

3GPP TSG RAN Rel-18 workshop

June 28 – July 02, 2021

Agenda: 4.2 Non-eMBB-driven Functional Evolution

TDOC: RWS-210198

For: discussion

AI based enhancements for Physical Layer

Source: Rakuten Mobile



Motivation to Support Artificial Intelligence in RAN

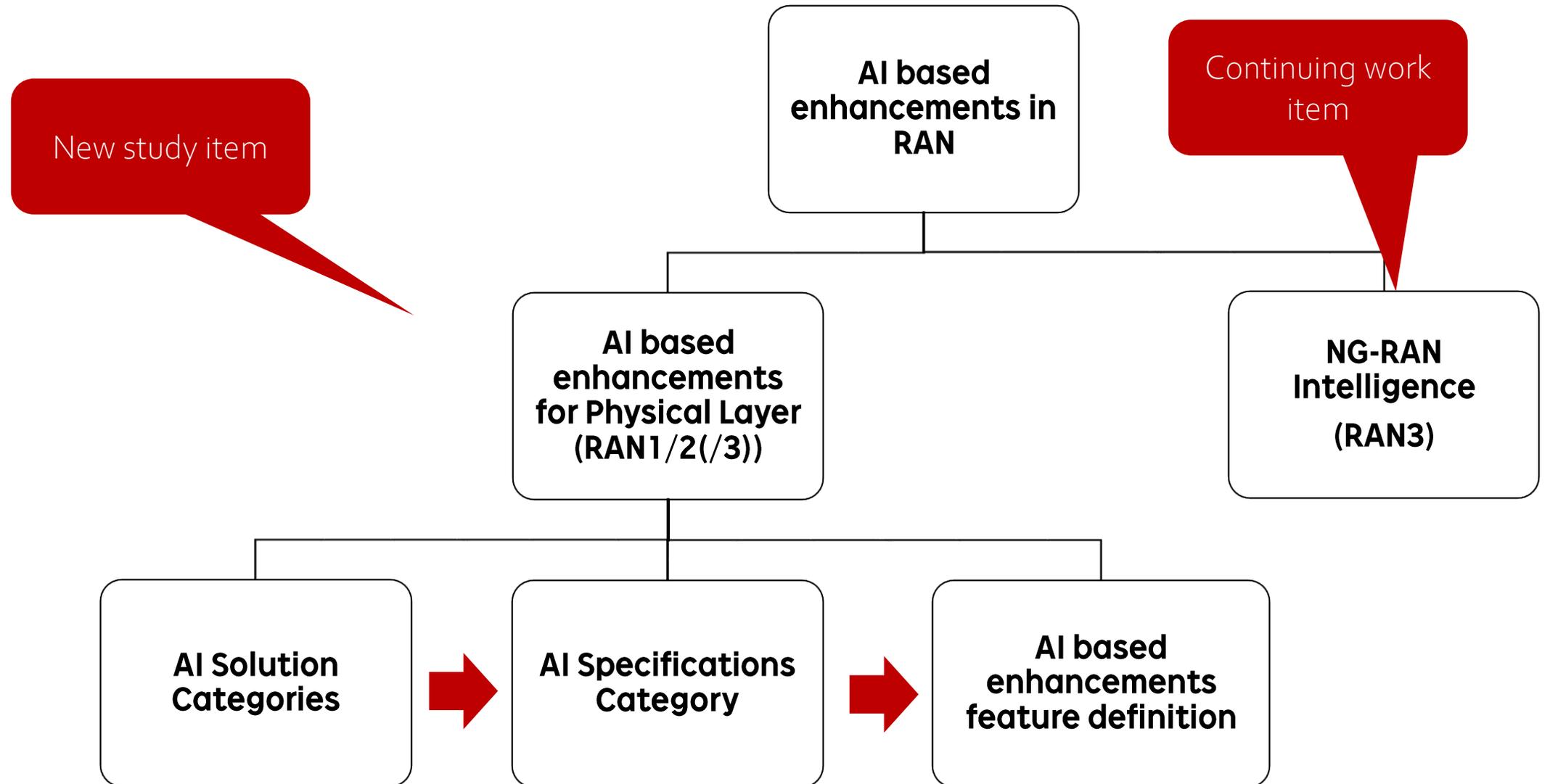
AI based enhancements for Physical Layer (5G NR air interface)

- AI (Artificial Intelligence) have transformed a number of industries, However, 3GPP have not started any discussion on utilizing AI for the improvement of Physical layer yet.
- A new study item is required in relevant RAN WGs (RAN1/2(/3)) over the entire duration of Rel-18 to evaluate possible benefits and feasibility of applying AI in 5G NR air interface as 5G-Advanced.

