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Foreword

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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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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.

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should indicates a recommendation to do something

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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]) and NG-RAN (see TS 38.300 [16] and TS 38.401 [17]).

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".

[16] 3GPP TS 38.300: "NR; NR and NG-RAN Overall description; Stage-2".

[17] 3GPP TS 38.401: "NG-RAN; Architecture description".

[18] 3GPP TS 28.541: " Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".

[19] 3GPP TS 28.623: "Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Solution Set (SS) definitions".

[20] 3GPP TS 29.520: "5G System; Network Data Analytics Services; Stage 3".

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 model: 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.

ML model training: 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.

ML model initial training: a process of training an initial version of an ML model.

ML model re-training: a process of training a previously trained version of an ML model and generate a new version.

NOTE 4: a new version of a trained ML model supports the same type of inference as the previous version of the ML model, i.e., the data type of inference input and data type of inference output remain unchanged between the two versions of the ML model, but parameter values might be different for the re-trained model.

ML model joint training: a process of training a group of ML models.

ML training function: a logical function with ML model training capabilities.

ML model testing: a process of evaluating the performance of an ML model using testing data different from data used for model training and validation.

ML model joint testing: a process of evaluating the performance of a group of ML models using testing data different from data used for model training and validation.

ML testing function: a logical function with ML model testing capabilities.

AI/ML inference: a process of running a set of input data through a trained ML model to produce set of output data, such as predictions.

NOTE 5: the inference represents the process to realize the AI capabilities by utilizing a trained ML model and other AI enablers if needed, hence the AI/ML prefix is used when referring to inference as compared to training and testing.

AI/ML inference function: a logical function that employs trained ML model(s) to conduct inference.

AI/ML inference emulation: running the inference process to evaluate the performance of an ML model in an emulation environment before deploying it into the target environment.

ML model deployment: a process of making a trained ML model available for use in the target environment.

ML model loading: a process of making a trained ML model available to an inference function.

AI/ML activation: a process of enabling the inference capability of an AI/ML inference function.

AI/ML deactivation: a process of disabling the inference capability of an AI/ML inference function.

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 and 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 generic AI/ML management related capabilities and services without specifically taking any of the above-mentioned learning methods into consideration. The AI/ML management capabilities which include the followings:

- ML model training.
- ML model testing.
- AI/ML inference emulation.
- ML model deployment.
- AI/ML inference.

4a AI/ML management functionality and service framework

4a.0 ML model lifecycle

AI/ML techniques are widely used in 5GS (including 5GC, NG-RAN, and management system), the generic AI/ML operational workflow shown in Figure 4a.0-1, highlights the main steps of an ML model lifecycle.

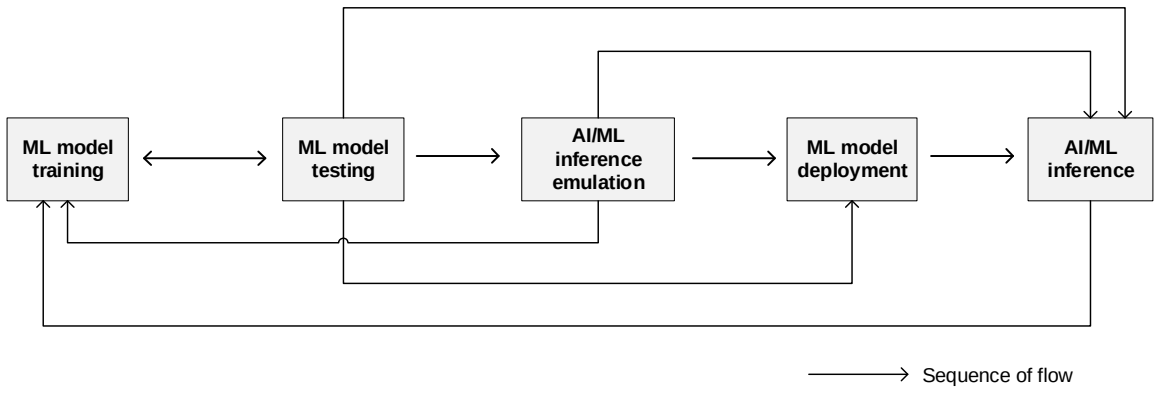


Figure 4a.0-1: ML model lifecycle

The ML model lifecycle includes training, testing, emulation, deployment, and inference. These steps are briefly described below:

- **ML model training:** training, including initial training and re-training, of an ML model or a group of ML models. It also includes validation of the ML model to evaluate the performance when the ML model performs on the training

data and validation data. If the validation result does not meet the expectation (e.g., the variance is not acceptable), the ML model needs to be re-trained.

- **ML model testing:** testing of a validated ML model to evaluate the performance of the trained ML model when it performs on testing data. If the testing result meets the expectations, the ML model may proceed to the next step If the testing result does not meet the expectations, the ML model needs to be re-trained.

- **AI/ML inference emulation:** running an ML model for inference in an emulation environment. The purpose is to evaluate the inference performance of the ML model in the emulation environment prior to applying it to the target network or system. If the emulation result does not meet the expectation (e.g., inference performance does not meet the target, or the ML model negatively impacts the performance of other existing functionalities) the ML model needs to be re-trained.

  NOTE: The AI/ML inference emulation is considered optional and can be skipped in the ML model lifecycle.

- **ML model deployment:** ML model deployment includes the ML model loading process (a.k.a. a sequence of atomic actions) to make a trained ML model available for use at the target AI/ML inference function.

  ML model deployment may not be needed in some cases, for example when the training function and inference function are co-located.

- **AI/ML inference:** performing inference using a trained ML model by the AI/ML inference function. The AI/ML inference may also trigger model re-training or update based on e.g., performance monitoring and evaluation.

  NOTE: depending on system implementation and AI/ML functionality arrangments, both AI/ML inference emulation and ML deployment steps may be skiped.

4a.1 Functionality and service framework for ML model training

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

As illustrated in Figure 4a.1-1 the ML model training capability is provided via ML training MnS in the context of SBMA to the authorized consumer(s) by ML training MnS producer.

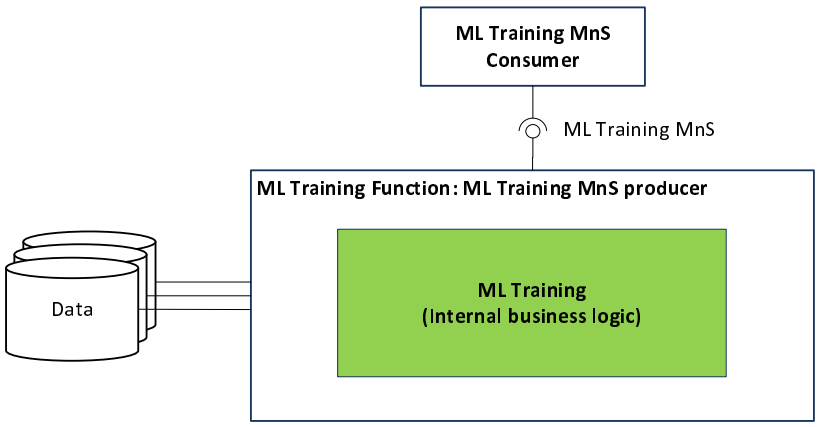


Figure 4a.1-1: Functional overview and service framework for ML model training

The internal business logic of ML model 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.

4a.2 AI/ML functionalities management scenarios (relation with managed AI/ML features)

The ML training function and/or AI/ML inference function can be located in the RAN domain MnS consumer (e.g. cross-domain management system) or the domain-specific management system (i.e. a management function for RAN or CN), or Network Function.

For MDA, the ML training function can be located inside or outside the MDAF. The AI/ML inference function is in the MDAF.

For NWDAF, the ML training function can be located in the MTLF of the NWDAF or the management system, the AI/ML inference function is in the AnLF.

For RAN, the ML training function and AI/ML inference function can both be located in the gNB, or the ML training function can be located in the management system and AI/ML inference function is located in the gNB.

Therefore, there might exist several location scenarios for ML training function and AI/ML inference function.

Scenario 1:

The ML training function and AI/ML inference function are both located in the 3GPP management system (e.g. RAN domain management function). For instance, for RAN domain-specific MDA, the ML training function and AI/ML inference functions for MDA can be located in the RAN domain-specific MDAF. As depicted in figure 4a.2-1.

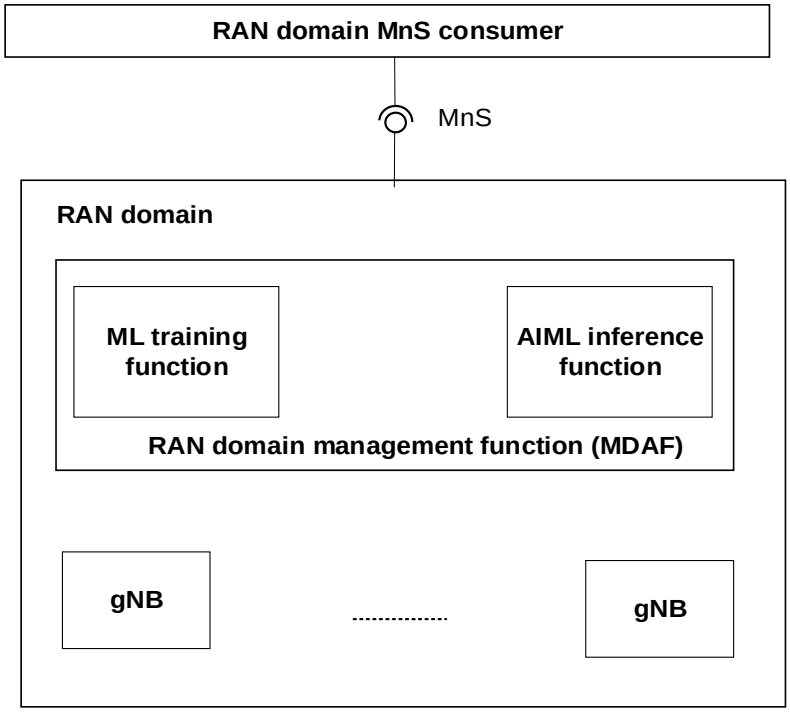


Figure 4a.2-1: Management for RAN domain specific MDAF

Similarly, for CN domain-specific MDA the ML training function and AI/ML inference function can be located in CN domain-specific MDAF.

Scenario 2:

For RAN AI/ML capabilities the ML training function is located in the 3GPP RAN domain-specific management function while the AI/ML inference function is located in gNB. See figure 4a.2-2.

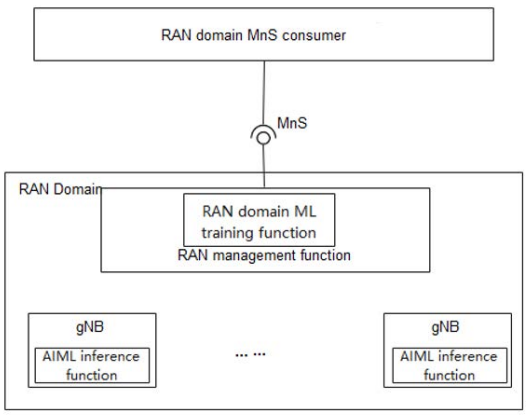


Figure 4a.2-2: Management where the ML model training is located in RAN domain management function and AI/ML inference is located in gNB

Scenario 3:

The ML training function and AI/ML inference function are both located in the gNB. See figure 4a.2-3.

