RWS-210235

Views on AI Based Physical Layer Enhancements

CAICT

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Backgrounds for Wireless and AI Integration

Status

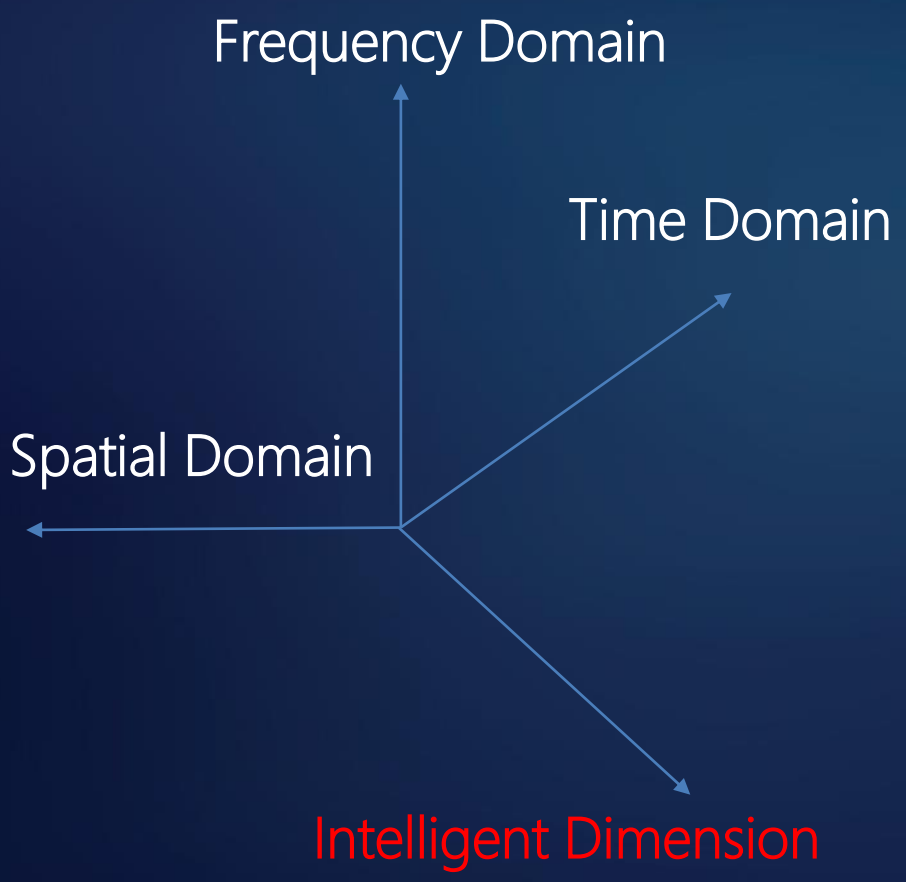
- Academic focus
- Hot topic for standardization organization
- Important direction for industry investments
- Potential Area for 6G

Chanllenges

- Consensus for Wireless and AI integration modes
- Typical dataset for AI based 5G technologies
- Simulation methodologies and verification methods

Systematic research and verification is important for wireless and AI integration

5G Intelligent Dimension



Definition

New resource dimension based on **5G big data**, **computing resources** and **AI technologies**

