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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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    where:

        x the first digit:

            1 presented to TSG for information;

            2 presented to TSG for approval;

            3 or greater indicates TSG approved document under change control.

        y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

        z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

    shall   indicates a mandatory requirement to do something

    shall not   indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

    should   indicates a recommendation to do something

    should not   indicates a recommendation not to do something

    may   indicates permission to do something

    need not   indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

    can   indicates that something is possible

    cannot   indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

    will   indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

    will not   indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

    might   indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

1 Scope

The present document specifies the Artificial Intelligence / Machine Learning (AI/ML) management capabilities and services for 5GS where AI/ML is used, including management and orchestration (e.g. MDA, see 3GPP TS 28.104 [2]) and 5G networks (e.g. NWDAF, see 3GPP TS 23.288 [3]).

The present document also describes the functionality and service framework for AI/ML management.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1]   3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2]   3GPP TS 28.104: "Management and orchestration; Management Data Analytics".

[3]   3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".

[4]   3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

[5]   3GPP TS 32.425: "Telecommunication management; Performance Management (PM); Performance measurements Evolved Universal Terrestrial Radio Access Network (E-UTRAN)".

[6]   3GPP TS 28.554: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)".

[7]   3GPP TS 32.422: "Telecommunication management; Subscriber and equipment trace; Trace control and configuration management".

[8]   Void

[9]   3GPP TS 28.405: "Telecommunication management; Quality of Experience (QoE) measurement collection; Control and configuration".

[10]   Void [11] 3GPP TS 28.532: "Management and orchestration; Generic management services".

[12]   3GPP TS 28.622: "Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS)".

[13]   3GPP TS 32.156: "Telecommunication management; Fixed Mobile Convergence (FMC) Model repertoire".

[14]   3GPP TS 32.160: "Management and orchestration; Management service template".

[15]   3GPP TS 28.533: "Management and orchestration; Architecture framework".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

ML entity: an entity that is either an ML model or contains an ML model and ML model related metadata, it can be managed as a single composite entity.

NOTE 1: Metadata may include e.g. the applicable runtime context for the ML model.

ML model: 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.

NOTE 2: The ML models are proprietary and not in scope for standardization.

ML model training: capabilities of an ML training function 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.

ML training: capabilities and associated end-to-end processes to enable an ML training function to perform ML model training (as defined above).

NOTE 3: ML training capabilities may include interaction with other parties to collect and format the data required for ML model training.

ML training function: a function with ML training capabilities.

AI/ML inference function: a function that employs an ML model to conduct inference.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and TS 28.533 [15]. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1] and TS 28.533 [15].

AI   Artificial Intelligence
ML   Machine Learning

4 Concepts and overview

4.1 Overview

The AI/ML techniques and relevant applications are being increasingly adopted by the wider industries and proved to be successful. These are now being applied to telecommunication industry including mobile networks.

Although AI/ML techniques in general are quite mature nowadays, some of the relevant aspects of the technology are still evolving while new complementary techniques are frequently emerging.

The AI/ML techniques can be generally characterized from different perspectives including the followings:

- **Learning methods**

The learning methods include supervised learning, semi-supervised learning, unsupervised learning and reinforcement learning. Each learning method fits one or more specific category of inference (e.g. prediction), and requires specific type of training data. A brief comparison of these learning methods is provided in table 4.1-1.

Table 4.1-1: Comparison of Learning methods

	Supervised learning	Semi-supervised learning	Unsupervised learning	Reinforcement learning
Category of inference	Regression (numeric), classification	Regression (numeric), classification	Association, Clustering	Reward-based behaviour
Type of training data	Labelled data (Note)	Labelled data (Note), and unlabelled data	Unlabelled data	Not pre-defined
NOTE: The labelled data refers to a set of training or testing data that have been assigned with one or more labels in order to add context and meaning.				

