

China Academy of Telecommunication Technology -

3GPP TSG RAN Rel-18 workshop

ELECTRONIC MEETING, JUNE 28 - JULY 2, 2021

DOCUMENT FOR: DISCUSSION

Agenda Item: 4.3

RWS-210413

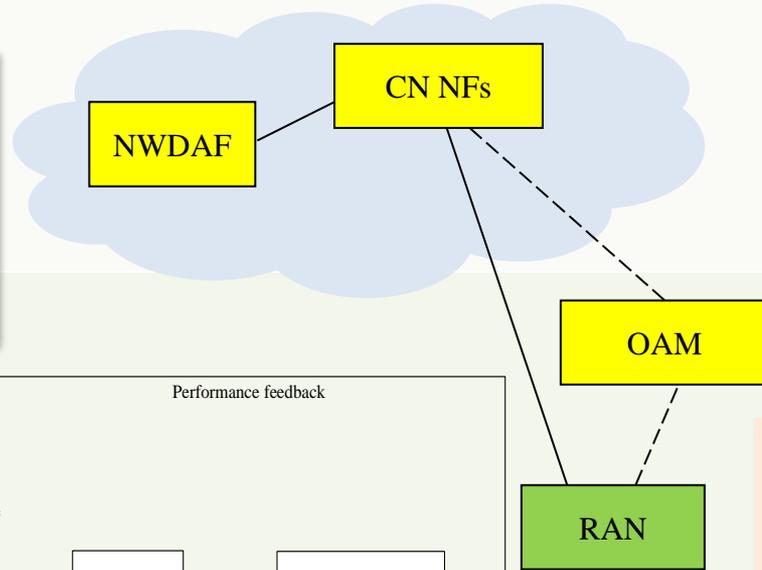
AI/ML for physical layer in Rel-18

China Academy of Telecommunications Technology (CATT)

AI/ML progress in 5GC and RAN (R16/17)

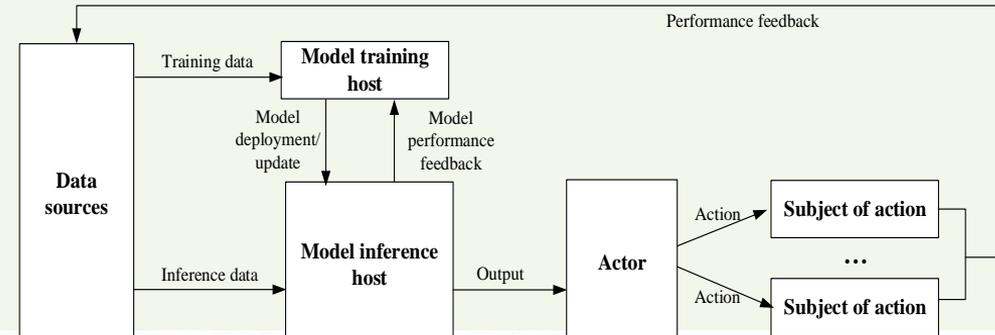
- 3GPP has started work on AI for 5GC and RAN, e.g., eNA, eNA_ph2, FS_eMDAS
- RAN3 study item (FS_NR_ENDC_data_collect) focuses on use cases for higher layer, e.g., load balancing etc

SA2/eNA, eNA_ph2
*Observed service experience,
 Slice load level,
 NF load, network performance,
 UE related analytics,
 User data congestion,
 QoS Sustainability, etc.*



SA5/FS_eMDAS, under study
*RAN user plane congestion analysis,
 Resource utilization analytics,
 Cross-slice resource optimization,
 NAS level congestion control optimization,
 etc.*

RAN3/FS_NR_ENDC_data_collect Studing
Energy saving, load balancing, traffic steering/mobility optimization (other use cases, e.g. optimization of physical layer parameters, are not precluded)

