Overview on Rel-18 AI/ML SI
- Considerations on Rel-18 continuations
- Considerations for Rel-19 SI
- New use cases for Rel-19 SI

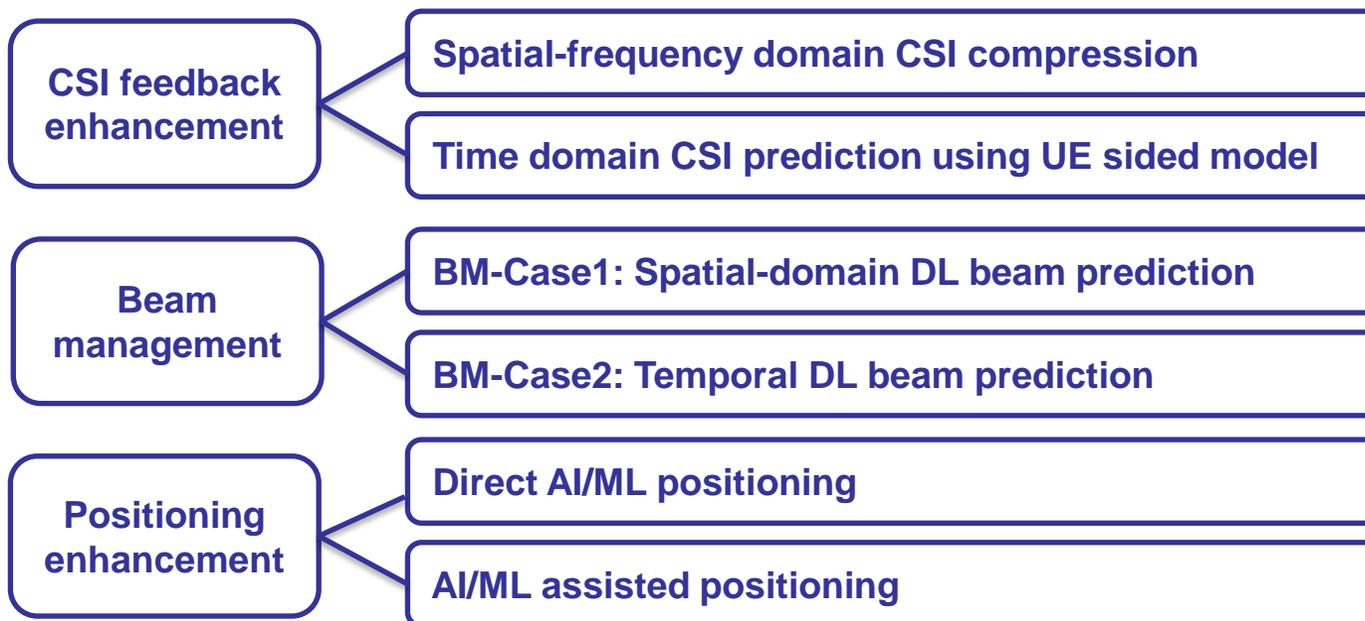
- General framework for AI/ML in NR air interface
  - » Terminology, collaboration level
  - » Life cycle management (LCM)
    - Model functionality based
    - Model ID based
    - UE capability
- Use Cases identification and evaluations
  - » CSI feedback enhancement
  - » Beam management
  - » Positioning accuracy enhancements
- Specification impact
  - » Physical layers
  - » Protocol layers
  - » Interoperability and testability

- In Rel-18 NR\_AIML\_Air study item, following components for LCM have been identified and focused by RAN1/RAN2/RAN4:
  - Data collection
    - Note: This also includes associated assistance information, if applicable.
  - Model training
  - Functionality/model identification
  - Model transfer
  - Model inference operation
  - Functionality/model selection, activation, deactivation, switching, and fallback operation.
    - Including: Decision by the network (either network initiated or UE-initiated and requested to the network), decision by the UE (event-triggered as configured by the network, UE's decision reported to the network, or UE-autonomous either with UE's decision reported to the network or without it)
  - Functionality/model monitoring
  - Model update
    - Note: Terminology is to be defined. This includes model finetuning, retraining, and re-development via online/offline training.
  - UE capability

## Our considerations

- » **Model deliver** should be supported, and **proprietary format** may be prioritized over open format at least in Rel-19.
- » **Model monitoring** is very important and needed to be designed carefully to guarantee the performance of AI/ML features. **Non-transparent fallback or de-activation mechanisms** will be needed when AI/ML model performance deteriorates.
- » For **data collection**, at least **CP based solution** can be a higher priority.