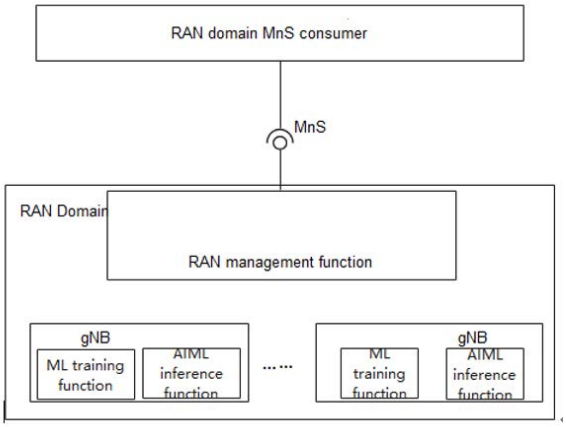


Figure 4a.2-3: Management where the ML model training and AI/ML inference are both located in gNB

Scenario 4:

For NWDAF, the ML training function and AI/ML inference function are both located in the NWDAF. See figure 4a.2-4.

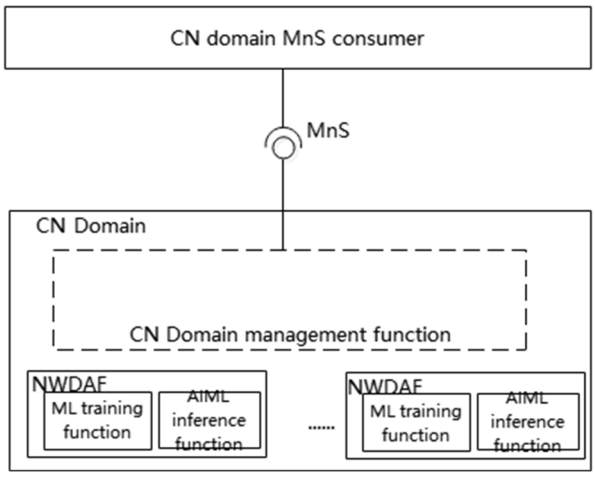


Figure 4a.2-4: Management where the ML model training and AI/ML inference are both located in CN

5 Void

6 AI/ML management use cases and requirements

6.1 ML model lifecycle management capabilities

Each operational step in the ML model lifecycle (see clause 4a.0.1) is supported by one or more AI/ML management capabilities as listed below.

Management capabilities for ML model training

- **ML model training management**: allowing the MnS consumer to request the ML model training, consume and control the producer-initiated training, and manage the ML model training/re-training process. The training management capability may include training performance management and setting a policy for the producer-initiated ML model training.

- ML model training capability also includes validation to evaluate the performance of the ML model when performing on the validation data, and to identify the variance of the performance on the training and validation data. If the variance is not acceptable, the ML model would need to be re-trained before being made available for the next step in the ML model lifecycle (e.g., ML model testing).

Management capabilities for ML testing

- **ML model testing management**: allowing the MnS consumer to request the ML model testing, and to receive the testing results for a trained ML model. It may also include capabilities for selecting the specific performance metrics to be used or reported by the ML testing function. MnS consumer may also be allowed to trigger ML model re-training based on the ML model testing performance results.

Management capabilities for AI/ML inference emulation:

- **AI/ML inference emulation:** a capability allowing an MnS consumer to request an ML inference emulation for a specific ML model or models (after the training, validation, and testing) to evaluate the inference performance in an emulation environment prior to applying it to the target network or system.

Management capabilities for ML model deployment:

- **ML model loading management**: allowing the MnS consumer to trigger, control and/or monitor the ML model loading process.

Management capabilities for AI/ML inference:

- **AI/ML inference management:** allowing an MnS consumer to control the inference, i.e., activate/deactivate the inference function and/or ML model/models, configure the allowed ranges of the inference output parameters. The capabilities also allow the MnS consumer to monitor and evaluate the inference performance and when needed trigger an update of an ML model or an AI/ML inference function.

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

6.2 Void

6.2a Void

6.2b ML model training

6.2b.1 Description

Before an ML model is deployed to conduct inference, the ML model algoritm associated with the ML model needs to be trained. The ML model training can be an initial training or the re-training of an already trained ML model.

The ML model is trained by the ML training MnS producer, and the training can be triggered by request(s) from one or more ML training MnS consumer(s), or initiated by the ML training MnS producer (e.g., as a result of model performance evaluation).

6.2b.2 Use cases

6.2b.2.1 ML model training requested by consumer

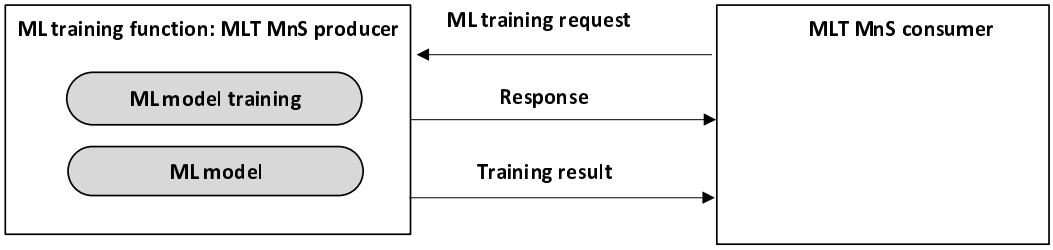


Figure 6.2b.2.1-1: ML model training requested by ML training MnS consumer

The ML model training may be triggered by the request(s) from one or more ML training MnS consumer(s). The consumer may be for example a network function, a management function, an operator, or another functional differentiation.

To trigger an initial ML model training, the MnS consumer needs to specify in the ML training request the inference type which indicates the function or purpose of the ML model, e.g. CoverageProblemAnalysis [see TS 28.104 [2]]. The ML training MnS producer can perform the initial training according to the designated inference type. To trigger an ML model re-training, the MnS consumer needs to specify in the ML training request the identifier of the ML model to be re-trained.

The consumer may provide the data source(s) that contain(s) the training data which are considered as inputs candidates for training. To obtain the valid training outcomes, consumers may also designate their requirements for model performance (e.g. accuracy, etc) in the training request.

The performance of the ML model depends on the degree of commonality between the distribution of the data used for training and the distribution of the data used for inference. As time progresses, the distribution of the input data used for inference might change as compared to the distribution of the data used for training. In such a scenario, the performance of the ML model degrades over time. The ML training MnS producer may re-train the ML model if the inference performance of the ML model falls below a certain threshold, which needs to be configurable by the MnS consumer.

Following the ML training request by the ML training MnS consumer, the ML training MnS producer provides a response to the consumer indicating whether the request was accepted.

If the request is accepted, the ML training MnS producer decides when to start the ML model training with consideration of the request(s) from the consumer(s). Once the training is decided, the producer performs the following:

- selects the training data, with consideration of the consumer provided candidate training data. Since the training data directly influences the algorithm and performance of the trained ML model, the ML training MnS producer may examine the consumer's provided training data and decide to select none, some or all of them. In addition, the ML training MnS producer may select some other training data that are available;
- trains the ML model using the selected training data;
- validate the trained model using validation set of the training data;
- provides the training results (including the identifier of the ML model generated from the initially trained ML model or the version number of the ML model associated with the re-trained model, training performance results, etc.) to the ML training MnS consumer(s).

6.2b.2.2 ML model training initiated by producer

The ML model training may be initiated by the ML training MnS producer, for instance as a result of performance evaluation of the ML model or based on feedback or new training data received from the consumer, or when new training data, which are not from the consumer, describing the new network status/events become available.

Therefore, there is a need to monitor the performance and/or the KPIs of the ML model and use the thresholds that the ML training MnS consumer configured for the ML training MnS producer to trigger the training or re-training.

When the ML training MnS producer decides to start the ML model training, the producer performs the followings:

- selects the training data;
- trains the ML model using the selected training data;
- provides the training results (including the identifier of the ML model generated frm the initially trained ML model or the version number of the ML model associated with the re-trained model, training performance, etc.) to the ML training MnS consumer(s) who have subscribed to receive the ML model training results.

6.2b.2.3 ML model selection

For a given machine learning-based use case, different entities that apply the respective ML model or AI/ML inference function may have different inference requirements and capabilities. For example, one consumer with specific responsibility wishes to have an AI/ML inference function supported by an ML model trained for city central business district where mobile users move at speeds not exceeding 30 km/hr. On the other hand, another consumer, for the same use case may support a rural environment and as such wishes to have an ML model and AI/ML inference function fitting that type of environment. The different consumers need to know the available versions of ML model, with the variants of trained ML models and to select the appropriate one for their respective conditions.

Besides, there is no guarantee that the available ML models have been trained according to the characteristics that the consumers expect. As such the consumers need to know the conditions for which the ML models have been trained to then enable them to select the models that are best fit to their conditions and needs.

The models that have been trained may differ in terms of complexity and performance. For example, a generic comprehensive and complex model may have been trained in a cloud-like environment, but such a model cannot be used in the gNB and instead, a less complex model, trained as a derivative of this generic model, could be a better candidate. Moreover, multiple less complex models could be trained with different levels of complexity and performance which would then allow different relevant models to be delivered to different consumers depending on operating conditions and performance requirements. The consumers need to know the alternative models available and interactively request and replace them when needed and depending on the observed inference-related constraints and performance requirements.

6.2b.2.4 Managing ML model training processes

This relates to the management and controlling of the ML model training processes.

To achieve the desired outcomes of any machine learning relevant use-case or task, the ML model applied for such use case or task, needs to be trained with the appropriate data. The training may be undertaken in a managed function or in a management function.

In either case, the network management system not only needs to have the required training capabilities but needs to also have the means to manage the training process of the ML models. The consumers need to be able to interact with the training process, e.g., to suspend or restart the process; and also need to manage and control the requests related to such training process.

6.2b.2.5 Handling errors in data and ML decisions

Ideally, the ML models are trained on good quality data, i.e. data that was collected correctly and reflected the real network status to represent the expected context in which the ML model is meant to operate. However, this is not always the case in real world as data cannot be completely error-free. Good quality data is void of errors, such as:

- Imprecise measurements
- Missing values or records
- Records which are communicated with a significant delay (in case of online measurements).

Without errors, an ML model can depend on a few precise inputs, and does not need to exploit the redundancy present in the training data. However, during inference, the ML model is very likely to come across these inconsistencies. When this happens, the ML model shows high error in the inference outputs, even if redundant and uncorrupted data are available from other sources.

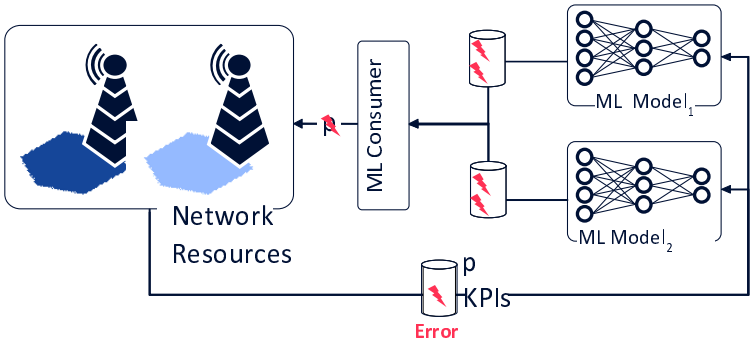


Figure 6.2b.2.5-1: The propagation of erroneous information

As such, the training function should attempt to identify errors in the input data. If an model has been trained on erroneous or inconsistent data, the consumer should be made aware of such.

