

AI-based PHY Layer Enhancement for 5G-Advanced



Motivation

- **AI/ML¹ is a powerful tool to address challenges for air interface designs**
 - **Efficient handling of nonlinear problem**
 - One interesting characteristic of AI is that a neural network can struggle in complex scenarios with many imperfections and nonlinearities.
 - **Joint optimization of multiple communication function blocks**
 - AI/ML may find solutions to complicated problems by model-driven approach with prior knowledge.
 - **Algorithm with lower complexity**
 - A known algorithm finds the optimum but has prohibitively high complexity for real-time implementation.
 - **Evolution based on learning**
 - In online, the communication function can be evolved by learning (e.g. reinforcement learning)

Potential Challenges [1/2]

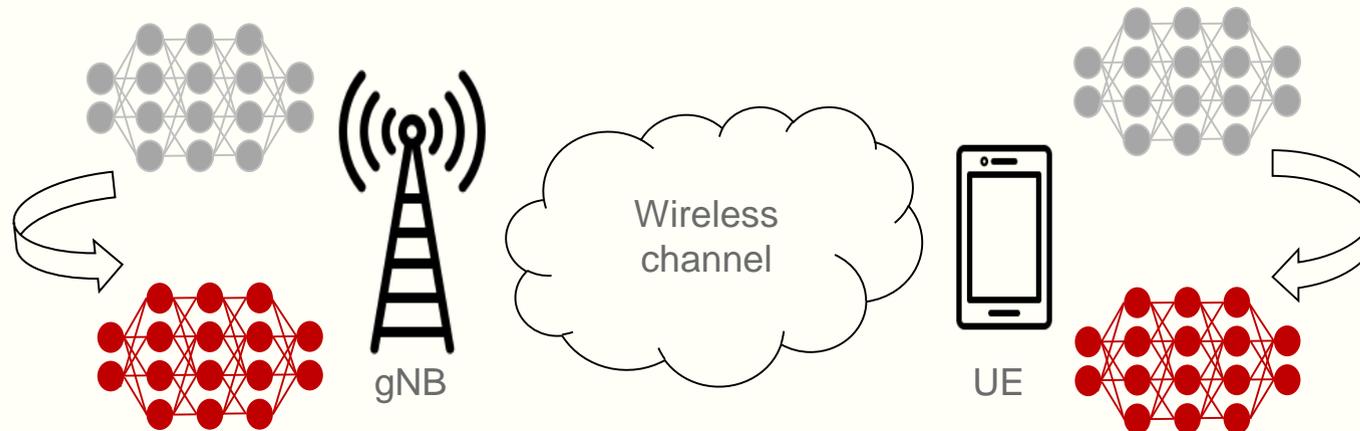
- **Performance Verification**

- How to guarantee the performance of AI-based function in the worst case?



- **Generalization**

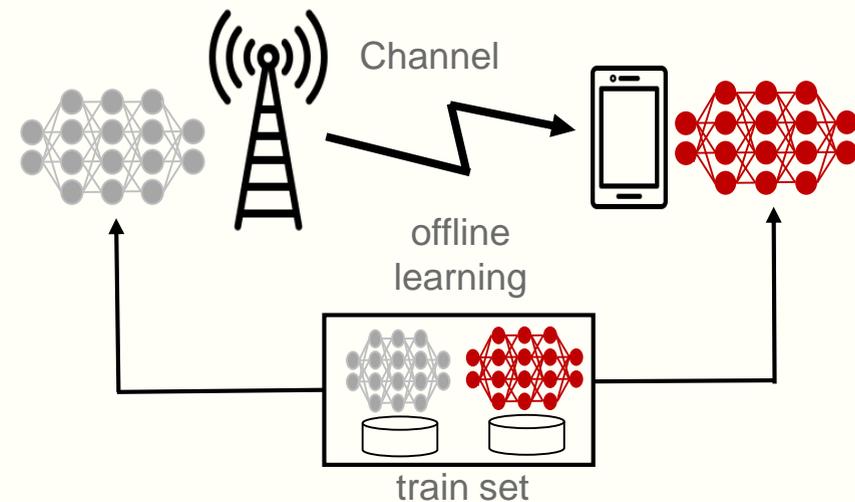
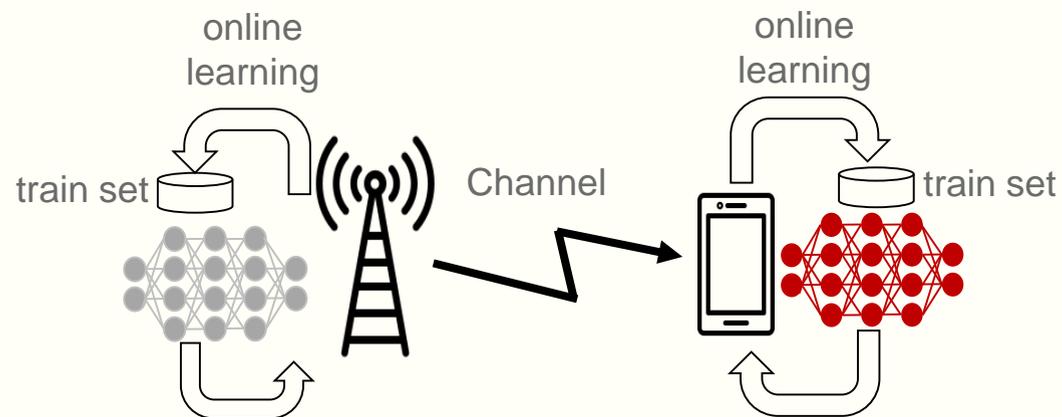
- How to learn with many different parameters of wireless system (e.g. number of users, antennas)?



Potential Challenges [2/2]

- **Learning**

- Offline learning may not work in a new wireless environment (e.g. when UE moves to a new cell)
 - Overhead and latency for online learning could be challenging.



- **Evaluation Methodology**

- Aligned AI/ML algorithm for evaluation among companies could be challenging
- Performance is highly dependent on the data set used for training

Potential approaches in PHY layer

- **Network AI based approaches**
 - A well-trained AI may provide a quick decision on many complex NW optimization problems which could be based on a predicted channel/mobility of UEs.
 - E.g. proactive/dynamic TRP coordination and interference management, etc.
- **UE AI based approaches**
 - UE AI can improve channel estimation/prediction performance. In addition, it may reduce latency/overhead by allowing more active involvement of UE in many decisions, which have been done solely by NW.
 - E.g. channel estimation/prediction, UE-centric BM/link adaptation, etc.
- **Joint operation of UE AI and NW AI**
 - Joint operation of UE AI and NW AI may be beneficial for fast/efficient learning and for achieving higher performance in some cases
 - E.g. positioning

Proposed SI objective

- **Study on AI/ML based PHY enhancement**
 - Identify use cases, deployment scenarios, and solutions for AI based physical layer enhancements
 - Network AI based approaches (e.g. MTRP, interference management)
 - UE AI based approaches (e.g. channel prediction, UE-centric BM/link adaptation)
 - Joint operation of UE AI and NW AI (e.g. positioning)
 - Study performance evaluation methodology for AI based solutions
 - Evaluate potential performance gain of AI based solutions