- For each use case, two sub-use cases are identified.



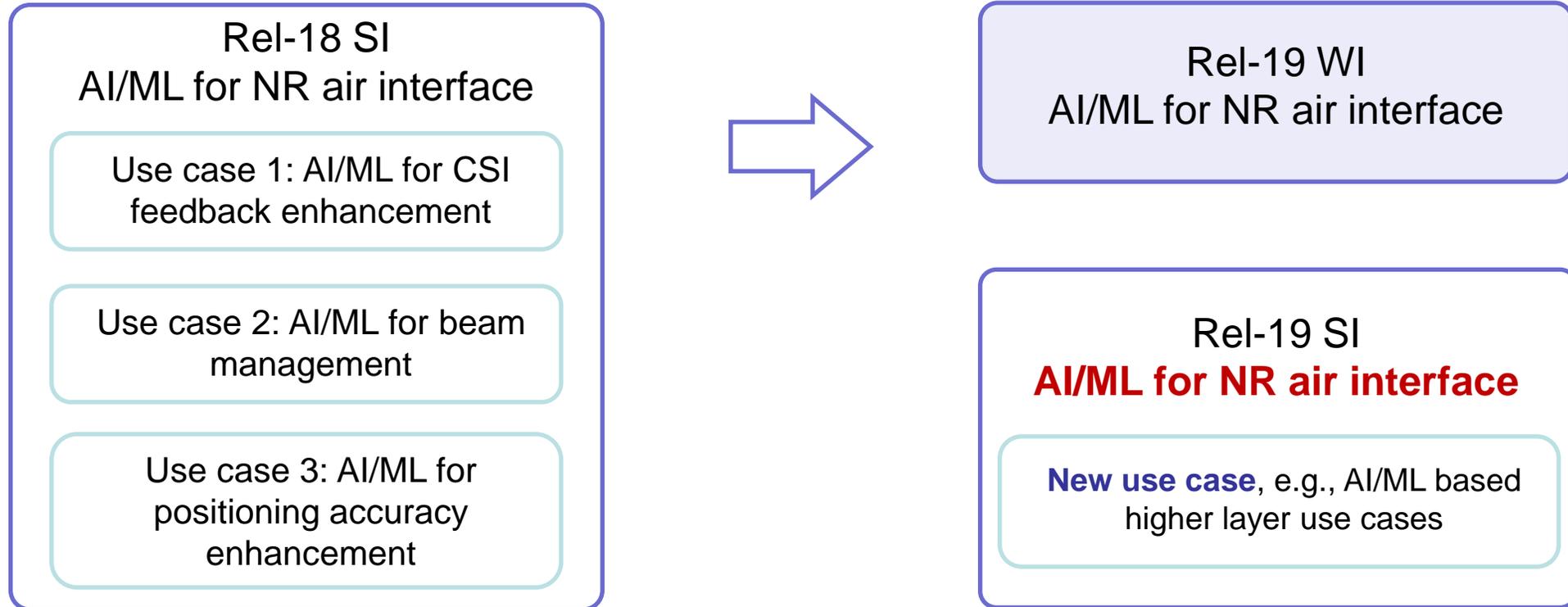
- Good progress on evaluations

- » Evaluation methodology and KPI determination

## Our considerations

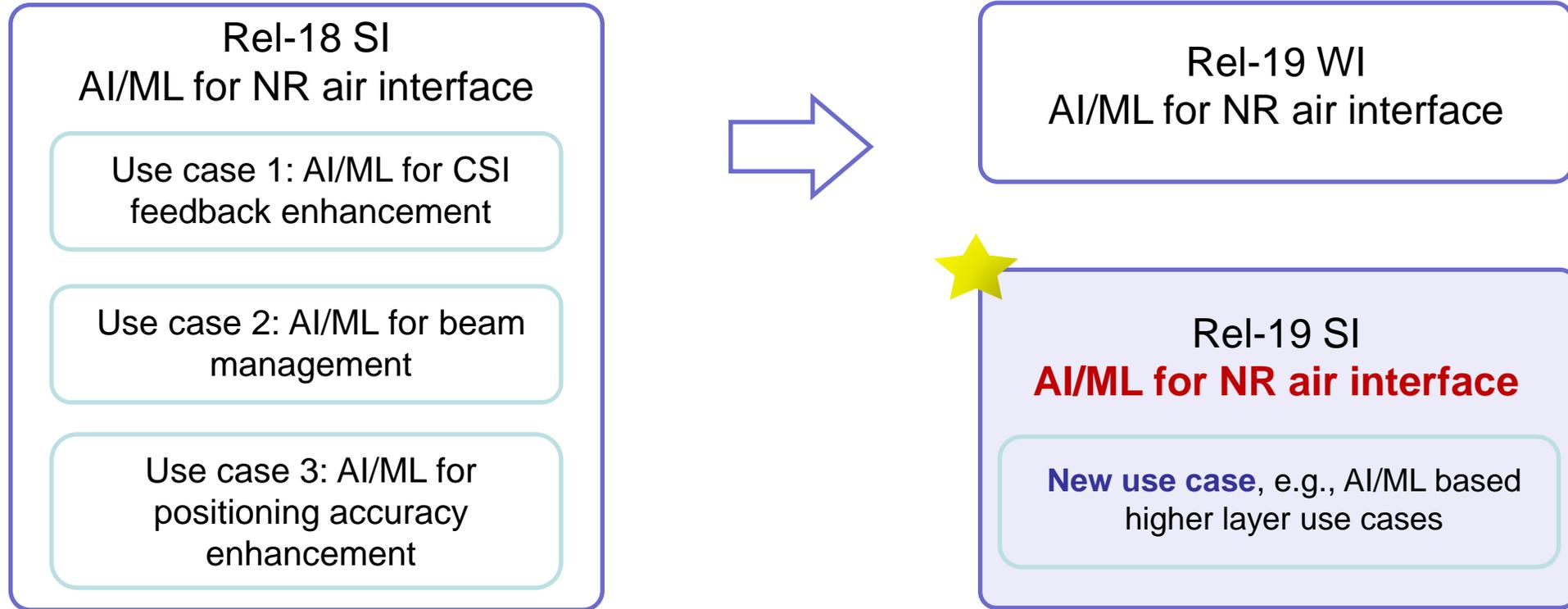
- » Based on the current evaluation results, **all use cases show gains** compared with legacy scheme.
- » Spatial-frequency CSI compression is with less gain compared to other