6.2b.2.6 ML model joint training

Each ML model supports a specific type of inference. An AI/ML inference function may use one or more ML models to perform the inference(s). When multiple ML models are employed, these ML models may operate together in a coordinated way, such as in a sequence, or even in a more complicated structure. In this case, any change in the performance of one ML model may impact another, and consequently impact the overall performance of the whole AI/ML inference function.

There are different ways in which the group of ML models may coordinate. An example is the case where the output of one ML model can be used as input to another ML model forming a sequence of interlinked ML models. Another example is the case where multiple ML models provide the output in parallel (either the same output type where outputs may be merged (e.g., using weights), or their outputs are needed in parallel as input to another ML model. The group of ML models needs to be employed in a coordinated way to support an AI/ML inference function.

Therefore, it is desirable that the ML models can be trained or re-trained jointly, so that the group of these ML models can complete a more complex task jointly with better performance.

The ML model joint training may be initiated by the ML training MnS producer or the ML training MnS consumer, with the grouping of the ML models shared by the ML training MnS producer with the ML training MnS consumer.

6.2b.2.7 ML model validation performance reporting

During the ML model training process, the generated ML model needs to be validated. The purpose of ML validation is to evaluate the performance of the ML model when performing on the validation data, and to identify the variance of the performance on the training data and the validation data. The training data and validation data are of the same pattern as they normally split from the same data set with a certain ratio in terms of quantity of the data samples.

In the ML model training, the ML model is generated based on the learning from the training data and validated using the validation data. The performance of the ML model has tight dependency on the data (i.e., training data) from which the ML model is generated. Therefore, an ML model performing well on the training data may not necessarily perform well on other data e.g., while conducting inference. If the performance of ML model is not good enough according to the result of ML validation, the ML model will be re-trained and validated again. The process of ML model tuning and validation is repeated by the ML model training function, until the performance of the ML model meets the expectation on both training data and validation data. The MnS producer subsequently selects one or more ML models with the best level of performance on both training data and validation data as the result of the ML model training, and reports accordingly to the consumer. The performance of each selected ML model on both training data and validation data also needs to be reported.

The performance result of the validation may also be impacted by the ratio of the training data and the validation data. MnS consumer needs to be aware of the ratio of training data and the validation data, coupled with the performance score on each data set, in order to be confident about the performance of ML model.

6.2b.2.8 Training data effectiveness reporting

Training data effectiveness refers to the process of evaluating the contribution of a single data instance or a type of input training data (e.g., one measurement type among all types of input training data) to ML model training process.

To efficiently train a ML model, high quality and large volume of training data instances are considered essential. The open use of all available data can be costly, both in terms of data collection process and from a computational resources perspective since the data also contains the unnecessary data samples that are computed through the ML model. It is better that the training function evaluates the usefulness of different data samples and indicates that level of usefulness to the consumer so that the data used for re-training can be further enhanced/optimized.

The 3GPP management system needs to support means to report the extent of effectiveness of the different training data samples used in ML model training based on insight of how the different portion of data contribute differently to the trained model accuracy.

6.2b.2.9 Performance management for ML model training

6.2b.2.9.1 Overview

In the ML model training, the performance of ML model needs to be evaluated on training data. The performance is the degree to which the ML models fulfil the objectives for which they were trained. The related performance indicators need to be collected and analyzed.

6.2b.2.9.2 Performance indicator selection for MLmodel training

The ML model training function may support training for a single or several ML model algorithm and may support the capability to evaluate each ML model by one or more performance indicators.

The MnS consumer may prefer to use some performance indicator(s) over others to evaluate one kind of ML model. The performance indicators for training mainly include the following aspects:ML model training process monitors performance indicators: the performance indicators of the system that trains the ML model, including training duration indicator.

- ML model training model performance indicators: performance indicators of the ML model itself, including but not limited to:

- Accuracy indicator,
- Precision indicator,
- Recall indicator,
- F1 score indicator,
- MSE (Mean Squared Error) indicator, and
- MAE (Mean Absolute Error) indicator,
- RMSE (Root Mean Square Error) indicator.

The MnS producer for ML model training needs to provide the name(s) of supported performance indicator(s) for the MnS consumer to query and select for ML model performance evaluation. The MnS consumer may also need to provide the performance requirements of the ML model using the selected performance indicators.

The MnS producer for ML model training uses the selected performance indicators for evaluating ML model training, and reports with the corresponding performance score in the ML model training report when the training is completed.

6.2b.2.9.3 ML model performance indicators query and selection for ML

ML model performance evaluation and management are needed during training. The related performance indicators need to be collected and analyzed. The MnS producer of ML model training should determine which indicators are needed, i.e., select some indicators based on the use case and use these indicators for performance evaluation.

The ML MnS consumer may have different requests on AI/ML performance, depending on its use case and requirements, which may imply that different performance indicators may be relevant for performance evaluation. The MnS producer for ML model training can be queried to provide the information on supported performance indicators referring to ML model training. Such performance indicators for training may be for example accuracy/precision/recall/F1-score/MSE/MAE. Based on supported performance indicators as well as based on consumer's requirements, the MnS consumer for ML model training may request a sub-set of supported performance indicators to be monitored and used for performance evaluation. Management capabilities are needed to enable the MnS consumer for ML model training or to query the supported performance indicators and select a sub-set of performance indicators to be used for performance evaluation.

6.2b.2.9.4 MnS consumer policy-based selection of ML model performance indicators for ML model training

ML model performance evaluation and management is needed during ML model training. The related performance indicators need to be collected and analysed. The MnS producer for ML model training should determine which indicators are needed or may be reported, i.e., select some indicators based on the service and use these indicators for performance evaluation.

The MnS consumer for ML model training may have differentiated levels of interest in the different performance dimensions or metrics. Thus, depending on its use case, the AI/ML MnS consumer may indicate the preferred behaviour and performance requirement that needs to be considered during training by the MnS producer. These performance requirements do not need to indicate the technical performance indicators used for ML model training, testing or inference, such as "accuracy" or "precision" or "recall" or "MSE" or "MAE" or "F1 score" etc. The ML MnS consumer for ML model training may not be capable enough to indicate the performance metrics to be used for training.

6.2b.3 Requirements for ML model training

Table 6.2b.3-1

Requirement label	Description	Related use case(s)
REQ-ML_TRAIN-FUN-01	The ML training MnS producer shall have a capability allowing an authorized ML training MnS consumer to request ML model training.	ML model training requested by consumer (clause 6.2b.2.1)
REQ- ML_TRAIN-FUN-02	The ML training MnS producer shall have a capability allowing the authorized ML training MnS consumer to specify the data sources containing the candidate training data for ML model training.	ML model training requested by consumer (clause 6.2b.2.1)
REQ- ML_TRAIN-FUN-03	The ML training MnS producer shall have a capability allowing the authorized ML training MnS consumer to specify the AI/ML inference name of the ML model to be trained.	ML model training requested by consumer (clause 6.2b.2.1)
REQ- ML_TRAIN-FUN-04	The ML training MnS producer shall have a capability to provide the training result to the ML training MnS consumer.	ML model training requested by consumer (clause 6.2b.2.1), ML model training initiated by producer (clause 6.2b.2.2)
REQ- ML_TRAIN-FUN-05	The ML training MnS producer shall have a capability allowing an authorized ML training MnS consumer to configure the thresholds of the performance measurements and/or KPIs to trigger the re-training of an ML model. (See Note)	ML model training initiated by producer (clause 6.2b.2.2)
REQ- ML_TRAIN-FUN-06	The ML training MnS producer shall have a capability to provide the version number of the ML model when it is generated by ML model re-training to the authorized ML training MnS consumer.	ML model training requested by consumer (clause 6.2b.2.1), ML model training initiated by producer (clause 6.2b.2.2)

Requirement label	Description	Related use case(s)
REQ- ML_TRAIN-FUN-07	The ML training MnS producer shall have a capability allowing an authorized ML training MnS consumer to manage the training process, including starting, suspending, or resuming the training process, and configuring the ML context for ML model training.	ML model training requested by consumer (clause 6.2b.2.1), ML model training initiated by producer (clause 6.2b.2.2), ML model joint training (clause 6.2b.2.6)
REQ- ML_TRAIN-FUN-08	The ML training MnS producer should have a capability to provide the grouping of ML models to an authorized ML training MnS consumer to enable coordinated inference.	ML model joint training (clause 6.2b.1.2.6)
REQ- ML_TRAIN-FUN-09	The ML training MnS producer should have a capability to allow an authorized ML training MnS consumer to request joint training of a group of ML models.	ML model joint training (clause 6.2b.2.6)
REQ- ML_TRAIN-FUN-10	The ML training MnS producer should have a capability to jointly train a group of ML models and provide the training results to an authorized consumer.	ML model joint training (clause 6.2b.2.6)
REQ-ML_SELECT-01	3GPP management system shall have a capability to enable an authorized ML training MnS consumer to discover the properties of available ML models including the contexts under which each of the models were trained.	ML model and ML model selection (clause 6.2b.2.3)
REQ-ML_SELECT-02	3GPP management system shall have a capability to enable an authorized ML training MnS consumer to select an ML model to be used for inference.	ML models and ML model selection (clause 6.2b.2.3)
REQ-ML_SELECT-03	3GPP management system shall have a capability to enable an authorized ML training MnS consumer to request for information and be informed about the available alternative ML models of differing complexity and performance.	ML model and ML model selection (clause 6.2b.2.3)
REQ-ML_SELECT-04	The 3GPP management system shall have a capability to provide a selected ML model to the authorized ML training MnS consumer.	ML model and ML model selection (clause 6.2b.2.3)
REQ-ML_TRAIN- MGT-01	The ML training MnS producer shall have a capability allowing an authorized consumer to manage and configure one or more requests for the specific ML model training, e.g. to modify the request or to delete the request.	ML model training requested by consumer (clause 6.2b.2.1), Managing ML model Training Processes (clause 6.2b.2.4)
REQ-ML_TRAIN- MGT-02	The ML training MnS producer shall have a capability allowing an authorized ML training MnS consumer to manage and configure one or more training processes, e.g. to start, suspend or restart the training.	ML model training requested by consumer (clause 6.2b.2.1), Managing ML model training processes (clause 6.2b.2.4)
REQ-ML_TRAIN- MGT-03	3GPP management system shall have a capability to enable an authorized ML training MnS consumer (e.g. the function/model different from the function that generated a request for ML model training) to request for a report on the outcomes of a specific training instance.	Managing ML model training processes (clause 6.2b.2.4)
REQ-ML_TRAIN- MGT-04	3GPP management system shall have a capability to enable an authorized ML training MnS consumer to define the reporting characteristics related to a specific training request or training instance.	Managing ML model training processes (clause 6.2b.2.4)
REQ-ML_TRAIN- MGT-05	3GPP management system shall have a capability to enable the ML training function to report to any authorized ML training MnS consumer about specific ML model training process and/or report about the outcomes of any such ML model training process.	Managing ML model training processes (clause 6.2b.2.4)
REQ-ML_ERROR-01	The 3GPP management system shall enable an authorized consumer of data services (e.g. an ML training function) to request from a producer of data services a Value Quality Score of the data, which is the numerical value that represents the dependability/quality of a given observation and measurement type.	Handling errors in data and ML decisions (clause 6.2b.2.5)