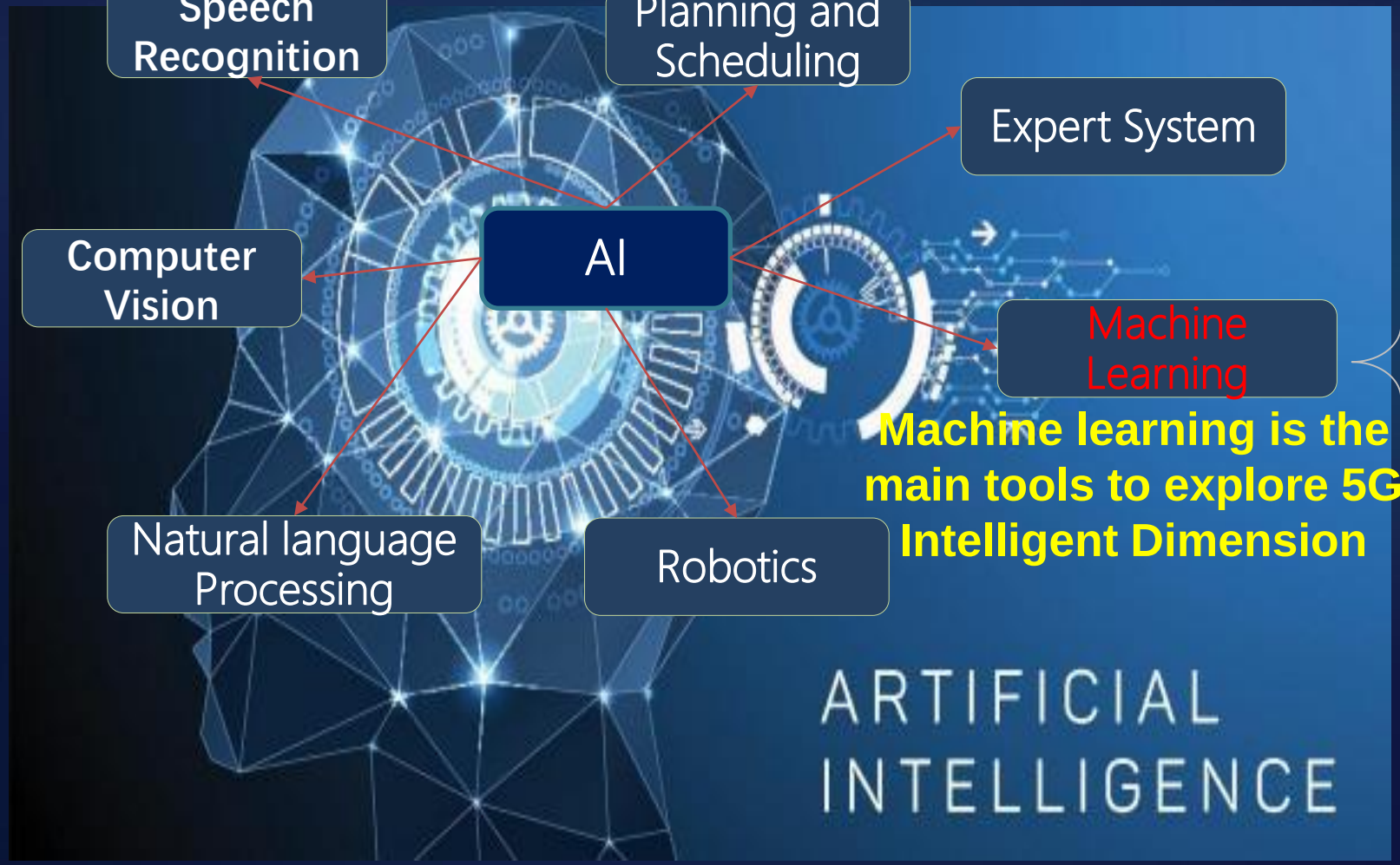
Key elements

5G Big Data: 5G original data + Data carried by 5G

Computing Resource: Terminal + Network +Cloud

AI Technologies: Machine Learning based AI algorithms

Basic theory for AI based 5G technologies



Machine learning is the main tools to explore 5G Intelligent Dimension

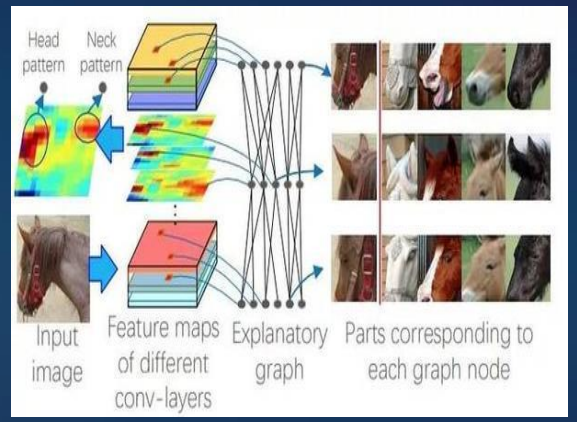
- Typical problem solved by ML
  - Classification
  - Regression
  - Clustering
  - Dimension reduction
- Typical ML algorithms
  - Supervised learning
  - Unsupervised learning
  - Deep learning