cases but can **be easily extended** to time domain compression with much larger gains.
- » Spatial-frequency domain CSI compression is the **only case using two-sided model** which has higher value for LCM definitions.

## ■ General consideration



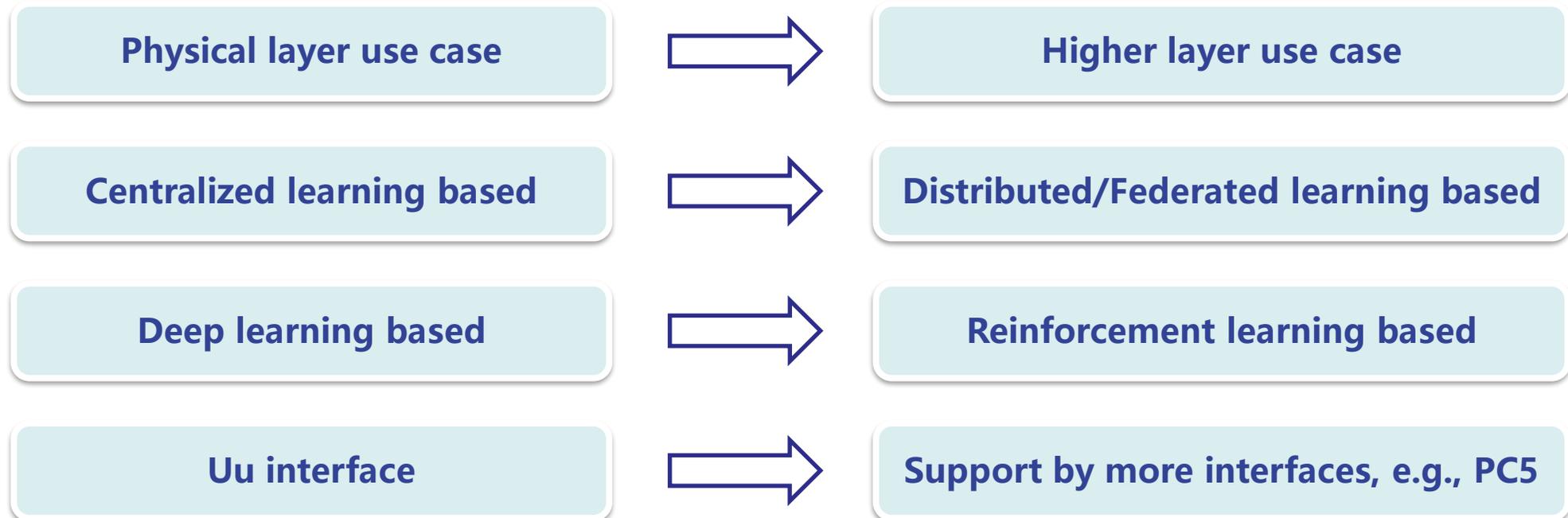
***Proposal 1: Rel-18 SI can be transferred to Rel-19 WI, and all six sub-use cases should be considered in the Rel-19 WI.***