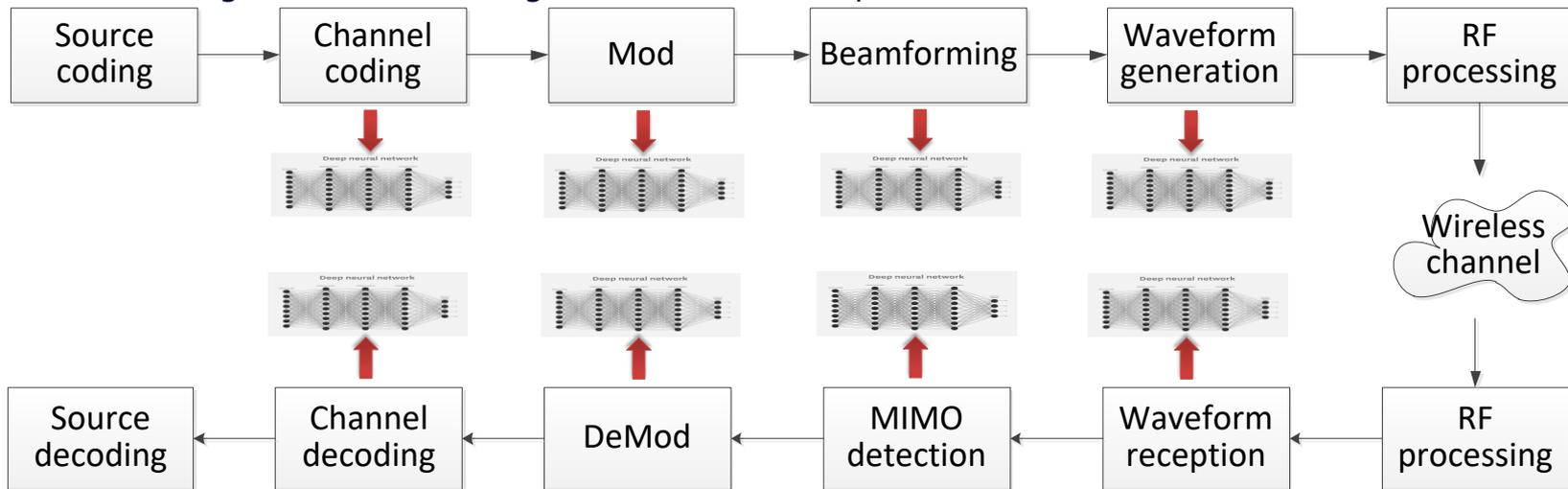


AI/ML for physical layer

- AI/ML for physical layer is expected to improve system performance, and gains lots of interest from both industry and academia.
- Advantages of AI/ML for physical layer
 - Learn hidden structure, hidden parameters and approximate any non-linear function
 - Optimization for system without precise mathematical model
- Challenges for AI/ML for physical layer
 - Algorithm suitable for wireless communication is unknown, CNN, DNN, DRL...
 - Lacking well recognized dataset for training, like ImageNet
 - Real-time training/inference may be a challenging task for gNB and UE
- Two approaches to use AI/ML for physical layer
 - AI-integrated physical layer
 - AI-empowered physical layer