Requirement label	Description	Related use case(s)
REQ-ML_ERROR-02	The 3GPP management system shall enable an authorized consumer of AI/ML decisions (e.g. a controller) to request ML decision confidence score which is the numerical value that represents the dependability/quality of a given decision generated by an AI/ML inference function.	Handling errors in data and ML decisions (clause 6.2b.2.5)
REQ-ML_ERROR-03	The 3GPP management system shall have a capability to enable an authorized consumer to provide to the ML Training MnS producer, a training data quality score, which is the numerical value that represents the dependability/quality of a given observation and measurement type.	Handling errors in data and ML decisions (clause 6.2b.2.5)
REQ-ML_ERROR-04	The 3GPP management system shall enable a producer of ML decisions (e.g. an AI/ML inference function) to provide to an authorized consumer of ML decisions (e.g. a controller) an AI/ML decision confidence score which is the numerical value that represents the dependability/quality of a given decision generated by the AI/ML inference function.	Handling errors in data and ML decisions (clause 6.2b.2.5)
REQ-ML_VLD-01	The ML training MnS producer should have a capability to validate the ML models during the ML model training process and report the performance of the ML models on both the training data and validation data to the authorized consumer.	ML model validation performance reporting (clause 6.2b.2.7)
REQ-ML_VLD-02	The ML training MnS producer should have a capability to report the ratio (in terms of quantity of data samples) of the training data and validation data used during the ML model training and validation process.	ML model validation performance reporting (clause 6.2b.2.7)
REQ-TRAIN_EFF-01	The 3GPP management system should have the capability to allow an authorized consumer to configure an ML training function to report the effectiveness of data used for model training.	Training data effectiveness reporting (clause 6.2b.2.8)
REQ-ML_TRAIN_PM-1	The ML Training MnS producer should have a capability to allow an authorized consumer to get the capabilities about what kind of ML models the ML training function is able to train.	Performance indicator selection for ML model training (clause 6.2b.2.9.2)
REQ-ML_TRAIN_PM-2	The ML Training MnS producer should have a capability to allow an authorized consumer to query what performance indicators are supported by the ML model training for each ML model.	Performance indicator selection for ML model training (clause 6.2b.2.9.2)
REQ-ML_TRAIN_PM-3	The ML Training MnS producer should have a capability to allow an authorized consumer to select the performance indicators from those supported by the ML training function for reporting the training performance for each ML model.	Performance indicator selection for ML model training (clause 6.2b.2.9.2)
REQ-ML_TRAIN_PM-4	The ML Training MnS producer should have a capability to allow an authorized consumer to provide the performance requirements for the ML model training using the selected the performance indicators from those supported by the ML training function.	Performance indicator selection for ML model training (clause 6.2b.2.9.2)
NOTE: The performance measurements and KPIs are specific to each type (i.e., the inference type that the ML model supports) of ML model.		

6.2c ML model testing

6.2c.1 Description

After the training and validation, the ML model needs to be tested to evaluate the performance of it when it conducts inference using testing data.

If the testing performance is not acceptable or does not meet the pre-defined requirements, the consumer may request the ML training MnS producer to re-train the ML model with specific training data and/or performance requirements.

6.2c.2 Use cases

6.2c.2.1 Consumer-requested ML model testing

After receiving an ML training report about a trained ML model from the ML training MnS producer, the consumer may request the ML testing MnS producer to test the ML model before applying it to the target inference function.

The ML model testing is to conduct inference on the tested ML model using the testing data as inference inputs and produce the inference output for each testing dataset example.

The ML testing MnS producer may be the same as or different from the ML training MnS producer.

After completing the ML model testing, the ML testing MnS producer provides the testing report indicating the success or failure of the ML model testing to the consumer. For a successful ML model testing, the testing report contains the testing results, i.e., the inference output for each testing dataset example.

6.2c.2.2 Producer-initiated ML model testing

The ML model testing may also be initiated by the MnS producer, after the ML model is trained and validated. A consumer (e.g., an operator) may still need to define the policies (e.g., allowed time window, maximum number of testing iterations, etc.) for the testing of a given ML model. The consumer may pre-define performance requirements for the ML model testing and allow the MnS producer to decide on whether ML model re-training/validation need to be triggered. ML model re-training may be triggered by the testing MnS producer itself based on the performance requirements supplied by the MnS consumer.

6.2c.2.3 Joint testing of multiple ML models

A group of ML models may work in a coordinated manner for complex use cases.

The group of ML models is generated by the ML training function. The group, including all contained ML models, needs to be tested. After the ML model testing of the group, the MnS producer provides the testing results to the consumer.

NOTE: This use case is about the ML models testing before deployment.

6.2c.2.4 Performance management for ML model testing

6.2c.2.4.1 Overview

During ML model testing, the performance of ML model needs to be evaluated on testing data. The performance is the degree to which the ML models fulfil the objectives for which they were trained. The related performance indicators need to be collected and analyzed.

6.2c.2.4.2 Performance indicator selection for ML model testing

The ML model testing function may support testing for a single or several ML model algorithms and may support the capability to evaluate each ML model by one or more performance indicators.

The MnS consumer may prefer to use some performance indicator(s) over others to evaluate one kind of ML model. The performance indicators for testing mainly include the following aspects:

- ML model testing performance indicators: performance indicators of the ML model itself, including but not limited to:
  - Accuracy indicator,
  - Precision indicator,
  - Recall indicator,
  - F1 score indicator,

- MSE (Mean Squared Error) indicator,
- MAE (Mean Absolute Error) indicator, and
- RMSE (Root Mean Square Error) indicator.

In a similar way as for training, the MnS producer for ML model testing needs to provide the name(s) of supported performance indicator(s) for the MnS consumer to query and select for ML model performance evaluation. The MnS consumer may also need to provide the performance requirements of the ML model using the selected performance indicators.

The MnS producer for ML model testing uses the selected performance indicators for evaluating ML model testing, and reports with the corresponding performance score in the ML testing report when testing is completed.

6.2c.2.4.3 ML model performance indicators query and selection for ML model testing

In a similar way as for training, the MnS producer of ML model training or testing should determine which indicators are needed, i.e., select some indicators based on the use case and use these indicators for performance evaluation.The ML MnS consumer for ML model testing may have different requests on AI/ML performance, depending on its use case and requirements, which may imply that different performance indicators may be relevant for performance evaluation. The procedure is the same as described in 6.2b.2.9.3 for traing.

6.2c.2.4.4 MnS consumer policy-based selection of ML model performance indicators for ML model testing

In a similar way as for training, the MnS consumer for ML model testing may have differentiated levels of interest in the different performance dimensions or metrics. Thus, depending on its use case, the AI/ML MnS consumer may indicate the preferred behaviour and performance requirement that needs to be considered during testing Same description in 6.2b.2.9.4 applies for policy basaed selection of performance indiactors for testing.

6.2c.3 Requirements for ML model testing

Table 6.2c.3-1

Requirement label	Description	Related use case(s)
REQ-ML_TEST-1	The ML testing MnS producer shall have a capability to allow an authorized consumer to request the testing of a specific ML model.	Consumer-requested ML model testing (clause 6.2c.2.1)
REQ-ML_TEST-2	The ML testing MnS producer shall have a capability to trigger the testing of an ML model and allow the MnS consumer to set the policy for the testing.	Producer-initiated ML model testing (6.2c.2.2)
REQ-ML_TEST-3	The ML testing MnS producer shall have a capability to report the performance of the ML model when it performs inference on the testing data.	Consumer-requested ML model testing (clause 6.2c.2.1), and Producer-initiated ML model testing (clause 6.2c.2.2)
REQ-ML_TEST-4	The ML testing MnS producer shall have a capability allowing an authorized consumer to request the testing of a group of ML models.	Joint testing of multiple ML models (clause 6.2c.2.3)
REQ-ML_TEST_PM-1	The ML testing MnS producer should have a capability to allow an authorized consumer to get the capabilities about what kind of ML models the ML testing function is able to test.	Performance indicator selection for ML model testing (clause 6.2c.2.4.2)
REQ-ML_TEST_PM-2	The ML testing MnS producer should have a capability to allow an authorized consumer to query what performance indicators are supported by the ML testing function for each ML model.	Performance indicator selection for ML model testing (clause 6.2c.2.4.2)

Requirement label	Description	Related use case(s)
REQ-ML_TEST_PM-3	The ML testing MnS producer should have a capability to allow an authorized consumer to select the performance indicators from those supported by the ML testing function for reporting the testing performance for each ML model.	Performance indicator selection for ML tra (clause 6.2c.2.4.2)

6.3 AI/ML inference emulation

6.3.1 Description

Before the ML model is applied in the production network, the MnS inference consumer may want to receive results of inference in one or more environments that emulate (to different extents) the expected inference characteristics, in a process that may be termed as Inference emulation. The Inference emulation phase enables this.

6.3.2 Use cases

6.3.2.1 AI/ML inference emulation

After the ML model is validated and tested during development, the MnS consumer may wish to receive information from an inference emulation process that indicates if the ML model or the associated ML inference function is working correctly under certain runtime context.

The management system should have the capabilities enabling an MnS consumer:

- request an inference emulation function to provide emulation reports; and
- to receive the results from running inference through an AI/ML inference emulation environment available at the emulation MnS producer.

6.3.3 Requirements for Managing AI/ML inference emulation

Table 6.3.3-1

Requirement label	Description	Related use case(s)
REQ-AI/ML_EMUL-1:	The MnS producer for AI/ML inference emulation should have a capability enabling an authorized MnS consumer to receive reporting about the ML inference emulation.	AI/ML Inference emulation (clause 6.3.2.1)
REQ-AI/ML_EMUL-2:	The MnS producer for AI/ML inference emulation should have a capability enabling an authorized MnS consumer to request an inference emulation function to provide inference emulation reports on an ML model or inference Function.	AI/ML Inference emulation (clause 6.3.2.1)

6.4 ML model deployment

6.4.1 ML model loading

6.4.1.1 Description

ML model loading refers to the process of making an ML model available for use in the inference function . After a trained ML model meets the performance criteria per the ML model testing and optionally ML emulation, the ML model could be loaded into the target inference function(s) in the system. The way for loading the ML model is not in scope of the present document.

6.4.1.2 Use cases

6.4.1.2.1 Consumer requested ML model loading

After a trained ML model or the coordination group of ML models are tested and optionally emulated, if the performance of the ML model or the coordination group of ML models meet the MnS consumer's requirements, the MnS consumer may request to load the one or more ML models to one or more target inference function(s) where the ML models will be used for conducting inference. Once the ML models loading request is accepted, the MnS consumer (e.g., operator) needs to know the progress of the loading and needs to be able to control (e.g., cancel, suspend, resume) the loading process. For a completed ML model loading, the ML model instance loaded to each target inference function needs to be manageable individually, for instance, to be activated/deactivated individually or concurrently.

6.4.1.2.2 Control of producer-initiated ML model loading

To enable more autonomous AI/ML operations, the MnS producer is allowed to load the ML model or the coordination group of ML models without the consumer's specific request.