## ■ General consideration

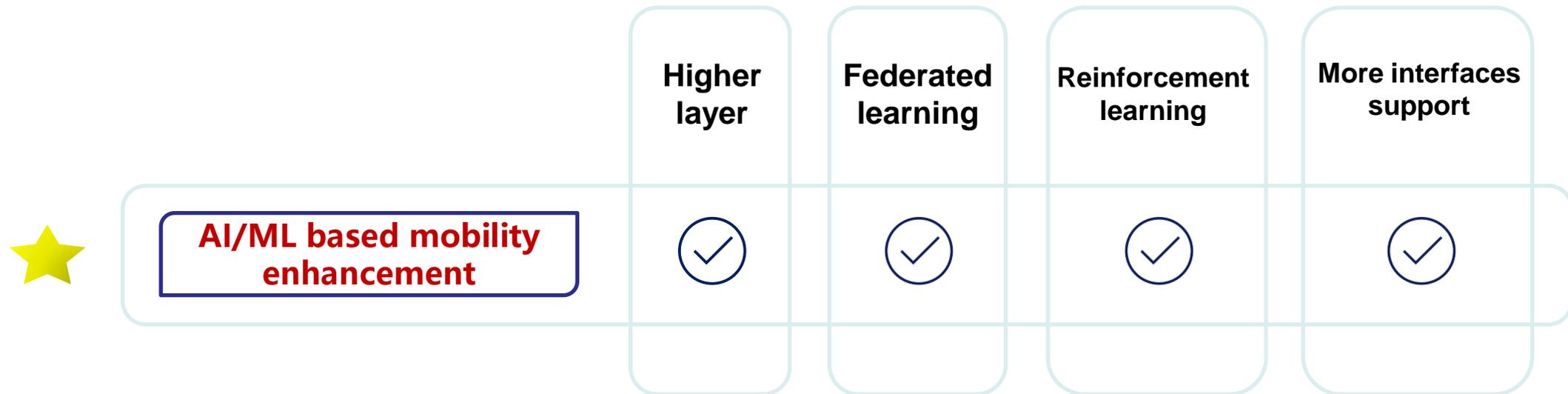


- » AI/ML for NR air-interface study item in Rel-18 focuses on the study of three typical **physical layer** use cases. Many AI/ML enabled use cases have been drawn a lot of interests in recent research and also were raised by many companies in former Rel-18 workshop.
- » Based on the current working progress, more use cases should be initiated discussion to forward the AI/ML research for pre-6G research.