  - Reinforcement learning
  - Federal learning

Challenges from Basic theory for AI based 5G technologies

Data Dependent

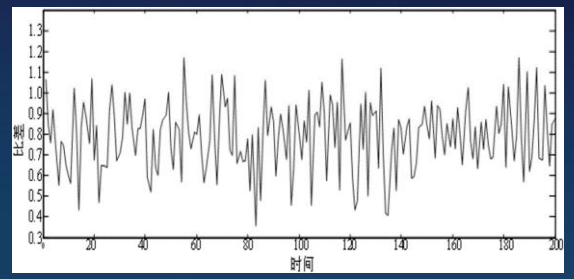
- Data acquisition is difficult
- Dataset integrity is hard to guarantee
- Data labeling is difficult

Interpretability

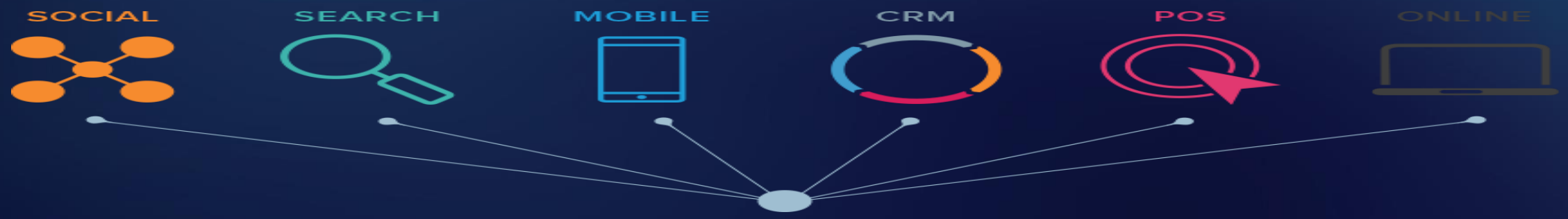


Output of each NN layer is hard to interpret

Uncertainty



The certainty of the AI model output is hard to guarantee



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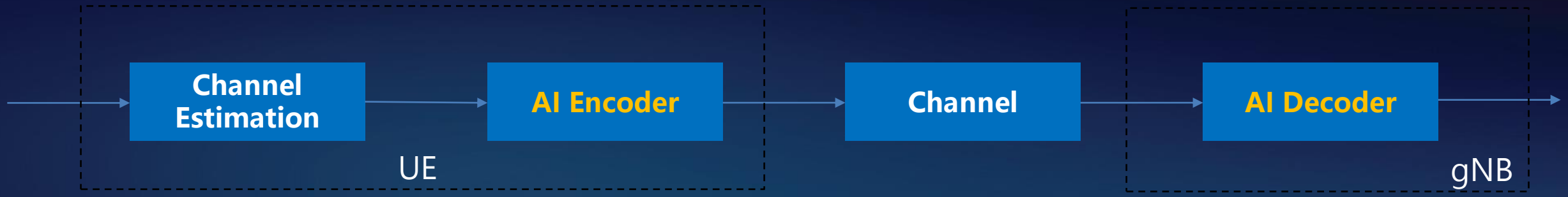
AI based CSI Feedback