In this case, the consumer needs to be able to set the policy for the ML loading, to make sure that ML models loaded by the MnS producer meet the performance target. The policy could be, for example, the threshold of the testing performance of the ML models, the threshold of the inference performance of the existing ML model, the time schedule allowed for ML model loading, etc.

ML models are typically trained and tested to meet specific requirements for inference, addressing a specific use case or task. The network conditions may change regularly, for example, the gNB providing coverage for a specific location is scheduled to accommodate different load levels and/or patterns of services at different times of the day, or on different days in a week. One or more ML models may be loaded per the policy to adapt to a specific load/traffic pattern.

6.4.1.2.3 ML model registration

After multiple iterations, there could be a large number of ML models with different versions, deployment environments, performance levels, and functionalities. ML model registration refers to the process of recording, tracking, controlling those trained ML models enabling future retrieval, reproducibility, sharing and loading in the target inference functions across different environments. For example, the inference MnS consumer could recall the most applicable version dealing with a sudden changed deployment environment of the target inference function by tracking the registration information.

The ML training MnS producer should register the ML model along with its loading information, e.g., ML model metadata and relevant information (e.g., description, version, version date, target inference function, deployment environment, etc.).

6.4.1.3 Requirements for ML model loading

Table 6.4.1.3-1

Requirement label	Description	Related use case(s)
REQ- ML_LOAD-FUN-01	The MnS producer for ML model loading shall have a capability allowing an authorized consumer to request to trigger loading of an ML model.	Consumer requested ML model loading (clause 6.4.1.2.1)
REQ- ML_LOAD-FUN-02	The MnS producer for ML model loading shall have a capability allowing an authorized consumer to provide a policy for the MnS producer to trigger loading of an ML model.	Producer-initiated ML model loading (clause 6.4.1.2.2)
REQ- ML_LOAD-FUN-03	The MnS producer for ML model loading shall be able to inform an authorized consumer about the progress of ML model loading.	Consumer requested ML model loading (clause 6.4.1.2.1) and Producer-initiated ML model loading (clause 6.4.1.2.2)

Requirement label	Description	Related use case(s)
REQ- ML_LOAD-FUN-04	The MnS producer for ML model loading shall have a capability allowing an authorized consumer to control the process of ML model loading.	Consumer requested ML model loading (clause 6.4.1.2.1) and Producer-initiated ML model loading (clause 6.4.1.2.2)
REQ- ML_REG-01	The ML training MnS producer should have a capability to register an ML model to record the relevant information that may be used for loading.	ML model registration (Clause 6.4.1.2.3)
REQ- ML_REG-02	The ML training MnS producer should have a capability to allow an authorized consumer (e.g., an AI/ML inference function) to acquire the registration information of ML models.	ML model registration (Clause 6.4.1.2.3)

6.5 AI/ML inference

6.5.1 AI/ML inference performance management

6.5.1.1 Description

During AI/ML inference, the performance of the AI/ML inference function and ML model need to be evaluated against the MnS consumer's provided performance expectations/targets, to identify and timely fix any problem. Actions to fix any problem would be e.g., to trigger the ML model re-training, ML model testing, or re-deployment.

6.5.1.2 Use cases

6.5.1.2.1 AI/ML inference performance evaluation

During AI/ML inference, the AI/ML inference function (including e.g., MDAF, NWDAF or RAN functions) uses one or more ML models for inference to generate the AI/ML inference output. The performance of a running ML model may degrade over time due to changes in network state, which will affect the related network performance and service. Thus, it is necessary to evaluate performance of the ML model during the AI/ML inference process. If the inference output is executed, the network performance related to each AI/ML inference function also needs to be evaluated.

The consumer (e.g., a Network or Management function) may take some actions according to the AI/ML inference output provided by the AI/ML inference function. If the actions are taken accordingly, the network performance is expected to be optimized. Each AI/ML inference function has its specific focus and will impact the network performance from different perspectives.

The consumer may choose to not take any actions for various reasons, e.g., lacking confidence in the inference output, avoiding potential conflict with other actions or when no actions are needed or recommended at all according to the inference output.

For evaluating the performance of the AI/ML inference function and ML model, the MnS producer responsible for ML inference performance management needs to be able to get the inference output generated by each AI/ML inference function. Then, the MnS producer can evaluate the performance based on the inference output and related network measurements (i.e., the actual output).

Depending on the performance evaluation results, some actions (e.g., deactivate the running model, start retraining, change the running model with a new one, etc) can be taken to avoid generating the inaccurate inference output.

To monitor the performance during AI/ML inference, the MnS producer responsible for AI/ML inference performance management can perform evaluation periodically. The performance evaluation period may be determined based on the network change speed. Besides, a consumer (e.g., an operator) may wish to control and manage the performance evaluation capability. For example, the operator may configure the performance evaluation period of a specified ML model.

6.5.1.2.2 AI/ML performance measurements selection based on MnS consumer policy

Evaluation and management of the performance of an ML model is needed during AI/ML inference. The related performance measurements need to be collected and analysed. The MnS producer for inference should determine which measurements are needed or may be reported, i.e., select some measurements based on the service and use these measurements for performance evaluation.

The MnS consumer for inference may have differentiated levels of interest in the different performance dimensions or metrics. Thus, depending on its use case, the MnS consumer may indicate the preferred behaviour and performance requirement that needs to be considered during inference from the ML model by the AI/ML inference MnS Producer. The AI/ML inference MnS consumer may not be capable enough to indicate the performance metrics. Instead, the AI/ML MnS consumer may indicate the requirement using a policy or guidance that reflects the preferred performance characteristics of the ML model. Based on the indicated policy/guidance, the AI/ML MnS producer may then deduce and apply the appropriate performance indicators for inference. Management capabilities are needed to enable the MnS consumer to indicate the behavioural and performance policy/guidance that may be translated by the MnS producer into one or more technical performance measurements during inference.

6.5.1.3 Requirements for AI/ML inference performance management

Table 6.5.1.3-1

Requirement label	Description	Related use case(s)
REQ-AI/ML_INF_PE-01	The MnS producer responsible for AI/ML inference management shall have a capability enabling an authorized consumer to get the inference output provided by an AI/ML inference function (e.g., MDAF, NWDAF or RAN function).	AI/ML inference performance evaluation (clause 6.5.1.2.1)
REQ-AI/ML_INF_PE-02	The MnS producer responsible for AI/ML inference management shall have a capability enabling an authorized consumer to get the performance evaluation of an AI/ML inference output as measured by a defined set of performance metrics	AI/ML inference performance evaluation (clause 6.5.1.2.1)
REQ-AI/ML_INF_PE-03	The MnS producer responsible for AI/ML inference management shall have a capability enabling an authorized consumer to provide feedback about an AI/ML inference output expressing the degree to which the inference output meets the consumer's expectations.	AI/ML inference performance evaluation (clause 6.5.1.2.1)
REQ-AI/ML_INF_PE-04	The MnS producer responsible for AI/ML inference management shall have a capability enabling an authorized consumer to be informed about the executed actions that were triggered based on the inference output provided by an AI/ML inference function (e.g., MDAF, NWDAF or RAN function).	AI/ML inference performance evaluation (clause 6.5.1.2.1)
REQ-AI/ML_INF_PE-05	The MnS producer responsible for AI/ML inference management shall have a capability enabling an authorized consumer to obtain the performance data related to an ML model or an AI/ML inference function (e.g., MDAF, NWDAF or RAN function).	AI/ML inference performance evaluation (clause 6.5.1.2.1)
REQ-AI/ML_PERF-SEL-1	The ML training MnS producer shall have a capability allowing an authorized MnS consumer to discover supported AI/ML performance measurements related to AI/ML inference and select some of the desired measurements based on the MnS consumer’s requirements.	AI/ML performance measurements selection based on MnS consumer policy (clause 6.5.1.2.2)
REQ-AI/ML_PERF-POL-1	The AI/ML MnS producer shall have a capability allowing the authorized MnS consumer to indicate a performance policy related to AI/ML inference.	AI/ML performance measurements selection based on MnS consumer policy (clause 6.5.1.2.2)

6.5.2 AI/ML update control

6.5.2.1 Description

In many cases, network conditions change makes the capabilities of the ML model(s) decay, or at least become inappropriate for the changed conditions. In such cases, the MnS consumer should still be enabled to trigger updates, e.g., when the consumer realizes that the insight or decisions generated by the function are no longer appropriate for the observed network states, when the consumer observes the inference performance of ML model(s) is decreasing.

The MnS consumer may request the AI/ML Inference MnS producer to use an updated ML model(s) for the inference with some specific performance requirements. This gives flexibility to the AI/ML inference MnS producer on how to address the requirements by for example getting ML model(s) updated, which may be loading the already trained ML model(s) or may lead to requesting to train/re-train the ML model(s) by utilizing the ML training MnS.

6.5.2.2 Use cases

6.5.2.2.1 Availability of new capabilities or ML models

Depending on their configurations, AI/ML inference functions may learn new characteristics during their utilization, e.g., if they are configured to learn through reinforcement learning or if they are configured to download new versions of their constituent ML model. In such cases, the authorized consumer of AI/ML may wish to be informed by the AI/ML Inference MnS producer (e.g., the operator, a management function, or a network function) about their new capabilities.

6.5.2.2.2 Triggering ML model update

When the inference capabilities of AI/ML inference functions degenerate, the typical action may be to trigger ML model re-training of the constituent ML models. It is possible, however, that the AI/ML inference MnS producer only offers inference capabilities and is not equipped with capabilities to update, train/re-train its constituent ML models. Nevertheless, the authorized MnS consumer may still need to request for improvements in the capabilities of the AI/ML inference function. In such cases, the authorized MnS consumer may still wish to request for an improvement and may specify in its request e.g., a new version of the ML models, i.e., to have the ML models updated or re-trained. The corresponding internal actions taken by the AI/ML MnS inference producer may not be necessarily known by the consumer.

The AI/ML inference MnS consumer needs to request the AI/ML inference MnS producer to update its capabilities or its constituent ML models and the AI/ML MnS producer should respond accordingly. For example, the AI/ML inference MnS producer may download new software that supports the required updates, download from a remote server a file containing configurations and parameters to update one or more of its constituent ML models, or it may trigger one or more remote or local AI/ML-related processes (including ML model training/re-training, testing, etc.) needed to generate the required updates. Related notifications for update can be sent to the AI/ML inference MnS consumer to indicate the information of the update process, e.g., the update is finished successfully, the maximum time taken to complete the update is reached but the performance does not achieve the requirements, etc.

Besides, an AI/ML inference MnS consumer may wish to manage the update process(es), e.g., to define policies on how often the update may occur, suspend or restart the update or adjust the update conditions or characteristics, the requirements could include, e.g., the times when the update may be executed, the expected achievable performance for updating, the expected time taken to complete the update, etc.

