3GPP RAN Rel-18 Workshop
June 28th – July 2nd, 2021

RWS-210430

Agenda Item : 4.3

Source : InterDigital

Title : On Studying AI/ML for the NR Physical Layer for Rel-18

Document for : Discussion and Decision

interdigital

Possible PHY Layer Enhancements for NR

AIML can be a useful tool to address a specific problem/optimization.

- **MIMO CSI feedback**
  - CSI feedback compression
  - CSI prediction
- **RS overhead reduction**
  - Adaptive RS density based on UE AI processing capability
- **Mobility/Beam management optimizations**
  - Optimized beam measurements
  - Predictive beam/mobility management
  - Enhanced beam failure recovery
- **Positioning enhancements**
  - Improved accuracy in NLOS
  - Robustness in presence of synchronization errors

Categorizing possible impact of AI solutions

Impacts to specification and complexity depend on placement and training method for the AI solution

- **OEM AI black box**
  - **Placement of AI model:** Local to the UE or gNB
  - **Training strategy**: Implementation
  - **Benefits:** Optimization of local processing targetting implementation based PHY performance improvement
  - **Possible Impacts:** Details of AI model and training is out of scope of 3GPP, possibly new feedback from the UE
- **UE-based AI black box**
  - **Placement of AI model:** Local to the UE
  - **Training strategy:** Offline, Online refinement possible
  - **Benefits:** Optimization of system performance
  - **Possible Impacts:** Details of AI model and training is out of scope of 3GPP, definition/indication of UE capability relating to AI processing, supported signaling for network control, feedback and procedures etc
- **Joint AI**
  - **Placement of AI model:** AI model at the UE and AI model at the gNB
  - **Training strategy:** Offline, Online or Remote
  - **Benefits:** Optimization of performance impacting multiple endpoints
  - **Possible Impacts:** Signaling to enable configuration of AI model, support for model training and/or download, definition/indication of UE capability relating to AI processing, potential new feedback, supported signaling for network control, feedback and procedures etc

Possible challenges

Scope of the work should limit the challenges that needs to be addressed within Rel-18 time frame

- **Challenge 1: Data sets for AI model training**
  - Do we have agree on data sets to use for evaluation ?
  - What are the assumptions to generate and/or collect data ?
  - How to ensure training data to represents realistic environment both in terms of quality and quantity ?
  - Would synthetic data be sufficient for evaluation ? Should the synthetic data be augmented with real data? How to define/collect realistic data set ?
- **Challenge 2: Definition of UE capability w.r.t AI processing**
  - How to define UE capability in terms of memory, processing power, latency, support for various AI model architectures etc
- **Challenge 3: Interoperable AI model representation**
  - Applicable for remote training and AI model download scenarios
- **Challenge 4: What is the methodology used to evaluate AI-based solutions?**
  - What methodology should RAN use to test conformance and performance ?
  - What methodology should RAN use specifying support for AI-based solutions ?
- **Challenge 5: Predictable and guaranteed performance of AI**
  - How to ensure predictable performance from a AI model ?

Proposal for Rel-18 SID Scope

If overall workload for R18 remains reasonable, the scope of a R18 study on AI-based PHY enhancements can focus on use cases, deployments and evaluation methodology

- **Scope for a RAN1-led study on evaluation of AI-based PHY enhancements**
  - Identify relevant use cases and scenarios for deployment of AI/ML.
  - Study evaluation methodology for AI-based PHY enhancements, including:
    - Agree upon terminology related to AI-based components to have common understanding.
    - Study characterization of AI performance. (e.g. assumptions on model architecture, parameterization, model size, training aspects, etc)
    - Identify appropriate legacy baseline (e.g. comparable in terms of performance, complexity etc) for each use case.
    - Study evaluation metrics including, spectral efficiency, power consumption, overhead, cost, complexity etc
    - Details of the data sets, including the methods for data collection, dataset structure including inputs/outputs, dataset size, training aspects etc.
  - Study characterization and signaling of UE capabilities w.r.t AI processing