Channel estimation

AI model based CSI compression

Compressed CSI bitstream is fed back to gNB

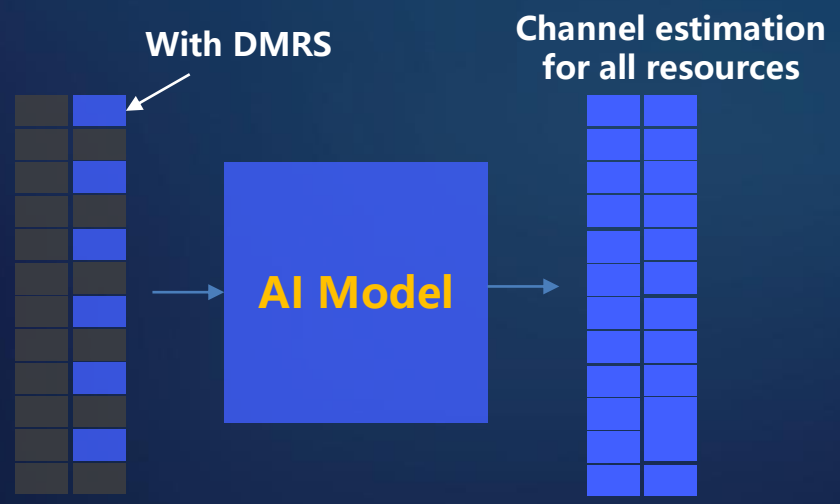
CSI bitstream decompression by AI model

- **Higher channel feedback accuracy with less feedback bits** could be achieved by using AI model to replace the existing 5G NR scheme
- Full channel CSI feedback is chosen as the contest subject for the 1st Wireless communication AI competition (WAIC) [1]

[1] RWS-210236 Introduction of the 1st Wireless communication AI competition(WAIC)

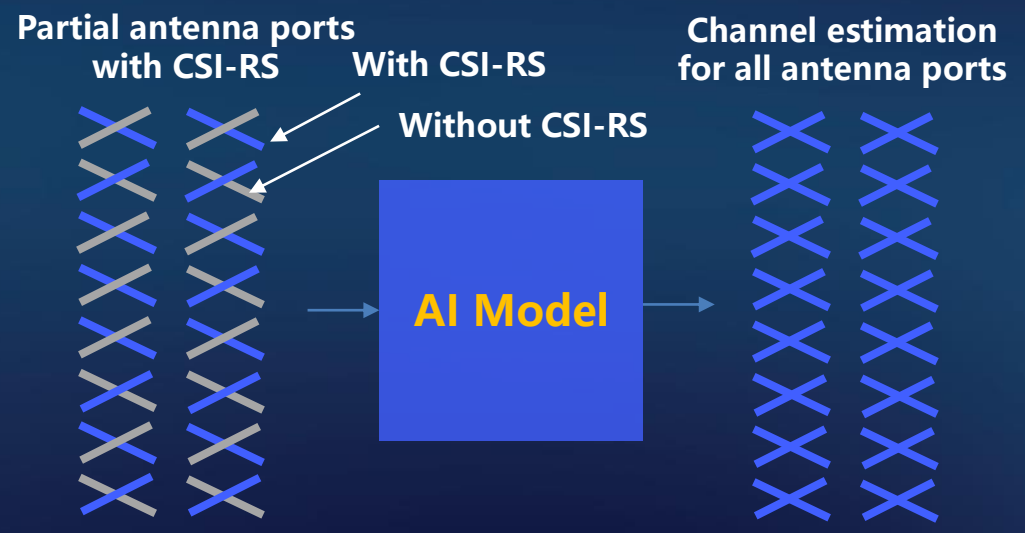
AI based Channel Estimation

AI based DMRS estimation



AI detection model could provide **higher channel estimation accuracy** than traditional algorithms