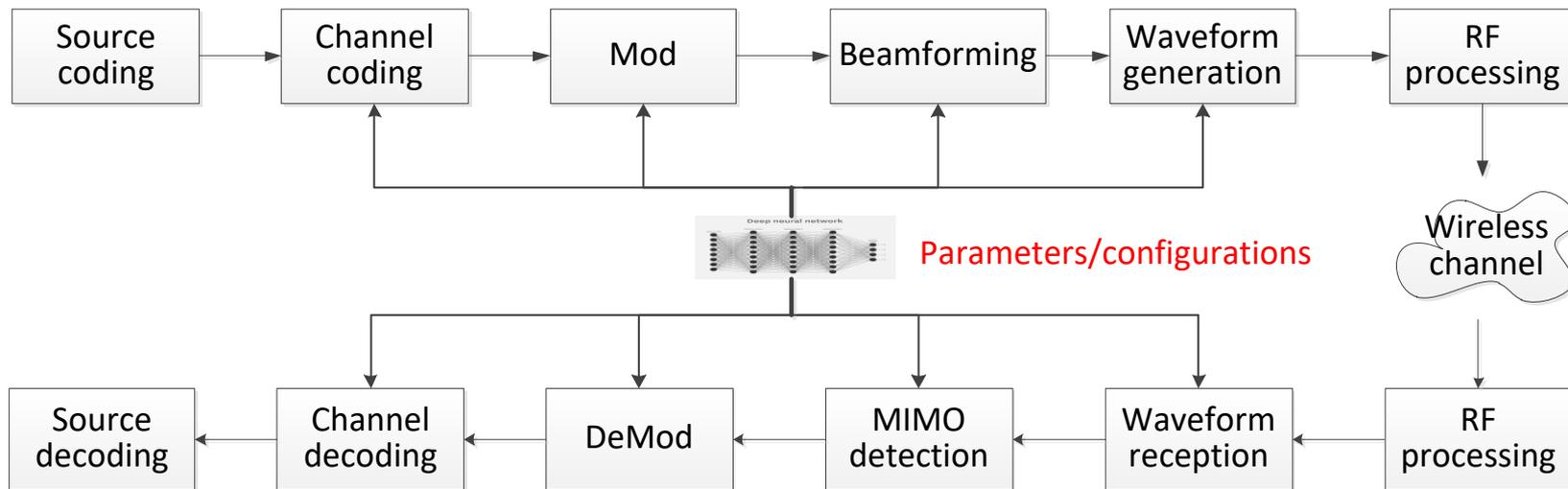
AI-integrated physical layer

- One or multiple modules of a traditional physical layer processing chain is substituted by AI-based module, e.g.,
 - Channel coding, modulation, beamforming
- This is a fundamental change of communication system and is capable of improving system performance significantly.
 - Learning the optimal design of a specific module, e.g., modulation
- This is a long-term evolution, huge amount of work required



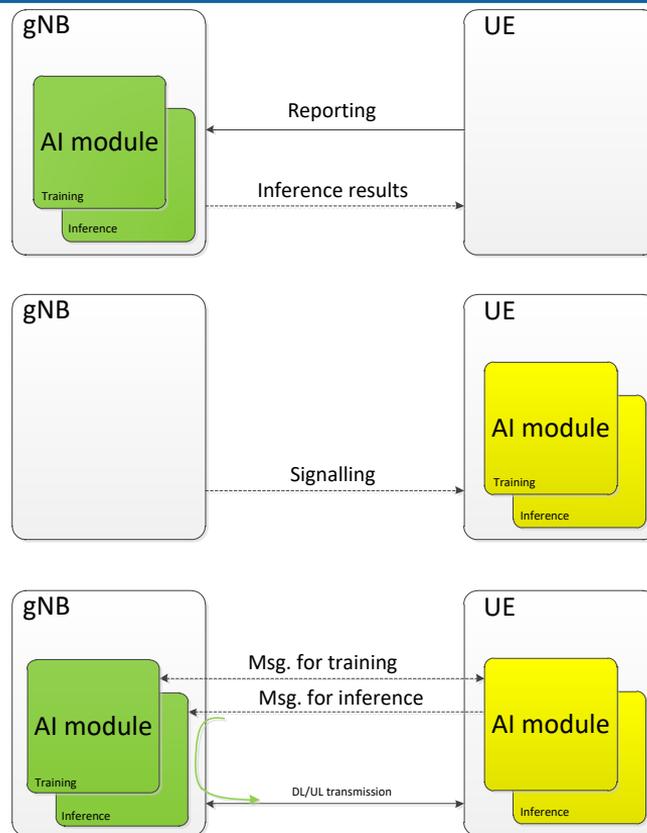
AI-empowered physical layer

- Parameters/configurations of one or more modules of a physical layer processing chain is optimized by an AI module.
- This is more like optimization algorithm we used in the past. The difference is that AI module is data-driven instead of model-driven.
- This might be feasible in short-term, e.g., Rel-18, Rel-19



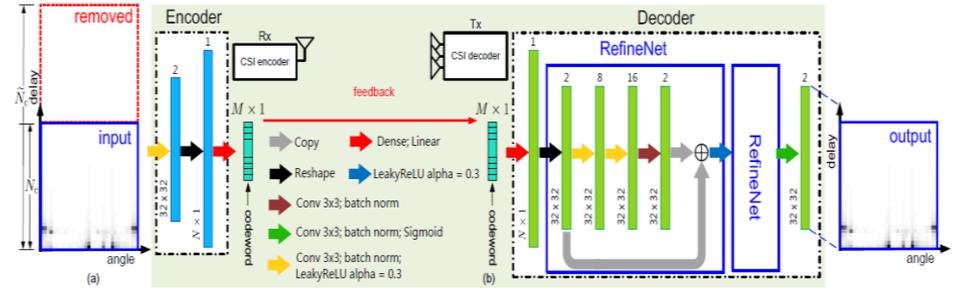
AI-empowered physical layer

- AI@Network
 - The AI module is stored at network
 - Training and inference happen at network
 - UE provides information reporting to help network train model or get inference result – **spec. impact**
- AI@UE
 - The AI module is stored at the UE
 - Inference happens only at UE
 - Network provides signalling for UE to train model or provides AI module – **spec. impact**
- AI@Network and UE
 - Both network and UE store parts of the AI module
 - The training and inference involve both of the network and UE – **spec. impact**
 - Higher complexity and extra burden on air interface is expected