NG-RAN intelligence

- The high level principles and the specification impacts for RAN intelligence are being studied in RAN3 as part of Rel17.
- Based on the outcome of the RAN3 study, the AI-based load balancing, energy saving and mobility optimization need to be specified in Rel-18.
 - **NOTE:** The continuing work item in RAN3 should be separated from the new study item on AI for 5G NR air interface.

Application of AI in RAN



AI Solution Categories

Topics	Independent AI	Joint or Co-ordinated AI
Location of AI Model	<ul style="list-style-type: none"> ▪ UE or gNB 	<ul style="list-style-type: none"> ▪ UE and/or gNB
Training Strategy	<ul style="list-style-type: none"> ▪ Implementation/vendor dependent 	<ul style="list-style-type: none"> ▪ Runtime offline, Online ▪ Standardized or non-standardized
Benefits	<ul style="list-style-type: none"> ▪ Localized improvement of Physical Layer performance in Uplink and/or Downlink 	<ul style="list-style-type: none"> ▪ E2E System performance improvement for multiple entities
3GPP Standardization Scope	<ul style="list-style-type: none"> ▪ Details of models and training should be out of 3GPP scope. ▪ However, possibility of a new UE AI Feedback along with Indication of UE Capability should be studied. 	<ul style="list-style-type: none"> ▪ Signaling, to enable configuration of AI Model. ▪ Support for model Training. ▪ Support for new model acquisition. ▪ Support for AI Capability Exchange (UE and gNB) ▪ Support for various AI related data exchange. ▪ Possibly multiple new feedbacks and procedures. ▪ AI Model Performance specifications.

Potential AI Specifications Categories

Categories	Topics for consideration
Physical Layer AI Enhancements Scope	Scope of AI based enhancements for Physical layer in Release 18 Study item.
AI Model Training and Data Sets	Possible data set to be used for Model Training I. Investigate Potential Data sets for different scenarios . II. Data generation, usage and collection methods. III. Global data sets or scenarios based custom data sets. IV. Data Granularity and size requirements
Device Capability	Define UE AI Capability , define new Categories Possibly include gNB categories based on AI Model Complexity
Interoperability	Scope of Standardization of universal Models. The level of interoperability of AI Model and training
AI Model's Performance Evaluation Methods	How to evaluate the AI models The need of AI related conformance specs

Potential feature: AI based enhancements for Physical Layer

Topics	Potential mechanism
MIMO CSI feedback	<ul style="list-style-type: none">▪ CSI feedback compression▪ CSI prediction
RS overhead reduction	<ul style="list-style-type: none">▪ Learning Model based on UE capability to reduce RS Symbols
Mobility Management	<ul style="list-style-type: none">▪ Predictive HO, Reselection Management
Beam Management	<ul style="list-style-type: none">▪ Predictive Beam Managements▪ Optimized Beam management▪ Improve Beam failure and recovery
Positioning Enhancements	<ul style="list-style-type: none">▪ NLOS Accuracy Enhancements▪ Robustness in presence of synchronization errors
Receiver Enhancements	<ul style="list-style-type: none">▪ Improved Symbol Detection▪ Channel estimation
MIMO Beamforming	<ul style="list-style-type: none">▪ Beamforming performance improvements including MU-MIMO

Proposals

1. A new study item is required in RAN1/RAN2 (potentially RAN3) over the entire duration of Rel-18 to evaluate possible benefits and feasibility of applying AI to Physical Layer (5G NR air interface).
2. During the study, categorize Physical Layer AI into “Independent AI” and “Joint/Co-ordinated AI”
 - 3GPP to mostly focus on Joint/Co-ordinated AI as it needs UE and gNB co-ordination.
 - 3GPP to standardize aspects like AI capability Exchange, Model acquisition, Configuration method.
3. We propose to have at least following objectives in this study item.
 - Study the AI Solution Category such as “Independent AI” and “Joint/Co-ordinated AI”
 - Study the model training & data sets, device capability, interoperability, AI Models performance evaluation method
 - Study potential solutions which includes at least MIMO CSI Feedback, RS Overhead reduction, Mobility Management, Beam Management, Positioning enhancements, Receiver enhancements & MIMO beamforming.

References

- [1] RP-210256 Motivation of study on radio enhancement based on AI OPPO
- [2] RP-210293 Initial Views on Release 18 NR Samsung
- [3] RP-210321 Study on AI based PHY layer enhancement in Rel-18vivo
- [4] RP-210393 New SID on evaluation methodology for AI enabled RAN CMCC
- [5] RP-210614 Support of Artificial Intelligence Applications for 5G Advanced ZTE, Sanechips
- [6] RP-210672 On the Scope of Rel-18 PHY Layer Enhancements using AI-based Solutions InterDigital, Inc.

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