6.5.2.3 Requirements for AIML update control

Table 6.5.2.3-1

Requirement label	Description	Related use case(s)
REQ-AIML_UPDATE-1	The AI/ML Inference MnS producer should have a capability to inform an authorized MnS consumer of the availability of AI/ML capabilities or ML models or versions thereof (e.g., as learned through a training process or as provided via a software update) and the readiness to update the AI/ML capabilities of the respective network function when triggered	Availability of new capabilities or ML models (clause 6.5.2.2.1)
REQ-AIML_UPDATE-2	The AI/ML Inference MnS producer should have a capability to inform an authorized MnS consumer of the expected performance gain if/when the AI/ML capabilities or ML models of the respective network function are updated with/to the specific set of newly available AI/ML capabilities	Availability of new capabilities or ML models (clause 6.5.2.2.1)
REQ-AIML_UPDATE-3	The AI/ML Inference MnS producer should have a capability to allow an authorized MnS consumer to request the AI/ML MnS producer to update its ML models using a specific version of newly available AI/ML capabilities or ML models or using AI/ML capabilities or ML models with requirements (e.g., the minimum achievable performance after updating, the maximum time taken to complete the update, etc)	Triggering ML model update (clause 6.5.2.2.2)

Requirement label	Description	Related use case(s)
REQ-AIML_UPDATE-4	The AI/ML Inference MnS producer should have a capability for the AI/ML MnS producer to inform an authorized MnS consumer about of the process or outcomes related to any request for updating the AI/ML capabilities or ML models	Triggering ML model update (clause 6.5.2.2.2)
REQ-AIML_UPDATE-5	The AI/ML Inference MnS producer should have a capability for the AI/ML MnS producer to inform an authorized MnS consumer about of the achieved performance gain following the update of the AI/ML capabilities of a network function with/to the specific newly available ML models or set of AI/ML capabilities	Triggering ML model update (clause 6.5.2.2.2)
REQ-AIML_UPDATE-6	The AI/ML Inference MnS producer should have a capability for an authorized MnS consumer (e.g., an operator or the function/ model that generated the request for updating the AI/ML capabilities) to manage the request and subsequent process, e.g. to suspend, re-activate or cancel the request or process; or to adjust the characteristics of the capability update; or to define how often the update may occur, suspend, restart or cancel the request or to further adjust the requirements of the update	Triggering ML model update (clause 6.5.2.2.2)

6.5.3 AI/ML inference capabilities management

6.5.3.1 Description

A network or management function that applies AI/ML to accomplish specific tasks may be considered to have one or more ML models, each having specific capabilities.

Different network functions, e.g., MDA Functions, may need to rely on existing AI/ML capabilities to accomplish the desired inference. However, the details of such ML-based solutions (i.e., which ML models are applied and how) for accomplishing those inference functionalities is not obvious. The management services are required to identify the capabilities of the involved ML models and to map those capabilities to the desired logic.

6.5.3.2 Use cases

6.5.3.2.1 Identifying capabilities of ML models

Network functions, especially network automation functions, may need to rely on capabilities of ML models that are not internal to those network functions to accomplish the desired automation (inference). For example, as stated in TS 28.104 [2], “An MDA Function may optionally be deployed as one or more AI/ML inference function(s) in which the relevant ML models are used for inference per the corresponding MDA.” Similarly, owing to the differences in the kinds and complexity of intents that need to be fulfilled, an intent fulfillment solution may need to employ the capabilities of existing AI/ML inference functions to fulfill the intents. In any such case, management services are required to identify the capabilities of those existing ML models that are employed by AI/ML inference functions.

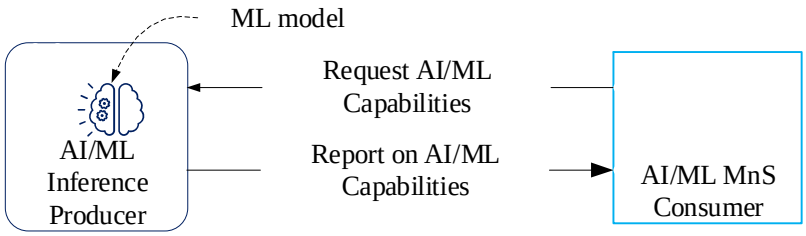


Figure 6.5.3.2.1-1: Request and reporting on AI/ML inference capabilities

Figure 6.5.3.2.1-1 shows that the consumer may wish to obtain information about the available AI/ML inference capabilities to determine how to use them for the consumer's needs, e.g., for fulfillment of intent targets or other automation targets.

6.5.3.2.2 Mapping of the capabilities of ML models

Besides the discovery of the capabilities of ML models, services are needed for mapping the ML modelsand capabilities. In other words, instead of the consumer discovering specific capabilities, the consumer may want to know the ML models that can be used to achieve a certain outcome. For this, the producer should be able to inform the consumer of the set of available ML models that together achieve the consumer's automation needs.

In the case of intents for example, the complexity of the stated intents may significantly vary - from simple intents which may be fulfilled with a call to a single ML model to complex intents that may require an intricate orchestration of multiple ML models. For simple intents, it may be easy to map the execution logic to one or multiple ML models. For complex intents, it may be required to employ multiple ML models along with a corresponding functionality that manages their interrelated execution. The usage of the ML models requires the awareness of their capabilities and interrelations.

Moreover, given the complexity of the required mapping to the multiple ML models, services should be supported to provide the mapping of ML models and capabilities.

6.5.3.3 Requirements for AI/ML inference capabilities management

Table 6.5.3.3-1

Requirement label	Description	Related use case(s)
REQ-ML_CAP-01	The AI/ML inference MnS Producer shall have a capability allowing an authorized MnS consumer to request the capabilities of existing ML models available within the AI/ML inference producer.	Identifying capabilities of ML models (clause 6.5.3.2.1)
REQ- ML_CAP-02	The AI/ML inference MnS Producer shall have a capability to report to an authorized MnS consumer the capabilities of an ML model as a decision described as a triplet <object(s), parameters, metrics> with the entries respectively indicating: the object or object types for which the ML model can undertake optimization or control; the configuration parameters on the stated object or object types, which the ML model optimizes or controls to achieve the desired outcomes; and the network metrics which the ML model optimizes through its actions.	Identifying capabilities of ML models (clause 6.5.3.2.1)
REQ-ML_CAP-03	The AI/ML inference MnS Producer shall have a capability to report to an authorized MnS consumer the capabilities of an ML model as an analysis described as a tuple <object(s), characteristics> with the entries respectively indicating: the object or object types for which the ML model can undertake analysis; and the network characteristics (related to the stated object or object types) for which the ML model produces analysis	Identifying capabilities of ML models (clause 6.5.3.2.1)
REQ-ML_CAP-04	The AI/ML inference MnS Producer shall have a capability allowing an authorized MnS consumer to request a mapping of the consumer's inference targets to the capabilities of one or more ML models.	Mapping of the capabilities of ML models (clause 6.5.3.2.2)

6.5.4 AI/ML inference capability configuration management

6.5.4.1 Description

The AI/ML inference function and the associated ML model may need to be managed and configured to conduct inference in the 5G system to align with the consumer´s expectation, e.g., to enable the AI/ML inference function to perform inference.

The MnS producer for AI/ML inference management needs to provide a capability for configuration of the AI/ML inference function.

6.5.4.2 Use cases

6.5.4.2.1 Managing NG-RAN AI/ML-based distributed Network Energy Saving

An NG-RAN AI/ML-based distributed Network Energy Saving capability may use one or more ML models or AI/ML Inference Functions to derive energy saving recommendations.

The MnS consumer monitors the network performance and determines whether to, and when to activate or deactivate an AI/ML Inference Functions related to an AI/ML-based Distributed Network Energy Saving function. The activation and deactivation actions for AI/ML Inference Functions related to an AI/ML-based Distributed Network Energy Saving conducted by the MnS producer may also be triggered by some defined policies provided by the consumer.

6.5.4.2.2 Managing NG-RAN AI/ML-based distributed Mobility Optimization

An AI/ML-based distributed Mobility Optimization capability may use one or more ML models or AI/ML Inference Functions to derive handover recommendations.

This NG-RAN AI/ML-based distributed Mobility Optimization capability may need to monitors the network performance and determines if activation or deactivation and AI/ML Inference Functions related to an AI/ML-based Distributed Mobility Optimization function is required. The activation and deactivation actions for AI/ML Inference Functions related to an AI/ML-based Distributed Mobility Optimization conducted by the MnS producer may also be triggered by some defined policies provided by the consumer.

6.5.4.2.3 Managing NG-RAN AI/ML-based distributed Load Balancing

An NG-RAN AI/ML-based distributed Load Balancing capability may use one or more ML models or AI/ML Inference Functions to derive load balancing recommendations.

This NG-RAN AI/ML-based distributed Load Balancing capability needs to be managed. The MnS consumer monitors the network performance and determines whether to, and when to activate or deactivate an AI/ML-based Distributed Load balancing function. The activation and deactivation actions for AI/ML-based Distributed Load balancing conducted by the MnS producer may also be triggered by some defined policies provided by the consumer.

6.5.4.3 Requirements for AI/ML inference management

Table 6.5.4.3-1

Requirement label	Description	Related use case(s)
REQ- AI/ML_INF-01	The MnS producer of NG-RAN AI/ML-based distributed Network Energy Saving should enable an authorized MnS consumer to to manage the ML model and/or AI/ML Inference Function related to Distribuited Energy Saving functions.	Managing AI/ML-based for NG-RAN distributed Network Energy Saving (clause 6.5.4.2.1)
REQ- AI/ML_INF-02	The MnS producer of NG-RAN AI/ML-based distributed Mobility Optimization should enable an authorized MnS consumer to manage the ML model and/or AI/ML Inference Function related to Distribuited Mobility Optimization functions.	Managing AI/ML-based for NG-RAN distributed Mobility Optimization (clause 6.5.4.2.2)
REQ- AI/ML_INF-03	The MnS producer of NG-RAN AI/ML-based distributed Load Balancing should enable an authorized MnS consumer to request to manage ML model and/or AI/ML Inference Function related to Distribuited the Load Balancing functions.	Managing AI/ML-based for NG-RAN distributed Load Balancing (clause 6.5.4.2.3)
REQ-AIML_ INF_ACT-1	The MnS producer for AI/ML inference management should have a capability allowing an authorized MnS consumer to activate and deactivate an ML inference function.	Managing AI/ML-enabled for Distributed Network Energy Saving (clause 6.5.4.2.1) Managing AI/ML-enabled for distributed Mobility Optimization (clause 6.5.4.2.2) Managing AI/ML-enabled for distributed Load balancing (clause 6.5.4.2.3)
REQ-AIML_ INF_ACT-2	The MnS producer for AI/ML inference management should have a capability to allow an authorized MnS consumer to provide the policy for activating and deactivating inference function. Note: The policies instructing the ML MnS producer on how or/and when to activate which ML capabilities.	Managing AI/ML-enabled for Distributed Network Energy Saving (clause 6.5.4.2.1) Managing AI/ML-enabled for distributed Mobility Optimization (clause 6.5.4.2.2)

Requirement label	Description	Related use case(s)
		Managing AI/ML-enabled for distributed Load balancing (clause 6.5.4.2.3)

6.5.5 AI/ML Inference History

6.5.5.1 Description

Different functionalities in the network or management domains may utilize AI/ML inference techniques to conduct their tasks under different contexts. Depending on the contexts, the outcome of the ML model at inference might be different. The history of such inference outcome and the corresponding context within which they were taken may be of interest to different consumers.