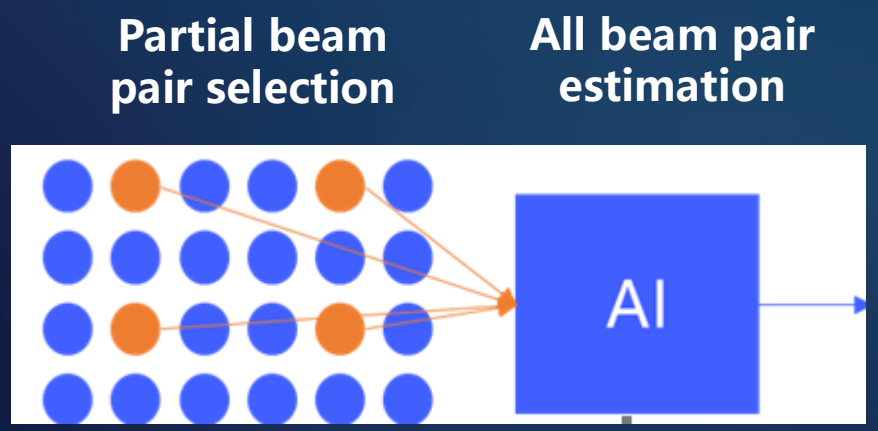
AI based CSI-RS estimation



AI detection model could provide **full ports channel estimation with partial ports CSI-RS distribution**

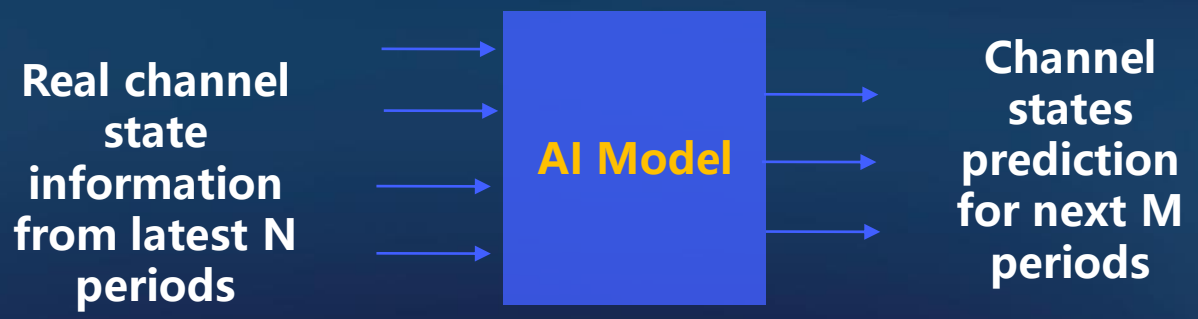
AI based Beam Management and Channel Prediction

Beam Management



Partial beam pair information could be used for full beam pair estimation. Measurement and beam paring time could be reduced .