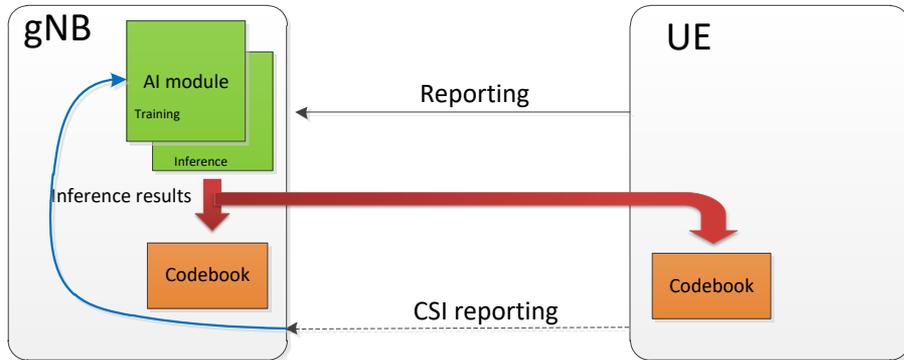


Potential usages of AI

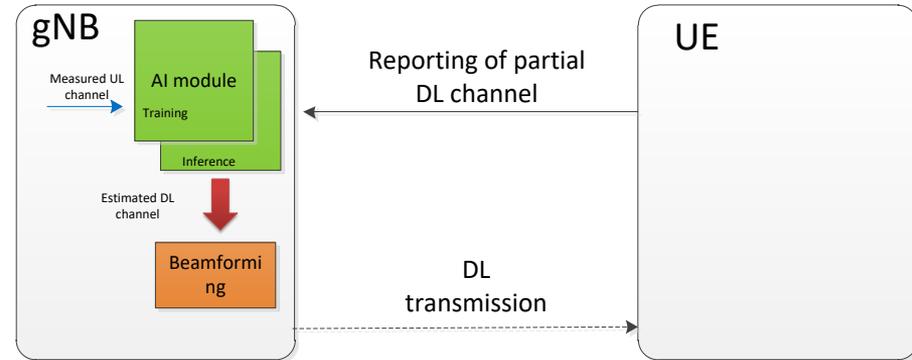
- AI for MIMO
 - AI for beam prediction/trajectory prediction (AI@Network)
 - AI for CSI compression/prediction (AI@Network, AI@UE and Network)



C. Wen, W. Shih and S. Jin, "Deep Learning for Massive MIMO CSI Feedback," in IEEE Wireless Communications Letters, vol. 7, no. 5, pp. 748-751, Oct. 2018, doi: 10.1109/LWC.2018.2818160.



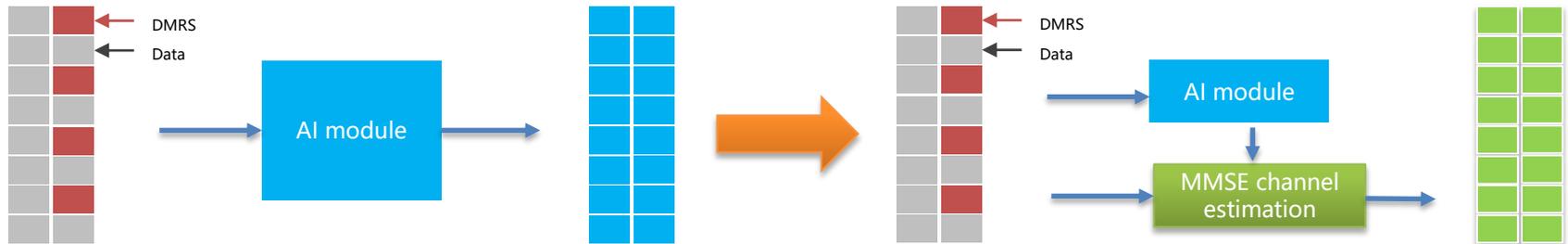
Codebook learning



DL channel prediction

Potential usages of AI

- AI for positioning (AI@Network)
 - UE provides measurements, e.g., received signal power, for LMF to calculate position using a well trained neural network
 - The network is scenario-specific
- AI for performance improvement – similar to performance improvement with advanced algorithm such as MMSE-IRC
 - Channel estimation (AI@UE) -> enhancement on reference signal design
 - Demodulation (AI@UE) -> enhancement on DMRS
 - Decoding (AI@UE)



Potential work on AI/ML for physical layer

- Study the feasibility of *AI-empowered* physical layer
 - Identify use cases of AI-empowered physical layer
 - Study the methodology for evaluation of AI/ML algorithms for physical layer
 - Methodology to construct data set for training and validation
 - Methodology for fair comparison between different AI/ML algorithms
 - The study should avoid the case that an AI module is distributed between network and UE due to its higher complexity and extra burden on air interface

טכנולוגיה