6.5.5.2 Use cases

6.5.5.2.1 AI/ML Inference History - tracking inferences and context

For different automation requirements in specific network domain, management/automation functions (e.g., MDAS, SON) may apply ML functionality to make the appropriate inferences in different contexts. The context is the set of appropriate conditions under which the inference was made including network conditions, traffic characteristics, time of day, weather, and climate, etc. And depending on the contexts, the different inferences may have different outcomes. The inference history, which is the history of such inferences and the contexts within which they are taken, may be of interest to different consumers. The AI/ML inference history includes outputs derived by the ML model and the contexts, e.g., network resources, time periods, traffic conditions, etc. The inference history output should be reported by the MnS Producer to the MnS Consumer.

The inferences may need to be tracked for future reference, e.g., to evaluate the appropriateness/usefullness of the inference outcome for those contexts or to evaluate degradations in the ML model's performance. For this, the network not only needs to have the required inference capabilities but needs also to have the means to track and enable usage of the history of the inferences made by the ML model. The MnS producer, i.e., a specific AI/ML inference function should also provide the capability for AI/ML inference history Control, the means to control the process of compiling and reporting on AI/ML inference history.

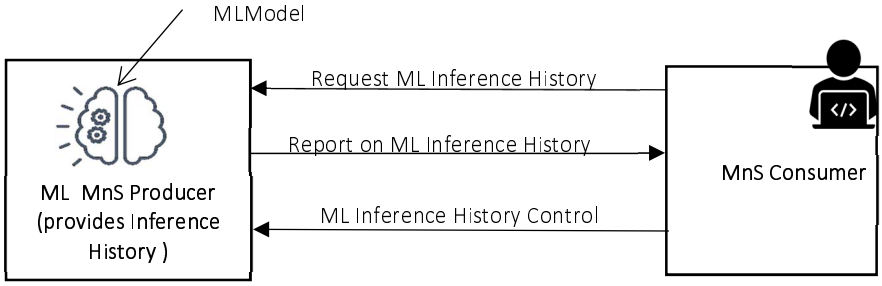


Figure 6.5.5.2.1-1: Example use and control of AI/ML inference history request and reporting.

6.5.5.3 Requirements for AI/ML Inference History

Table 6.5.5.3-1

Requirement label	Description	Related use case(s)
REQ-AI/ML_INF-HIST-01	The MnS producer for AI/ML inference management should have a capability allowing an authorized consumer to receive the inference history of a specific ML model.	AI/ML Inference History - tracking inferences and context (clause 6.5.5.2.1)

Requirement label	Description	Related use case(s)
REQ-AI/ML-INF-HIST-02	The MnS producer for AI/ML inference management should have a capability enabling an authorized consumer to define the reporting characteristics of historical inference outputs related to a specific instance of an ML model.	AI/ML Inference History - tracking inferences and context (clause 6.5.5.2.1)

7 Information model definitions for AI/ML management

7.1 Imported and associated information entities

7.1.1 Imported information entities and local labels

Table 7.1.1-1

Label reference	Local label
3GPP TS 28.622 [12], IOC, `Top`	`Top`
3GPP TS 28.622 [12], IOC, `SubNetwork`	`SubNetwork`
3GPP TS 28.622 [12], IOC, `ManagedElement`	`ManagedElement`
3GPP TS 28.622 [12], IOC, `ManagedFunction`	`ManagedFunction`
3GPP TS 28.622 [12], IOC, `ThresholdMonitor`	`ThresholdMonitor`
3GPP TS 28.541 [18], IOC, `GNBCUCPFunction`	`GNBCUCPFunction`
3GPP TS 28.104 [2], IOC, `MDAFunction`	`MDAFunction`
3GPP TS 28.622 [12], dataType, `TimeWindow`	`TimeWindow`
3GPP TS 28.622 [12], dataType, `GeoArea`	`GeoArea`
3GPP TS 28.622 [12], dataType, `ThresholdInfo`	`ThresholdInfo`
3GPP TS 28.622 [12], dataType, `ProcessMonitor`	`ProcessMonitor`

7.1.2 Associated information entities and local labels

Table 7.1.2-1

Label reference	Local label
3GPP TS 28.104 [2], IOC, `MDAFunction`	`MDAFunction`
3GPP TS 28.541 [18], IOC, `NWDAFFunction`	`NWDAFFunction`

7.2 Void

7.2a Common information model definitions for AI/ML management

7.2a.1 Class diagram

7.2a.1.1 Relationships

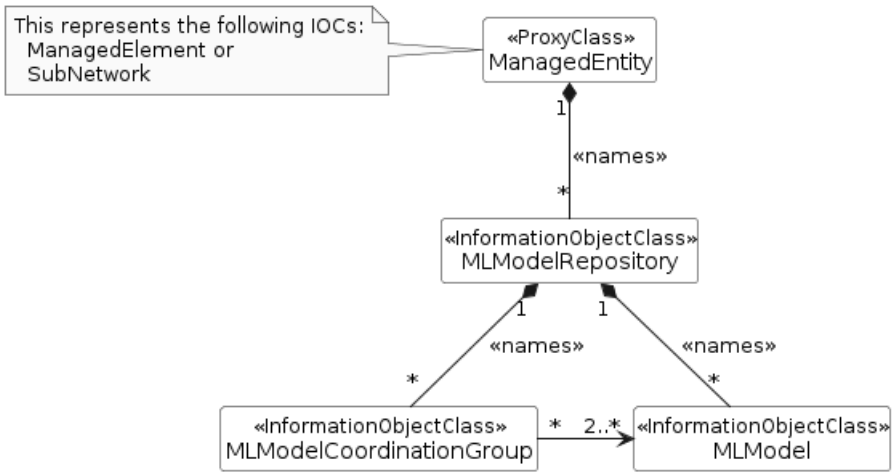


Figure 7.2a.1.1-1: Relations for common information models for AI/ML management

7.2a.1.2 Inheritance

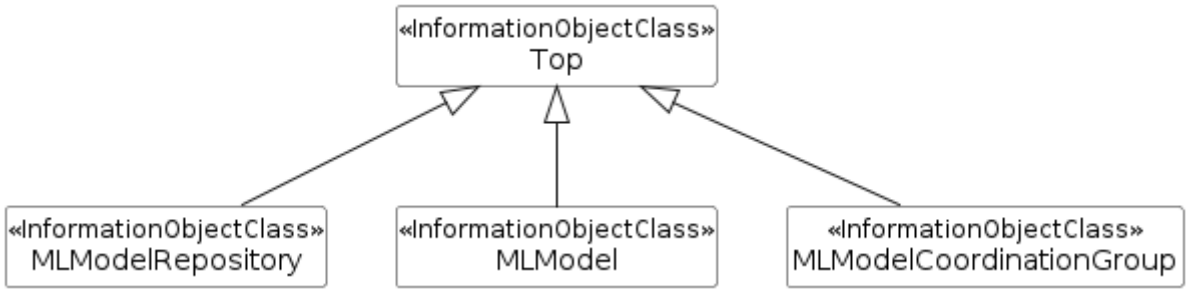


Figure 7.2a.1.2-1: Inheritance Hierarchy for common information models for AI/ML management

7.2a.2 Class definitions

7.2a.2.1 `MLModel`

7.2a.2.1.1 Definition

This IOC represents the ML model. ML model algorithm or ML model are not subject to standardization. It is name-contained by `MLModelRepository`.

This `MLModel` MOI can be created by the system (MnS producer) or pre-installed. The MnS consumer can request the system to delete the MLModel MOI.

The `MLModel` may contain 3 types of contexts - TrainingContext, ExpectedRunTimeContext and RunTimeContext which represent status and conditions of the `MLModel`. These contexts are of mLContext <<dataType>>, see clauses 7.4.3 and 7.5.1 for details.
It also contains a reference named `retrainingEventsMonitorRef` which is a pointer to `ThresholdMnonitor` MOI. This indicates the list of performance measurements and the corresponding thresholds that are monitored and used to identify the need for re-training by the MnS Producer. After the `MLModel` MOI has been instantiated, the MnS Consumer can request MnS producer to instantiate a `ThresholdMonitor` MOI and update the reference in the `MLModel` MOI that can be used by the MnS producer to decide on the re-training of the `MLModel`. The MnS producer can be ML Training MnS producer or AI/ML Inference MnS Producer.

7.2a.2.1.2 Attributes

Table 7.2a.2.1.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
mLModelId	M	T	F	F	T
aIMLInferenceName	M	T	F	F	T
mLModelVersion	M	T	F	F	T
expectedRunTimeContext	M	T	T	F	T
trainingContext	CM	T	F	F	T
runTimeContext	O	T	F	F	T
supportedPerformanceIndicators	O	T	F	F	T
mLCapabilitiesInfoList	M	T	F	F	T
Attribute related to role					
retrainingEventsMonitorRef	O	T	T	F	T
sourceTrainedMLModelRef	CM	T	F	F	T
aIMLInferenceReportRefList	O	T	F	F	T
usedByFunctionRefList	O	T	F	F	T

7.2a.2.1.3 Attribute constraints

Table 7.2a.2.1.3-1

Name	Definition
trainingContext Support Qualifier	Condition: The trainingContext represents the status and conditions related to training and should be added when training is completed.
sourceTrainedMLModelRef Support Qualifier	Condition: The MLModel MOI containing this attribute represents an ML model loaded to an inference function.

7.2a.2.1.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.2a.2.2 MLModelRepository

7.2a.2.2.1 Definition

The IOC MLModelRepository represents the repository that contains the ML models. It is name-contained by SubNetwork or ManagedElement.

This MLModelRepository instance can be created by the system (MnS producer) or pre-installed.

The MLModelRepository MOI may contain one or more MLModel(s).

7.2a.2.2.2 Attributes

The MLModelRepository IOC includes attributes inherited from TOP IOC.

7.2a.2.2.3 Attribute constraints

None.

7.2a.2.2.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.2a.2.3 MLModelCoordinationGroup

7.2a.2.3.1 Definition

This IOC represents the group of ML models, which can be trained and tested jointly and used to perform inference in a coordinated way. It is name-contained by `MLModelRepository`.

This MLModelCoordinationGroup instance is created by the system (MnS producer) or pre-installed. The MnS consumer can request the System to delete the MLModelCoordinationGroup MOI.

One ML model may have dependencies on one or more of the other ML models of the same group.

One group is associated with at least two ML models.

7.2a.2.3.2 Attributes

Table 7.2a.2.3.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
Attribute related to role					
`memberMLModelRefList`	M	T	F	F	T

7.2a.2.3.3 Attribute constraints

None.

7.2a.2.3.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3 Void

7.3a Information model definitions for AI/ML operational phases

7.3a.1 Information model definitions for ML model training

7.3a.1.1 Class diagram

7.3a.1.1.1 Relationships

This clause depicts the set of classes (e.g. IOCs) that encapsulates the information relevant to ML model training. For the UML semantics, see TS 32.156 [13].