- **Learning complexity:**

    - As per the learning complexity, there are Machine Learning (i.e. basic learning) and Deep Learning.

- **Learning architecture**

    - Based on the topology and location where the learning tasks take place, the AI/ML can be categorized to centralized learning, distributed learning and federated learning.

- **Learning continuity**

    - From learning continuity perspective, the AI/ML can be offline learning or continual learning.

Artificial Intelligence/Machine Learning (AI/ML) capabilities are used in various domains in 5GS, including management and orchestration (e.g. MDA, see 3GPP TS 28.104 [2]) and 5G networks (e.g. NWDAF, see 3GPP TS 23.288 [3]).

The AI/ML-inference function in the 5GS uses the ML model for inference.

Each AI/ML technique, depending on the adopted specific characteristics as mentioned above, may be suitable for supporting certain type/category of use case(s) in 5GS.

To enable and facilitate the AI/ML capabilities with the suitable AI/ML techniques in 5GS, the ML model and AI/ML inference function need to be managed.

The present document specifies the AI/ML management related capabilities and services, which include the followings:

- ML training.

4A AI/ML management functionality and service framework

4A.1 Functionality and service framework for ML training

An ML training Function playing the role of ML training MnS producer, may consume various data for ML training purpose.

As illustrated in Figure 4A.1-1 the ML training capability is provided via ML training MnS in the context of SBMA to the authorized consumer(s) by ML training MnS producer.
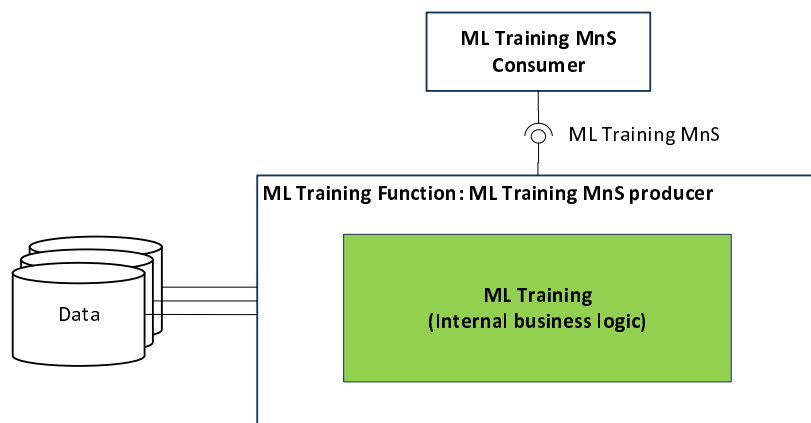
Figure 4A.1-1: Functional overview and service framework for ML training

The internal business logic of ML training leverages the current and historical relevant data, including those listed below to monitor the networks and/or services where relevant to the ML model, prepare the data, trigger and conduct the training:

- Performance Measurements (PM) as per 3GPP TS 28.552 [4], 3GPP TS 32.425 [5] and Key Performance Indicators (KPIs) as per 3GPP TS 28.554 [6].

- Trace/MDT/RLF/RCEF data, as per 3GPP TS 32.422 [7].

- QoE and service experience data as per 3GPP TS 28.405 [9].

- Analytics data offered by NWDAF as per 3GPP TS 23.288 [3].

- Alarm information and notifications as per 3GPP TS 28.532 [11].

- CM information and notifications.

- MDA reports from MDA MnS producers as per 3GPP TS 28.104 [2].

- Management data from non-3GPP systems.

- Other data that can be used for training.

5 Void

6 AI/ML management use cases and requirements

6.1 General

The use cases and requirements for AI/ML management are specified in the following clauses.

6.2 ML training

6.2.1 Description

In operational environment before the ML entity is deployed to conduct inference, the ML model associated with the ML entity needs to be trained (e.g. by ML training function which may be a separate or an external entity to the AI/ML inference function).

NOTE: In the present document, ML entity training refers to ML model training associated with an ML entity.