**3GPP TSG-SA Meeting #105 *DRAFT rev* SP-241326**

**Melbourne, Australia, Sept 10 – 13, 2024**

**Source: Nokia**

**Title: Rel-19 pCR TR 22.850 AIML terminology analysis across 3GPP**

**Document for: Approval**

**Agenda Item: 7**

# 1 Decision/action requested

***The group is asked to discuss and agree on the proposal.***

# 2 References

None.

# 3 Rationale

This pCR aims to capture AI/ML-related terminology from Release 18 and Release 19 AI/ML activities across 3GPP. It seeks to identify inconsistencies and misalignments among them and proposes solutions to resolve these issues.

# 4 Detailed proposal

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| **Start of modification** |

# 6 Analysis on AI/ML across 3GPP

## 6.1 General

This clause will identify any potential misalignments and inconsistencies for AI/ML across 3GPP, based on Clause 5.

NOTE 1: Any RAN related aspects are subject to early coordination and feedback from TSG RAN.

## 6.2 AI/ML related terminology

### 6.2.a Analysis on ML model

The term ‘ML model’ has been defined differently by SA5, SA6 and RAN1, as illustrated in Table A.

Editor’s note: Whether a unified definition can be derived is FFS.

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| **TSG (TS/TR)** | **ML model** |
| 3GPP SA5 TS 28.105 [c] | A manageable representation of an ML model algorithm.  NOTE 1: an ML model algorithm is a mathematical algorithm through which running a set of input data can generate a set of inference output.  NOTE 2: ML model algorithm is proprietary and not in scope for standardization and therefore not treated in this specification.  NOTE 3: ML model may include metadata. Metadata may include e.g. information related to the trained model, and applicable runtime context. |
| 3GPP SA6 TR 23.700-82 [d] | According to 3GPP TS 28.105 [c], mathematical algorithm that can be "trained" by data and human expert input as examples to replicate a decision an expert would make when provided that same information. |
| 3GPP RAN1 TR 38.843 [e] | A data driven algorithm that applies AI/ML techniques to generate a set of outputs based on a set of inputs. |

**Table A**: Definition of ML model as defined across 3GPP WGs.

### 6.2.b Analysis on ML model training

The term ‘ML model training’ has been defined differently by SA5, SA6 and RAN1, as illustrated in Table B. RAN3 follows the definition of SA5.

Editor’s note: Whether a unified definition can be derived is FFS.

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| **TSG (TS/TR)** | **ML model training** |
| 3GPP SA5 TS 28.105 [c] | A process performed by an ML training function to take training data, run it through an ML model algorithm, derive the associated loss and adjust the parameterization of that ML model iteratively based on the computed loss and generate the trained ML model. |
| 3GPP SA6 TR 23.700-82 [d] | According to 3GPP TS 28.105 [c], ML model training includes capabilities of an ML training function or service to take data, run it through an ML model, derive the associated loss and adjust the parameterization of that ML model based on the computed loss. |
| 3GPP RAN1 TR 38.843 [e] | A process to train an AI/ML Model [by learning the input/output relationship] in a data driven manner and obtain the trained AI/ML Model for inference. |
| 3GPP RAN3 TS 38.300 [f] | AI/ML Model Trainingfollows the definition of the "ML model training" as specified in clause 3.1 of TS 28.105 [c]. |

**Table B**: Definition of ML model training as defined across 3GPP WGs.

### 6.2.c Analysis on ML model re-training

The term ‘ML model re-training’ has been defined differently by SA5 and RAN1, as illustrated in Table C. RAN1 introduces two new terms, i.e., ML model parameter update and ML model update, which is nothing but ML model re-training.

Editor’s note: Whether a unified definition can be derived is FFS.

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| **TSG (TS/TR)** | **ML model re-training / ML model parameter update / ML model update** |
| 3GPP SA5 TS 28.105 [c] | *ML model re-training:* A process of training a previous version of an ML model and generate a new version. |
| 3GPP RAN1 TR 38.843 [e] | *ML model parameter update:* A process of updating the model parameters of a model.  *Model update:* A process of updating the model parameters and/or model structure of a model |

**Table C**: Definition of ML model re-training / ML model parameter update as defined across 3GPP WGs.

### 6.2.d Analysis on ML model testing

The term ‘ML model testing’ has been defined differently by SA5 and RAN1, as illustrated in Table D.