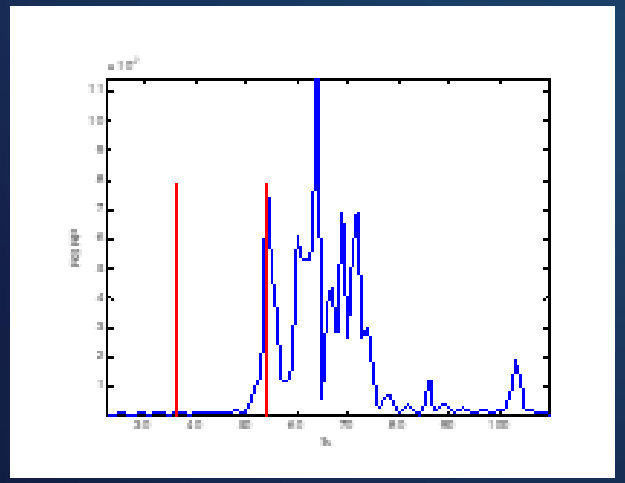
Channel Prediction



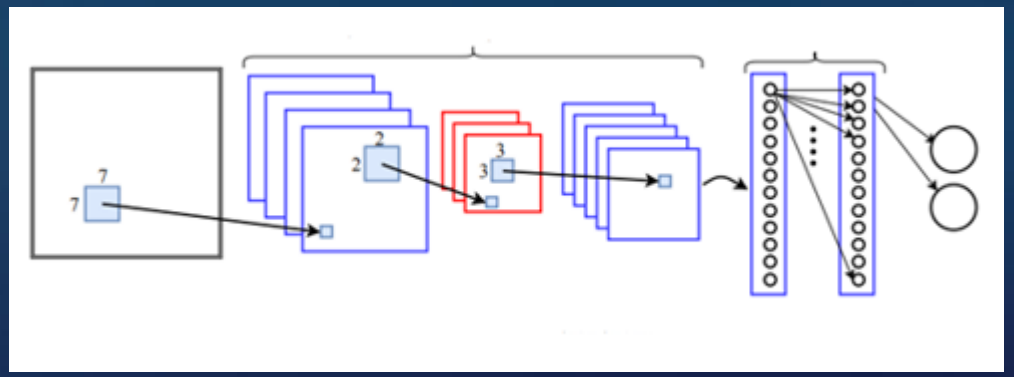
AI model could provide better channel prediction performance in complex high frequency and MIMO scenarios.

AI based Positioning

AI based positioning solutions could increase accuracy dramatically for typical NLOS scenarios



Channel impulse response as input



AI model could be used for location prediction

Terminal Position

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Key issues for AI based PHY layer enhancements

Use cases

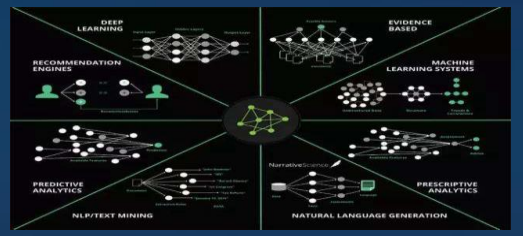
Use cases for AI based PHY layer enhancements

Dataset

Typical dataset setup and management

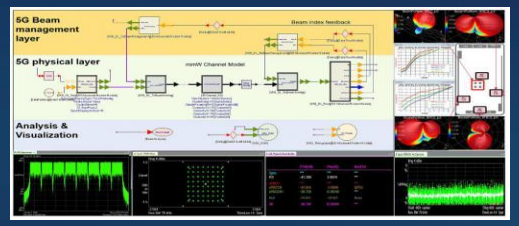
Algorithms

Use case related algorithms and models



Simulaiton

Simulation tools and methodologies



Verification

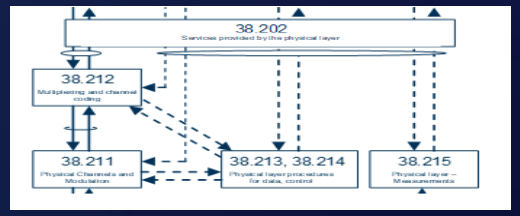
Test verification tools and methods

Milestone

Key features selection and timeline

Standards

Standardization system building



Industrialization

KPIs and systematic verification

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Proposed time plan for AI based PHY layer enhancements

Pre-Phase（2021）	Phase 1(6-9month)	Phase 2（9-12month）	Phase3（R19）
Initial Discussions	RAN Level Study	WGs level study and specification	WGs specification
• Initial consensus building • Whole pictures for AI based PHY layer enhancements • Scopes for RAN/RAN1 level study	• Collection of AI related information • Typical use cases and scenarios identification • Guidelines for WGs level study and specification works	RAN1/RAN2 level study follows the output of RAN level study • Dataset construction • Simulation methodology • Detail research and evaluation for different use cases	• RAN1/RAN2/RAN3 level specification works • RAN4 works if needed

Notes：RAN3 related specification works for high level could carry out on parallel with RAN/RAN1 works

Thanks