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



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



***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.***

## ■ 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.

## ■ Feasibility analysis with field test – Highway

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

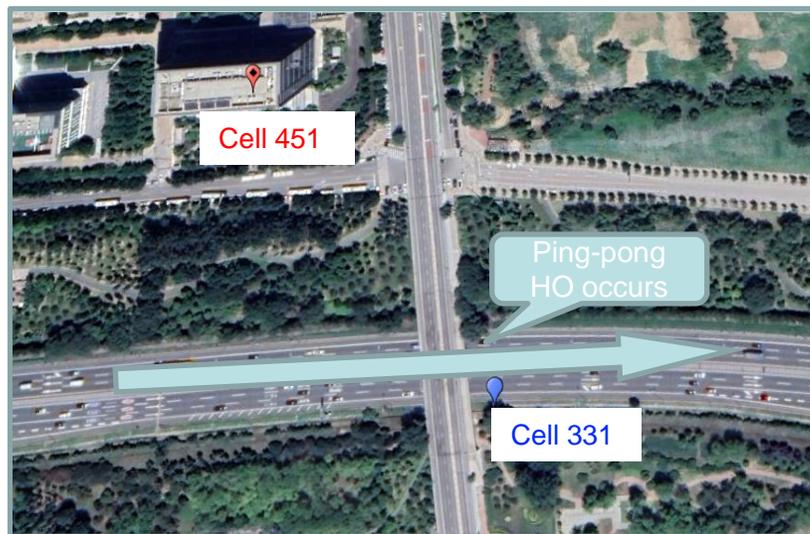


Figure 1: Map of deployment

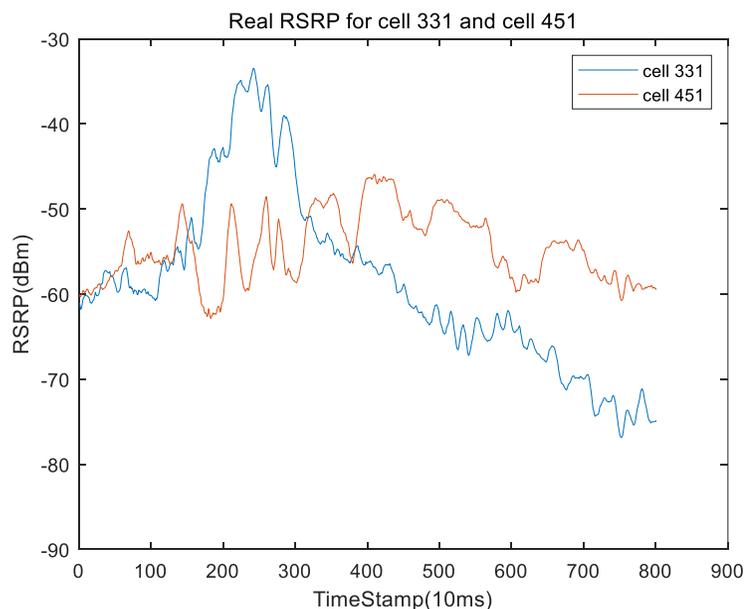


Figure 2: Field test RSRP

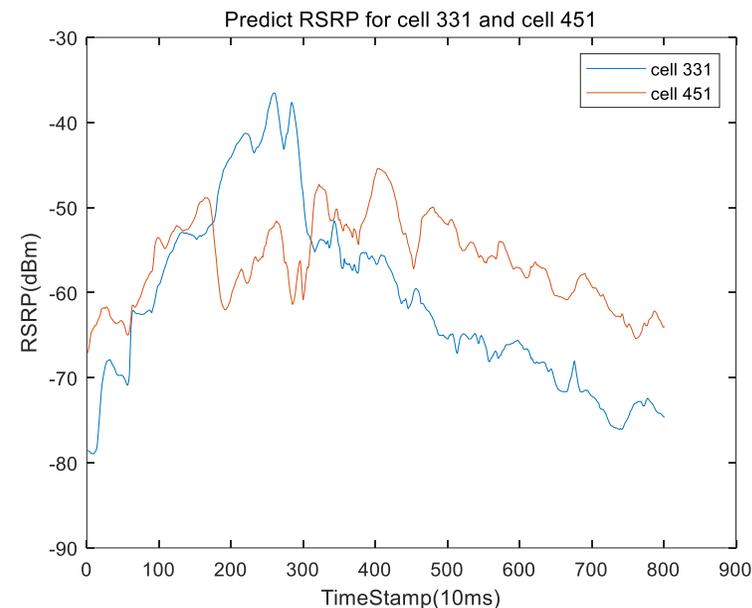


Figure 3: Predict RSRP

- 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 our companion contribution.

RWS-230240: "Motivations on AI/ML-based mobility enhancement", China Telecom, vivo.

## ■ 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: Agree on a RAN2 leading AI/ML-based mobility enhancement study item in Rel-19.***

- Rel-18 SI can be transferred to Rel-19 WI, and all six sub-use cases should be considered in the Rel-19 WI.
  - » Model deliver should be supported, and proprietary format may be prioritized over open format at least in Rel-19.
  - » Non-transparent model monitoring, e.g., fallback or de-activation mechanisms, will be needed to guarantee the performance of AI/ML features.
  - » For data collection, at least CP based solution can be a higher priority.
- Further study on new use case(s) in a separate SI can be considered based on the Rel-18 AI/ML air interface framework.
  - » Agree on a RAN2 leading AI/ML-based mobility enhancement study item in Rel-19.

**Thanks!**

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