Editor’s note: Whether a unified definition can be derived is FFS.

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| **TSG (TS/TR)** | **ML model testing** |
| 3GPP SA5 TS 28.105 [c] | A process of testing an ML model using testing data. |
| 3GPP RAN1 TR 38.843 [e] | A subprocess of training, to evaluate the performance of a final AI/ML model using a dataset different from one used for model training and validation. Differently from AI/ML model validation, testing does not assume subsequent tuning of the model. |

**Table D**: Definition of ML model testing as defined across 3GPP WGs.

### 6.2.e Analysis on ML model inference

The term ‘ML model inference’ has been defined differently by SA5, SA6 and RAN1, as illustrated in Table E. RAN3 follows the definition of SA5.

Editor’s note: Whether a unified definition can be derived is FFS.

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| **TSG (TS/TR)** | **ML model inference** |
| 3GPP SA5 TS 28.105 [c] | A process of running a set of input data through a trained ML model to produce set of output data, such as predictions. |
| 3GPP SA6 TR 23.700-82 [d] | According to 3GPP TS 28.105 [c], ML model training includes capabilities of an ML model inference function that employs an ML model and/or AI decision entity to conduct inference. |
| 3GPP RAN1 TR 38.843 [e] | A process of using a trained AI/ML model to produce a set of outputs based on a set of inputs. |
| 3GPP RAN3 TS 38.300 [f] | AI/ML Model Inference follows the definition of the "AI/ML inference" as defined in clause 3.1 of TS 28.105 [c]. |

**Table E**: Definition of ML model inference as defined across 3GPP WGs.

### 6.2.f Analysis on ML model activation & ML model de-activation

The term ‘ML model activation’ and ‘ML model deactivation’ have been defined by RAN1, as illustrated in Table F. SA5 mentions the terms ML activation and ML deactivation several times in 3GPP TS 28.105 [c] but does not provide a definition.

Editor’s note: Whether a unified definition can be derived is FFS.

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| **TSG (TS/TR)** | **ML model inference** |
| 3GPP RAN1 TR 38.843 [e] | *ML Model activation:* enable an AI/ML model for a specific AI/ML-enabled feature.  *ML Model deactivation:* disable an AI/ML model for a specific AI/ML-enabled feature. |

**Table F**: Definition of ML model inference as defined across 3GPP WGs.

### 6.2.g Analysis on ML model lifecycle

The term ‘ML model lifecycle’ has been defined by SA6, as illustrated in Table G. However, 3GPP SA2 TS 23.288 [a] 3GPP SA2 TR 23.700-84 [b], 3GPP SA4 TR 26.927 [g], 3GPP SA5 TS 28.105 [c], 3GPP SA6 TR 23.700-82 [d], 3GPP RAN1 TR 38.843 [e] and RAN3 also mentions one or more phases of ML model life cycle without providing a clear definition of ML model lifecycle.

Editor’s note: Whether a unified definition can be derived is FFS.

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| **TSG (TS/TR)** | **ML model lifecycle** |
| 3GPP SA6 TR 23.700-82 [d] | The lifecycle of an ML model includes data collection, data processing, model training, model verification, model, instantiation and deployment, model monitoring and termination of ML model components. |

**Table G**: Definition of ML model lifecycle as defined across 3GPP WGs.

### 6.2.h Analysis on ML model lifecycle management / Functionality-based lifecycle management

The terms ‘ML model-based lifecycle management’, ‘ML-enabled functionality’, and ‘Functionality-based lifecycle management’ have been defined by RAN1, as illustrated in Table H. SA5 describes the lifecycle management capabilities for ML model training, ML model testing, ML inference emulation, ML model deployment and ML inference in clause 6 of 3GPP TS 28.105 [c]. In clause 8.12 of 3GPP TR 23.700-82 [d], SA6 describes solutions to support AI/ML model lifecycle management for ML model re-training and update when model performance degradation is observed by AI/ML Enablement.

Editor’s note: Whether a unified definition can be derived is FFS.

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| **TSG (TS/TR)** | **ML model lifecycle management / Functionality-based lifecycle management** |
| 3GPP RAN1 TR 38.843 [e] | **ML model-based lifecycle management:** Operates based on identified logical models, where a model may be associated with specific configurations/conditions associated with UE capability of an AI/ML-enabled Feature / Feature Group and additional conditions (e.g., scenarios, sites, and datasets) as determined/identified between UE-side and NW-side. The models are identified at the Network, and Network/UE may activate/deactivate/select/switch individual AI/ML models via model ID.  **(ML-enabled) Functionality:** An AI/ML-enabled Feature/Feature Group enabled by configuration(s), where configuration(s) is(are) supported based on conditions indicated by UE capability.  **Functionality-based lifecycle management:** Signaling procedure where network indicates activation/deactivation/fallback/switching of AI/ML functionality via 3GPP signalling (e.g., RRC, MAC-CE, DCI); operates based on, at least, one configuration of AI/ML-enabled Feature/FG or specific configurations of an AI/ML-enabled Feature / Feature Group. |

**Table H**: Definitions of ML model-based lifecycle management, ML-enabled functionality and Functionality-based lifecycle management as defined across 3GPP WGs.

### 6.2.i Analysis on Horizontal Federated Learning

The term ‘Horizontal Federated Learning’ has been defined in SA2 and RAN1 defines ‘Federated Learning’, as illustrated in Table I.

Editor’s note: Whether a unified definition can be derived is FFS.

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| **TSG (TS/TR)** | **ML model inference** |
| 3GPP SA2 TR 23.700-84 [b] | *Horizontal Federated Learning*: A federated learning technique without exchanging/sharing local data set, wherein the local data set in different FL clients for local model training have the same feature space for different samples (e.g. UE IDs). |
| 3GPP RAN1 TR 38.843 [e] | *Federated Learning*: A machine learning technique that trains an AI/ML model across multiple decentralized edge nodes (e.g., UEs, gNBs) each performing local model training using local data samples. The technique requires multiple interactions of the model, but no exchange of local data samples. |

**Table I**: Definition of Horizontal Federated Learning as defined across 3GPP WGs.

### 6.2.j Analysis on Vertical Federated Learning

The term ‘Vertical Federated Learning’ has been defined in SA2 and RAN1 defines ‘Federated Learning’, as illustrated in Table J.

Editor’s note: Whether a unified definition can be derived is FFS.

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| **TSG (TS/TR)** | **ML model inference** |
| 3GPP SA2 TR 23.700-84 [b] | *Vertical Federated Learning*: A federated learning technique without exchanging/sharing local data set, wherein the local data set in different VFL Participant for local model training have different feature spaces for the same samples (e.g. UE IDs). |
| 3GPP RAN1 TR 38.843 [e] | *Federated Learning*: A machine learning technique that trains an AI/ML model across multiple decentralized edge nodes (e.g., UEs, gNBs) each performing local model training using local data samples. The technique requires multiple interactions of the model, but no exchange of local data samples. |

**Table J**: Definition of Vertical Federated Learning as defined across 3GPP WGs.

### 6.2.k Analysis on Decision vs Prediction vs Output

RAN1 and RAN3 only uses “prediction” in all corresponding ML related TRs/TSs. SA2 uses “output” in all corresponding TRs/TSs where output may include both statistics and predictions. SA5 uses “decision” in all corresponding TRs/TSs with few occurrences of “prediction”.

Editor’s note: Whether a unified definition can be derived is FFS.

### 6.2.l Analysis on ML vs AI vs AI/ML

RAN1, RAN2, RAN3 and SA1 only uses “AI/ML” in all corresponding ML related TRs/TSs. SA2 uses “ML” in all corresponding ML related TRs/TSs. SA3, SA4 and SA6 uses a mix of “AI/ML”, “AI” and “ML” in all corresponding ML related TRs/TSs. SA5 uses “ML” for training/testing/emulation and “AI/ML” for inference in all corresponding ML related TRs/TSs.

Editor’s note: Whether a unified definition can be derived is FFS.

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| **End of modifications** |