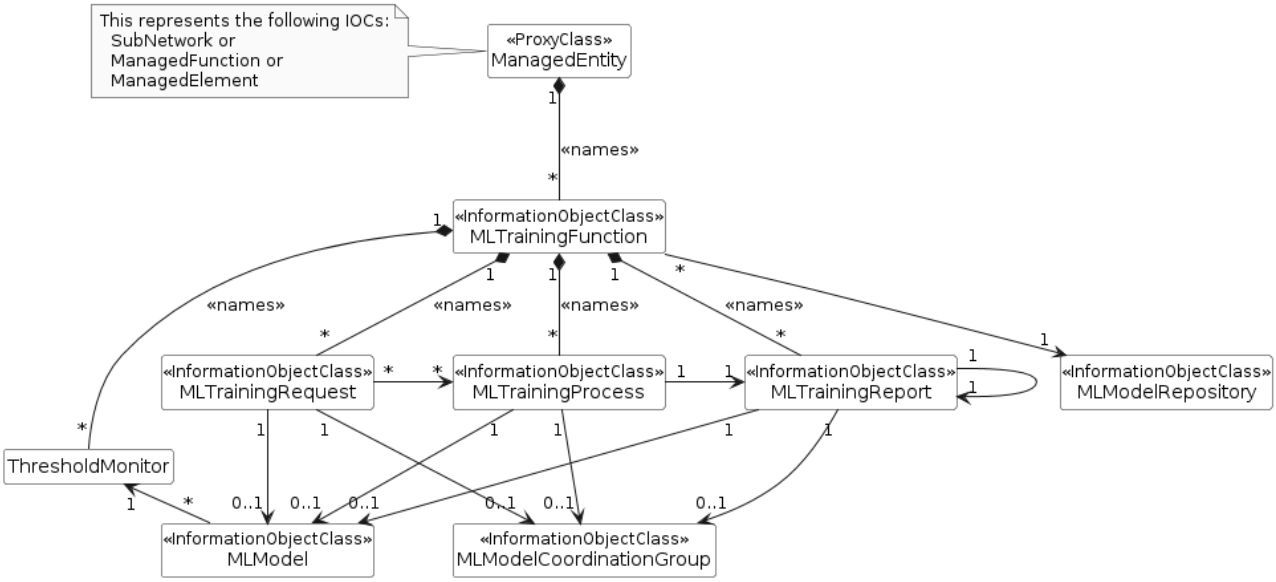


Figure 7.3a.1.1.1-1: NRM fragment for ML model training

7.3a.1.1.2 Inheritance

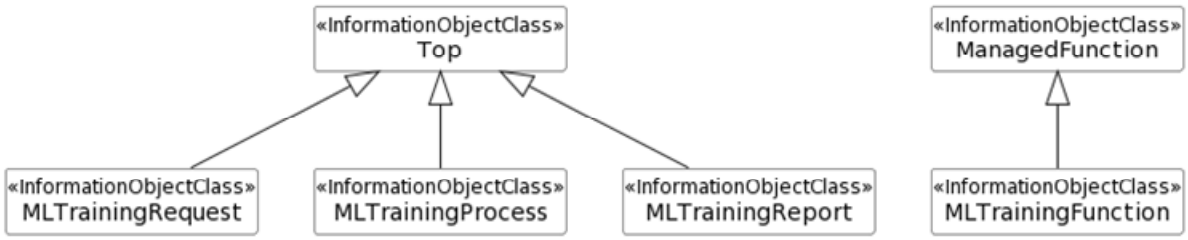


Figure 7.3a.1.1.2-1: Inheritance Hierarchy for ML model training related NRMs

7.3a.1.2 Class definitions

7.3a.1.2.1 `MLTrainingFunction`

7.3a.1.2.1.1 Definition

The IOC `MLTrainingFunction` represents the model that undertakes ML model training. The MOI of `MLTrainingFunction` is also the container of the `MLTrainingRequest, MLTrainingReport, MLTrainingProcess and ThresholdMonitor` MOI(s).

This `MLTrainingFunction` instance is created by the system (MnS producer) or pre-installed, it can only be deleted by the system.

The `ThresholdMonitor` contains the list of performance measurements and the corresponding thresholds that are monitored and used to identify the need for ML model re-training by the MnS Producer.

TheML training function represented by `MLTrainingFunction` MOI supports training of one or more `MLModel(s)`.

7.3a.1.2.1.2 Attributes

Table 7.3a.1.2.1.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
Attribute related to role					
mLModelRepositoryRef	M	T	F	F	T

7.3a.1.2.1.3 Attribute constraints

None.

7.3a.1.2.1.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.1.2.2 MLTrainingRequest

7.3a.1.2.2.1 Definition

The IOC MLTrainingRequest represents the ML model training request that is trigered by the ML training MnS consumer.

To trigger the ML model training process, ML training MnS consumer needs create MLTrainingRequest object instances on the ML training MnS producer. The MLTrainingRequest MOI is contained under one MLTrainingFunction MOI.

The MLTrainingRequest MOI may represent the request for initial ML model training or re-training. For ML model re-training, the MLTrainingRequest is associated to one MLModel for re-training a single ML model, or associated to one MLModelCoordinationGroup.

The MLTrainingRequest has a source to identify where it is coming from, which is represented with trainingRequestSource attribute. This attribute may be used by a ML Training MnS producer to prioritize the training resources for different sources.

Each MLTrainingRequest indicates the expectedRunTimeContext that describes the specific conditions for which the MLModel should be trained.

In case the request is accepted, the ML training MnS producer decides when to start the ML model training based on consumer requirements. Once the MnS producer decides to start the training based on the request, the ML training MnS producer instantiates one or more MLTrainingProcess MOI(s) that are responsible to perform the followings:

- collects (more) data for training, if the training data are not available or the data are available but not sufficient for the training;
- prepares and selects the required training data, with consideration of the consumer's request provided candidate training data if any. The ML training MnS producer may examine the consumer's provided candidate training data and select none, some or all of them for training. In addition, the ML training MnS producer may select some other training data that are available in order to meet the consumer's requirements for the ML model training;
- trains the MLModel using the selected and prepared training data.

The MLTrainingRequest may have a requestStatus field to represent the status of the specific MLTrainingRequest:

- The attribute values are "NOT_STARTED", " IN_PROGRESS", "SUSPENDED", "FINISHED", and "CANCELLED".

- When value turns to " IN_PROGRESS", the ML training MnS producer instantiates one or more `MLTrainingProcess` MOI(s) representing the training process(es) being performed per the request and notifies the MLT MnS consumer(s) who subscribed to the notification.

When all of the training process associated to this request are completed, the value turns to "FINISHED".

The ML training MnS prodcuer shall delete the corresponding `MLTrainingRequest` instance in case of the status value turns to "FINISHED" or "CANCELLED". The MnS producer may notify the status of the request to MnS consumer after deleting `MLTrainingRequest` instance.

7.3a.1.2.2.2 Attributes

Table 7.3a.1.2.2.1-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
aIMLInferenceName	CM	T	F	F	T
candidateTrainingDataSource	O	T	T	F	T
trainingDataQualityScore	O	T	T	F	T
trainingRequestSource	M	T	T	F	T
requestStatus	M	T	F	F	T
expectedRuntimeContext	M	T	T	F	T
performanceRequirements	M	T	T	F	T
cancelRequest	O	T	T	F	T
suspendRequest	O	T	T	F	T
Attribute related to role					
mLModelRef	CM	T	F	F	T
mLModelCoordinationGroupRef	CM	T	F	F	T

7.3a.1.2.2.3 Attribute constraints

Table 7.3a.1.2.2.3-1

Name	Definition
aIMLInferenceName Support Qualifier	Condition: `MLTrainingRequest` MOI represents the request for ML model initial training.
mLModelRef Support Qualifier	Condition: `MLTrainingRequest` MOI represents the request for ML model re-training.
mLModelCoordinationGroupRef Support Qualifier	Condition: `MLTrainingRequest` MOI represents the request for the joint training of an existing `mLModelCoordinationGroup`.

7.3a.1.2.2.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.1.2.3 `MLTrainingReport`

7.3a.1.2.3.1 Definition

The IOC `MLTrainingReport` represents the ML model training report that is provided by the training MnS producer. The `MLTrainingReport` is associated with one `MLModel` or one `MLModelCoordinationGroup`.

The `MLTrainingReport` instance is created by the training MnS producer automatically when creating an `MLTrainingRequest` instance.

The `MLTrainingReport` MOI is contained under one `MLTrainingFunction` MOI.

7.3a.1.2.3.2 Attributes

Table 7.3a.1.2.3.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
usedConsumerTrainingData	CM	T	F	F	T
modelConfidenceIndication	O	T	F	F	T
modelPerformanceTraining	M	T	F	F	T
areNewTrainingDataUsed	M	T	F	F	T
modelPerformanceValidation	O	T	F	F	T
Attribute related to role					
trainingRequestRef	CM	T	F	F	T
trainingProcessRef	M	T	F	F	T
lastTrainingRef	CM	T	F	F	T
mLModelGeneratedRef	M	T	F	F	T
mLModelCoordinationGroupGeneratedRef	CM	T	F	F	T
mLModelRef	M	T	F	F	T

7.3a.1.2.3.3 Attribute constraints

Table 7.3a.1.2.3.3-1

Name	Definition
trainingRequestRef Support Qualifier	Condition: The MLTrainingReport MOI represents the report for the ML model training that was requested by the MnS consumer (via MLTrainingRequest MOI).
lastTrainingRef Support Qualifier	Condition: The MLTrainingReport MOI represents the report for the ML model training that was not ML model initial training (i.e. the model has been trained before).
mLModelCoordinationGroupGeneratedRef Support Qualifier	Condition: The MLTrainingReport MOI represents the report for ML model joint training.

7.3a.1.2.3.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.1.2.4 MLTrainingProcess

7.3a.1.2.4.1 Definition

The IOC MLTrainingProcess represents the ML model training process. When a ML model training process starts, an instance of the MLTrainingProcess is created by the MnS Producer and notification is sent to MnS consumer who has subscribed to it.The MnS producer can delete the MLTrainingProcess instance whose attribute status equals to "FINISHED" or or "CANCELLED" automatically.

One MLTrainingProcess MOI may be instantiated for each MLTrainingRequest MOI or a set of MLTrainingRequest MOIs.

For each MLModel under training, a MLTrainingProcess is instantiated, i.e. an MLTrainingProcess is associated with one MLModel or one MLModelCoordinationGroup. The MLTrainingProcess may be associated with one or more MLTrainingRequest MOI.

The MLTrainingProcess does not have to correspond to a specific MLTrainingRequest, i.e. a MLTrainingRequest does not have to be associated to a specific MLTrainingProcess. The MLTrainingProcess may be managed separately from the MLTrainingRequest MOIs, e.g. the MLTrainingRequest MOI may come from consumers which are network functions while the operator may wish to manage the MLTrainingProcess that is instantiated following the requests. Thus, the MLTrainingProcess may be associated to either one or more MLTrainingRequest MOI.

Each MLTrainingProcess instance needs to be managed differently from the related MLModel, although the MLTrainingProcess may be associated to only one MLModel. For example, the MLTrainingProcess may be triggered to start with a specific version of the MLModel and multiple MLTrainingProcess instances may be triggered for different versions of the MLModel. In either case the MLTrainingProcess instances are still associated with the same MLModel but are managed separately from the MLModel.

Each MLTrainingProcess has a priority that may be used to prioritize the execution of different MLTrainingProcess instances.

Each MLTrainingProcess may have one or more termination conditions used to define the points at which the MLTrainingProcess may terminate.

The "progressStatus" attribute represents the status of the ML model training and includes information the ML training MnS consumer can use to monitor the progress and results. The data type of this attribute is "ProcessMonitor" (see 3GPP TS 28.622 [12]). The following specializations are provided for this data type for the ML model training process:

- The "status" attribute values are "RUNNING", "CANCELLING", "SUSPENDED", "FINISHED", and "CANCELLED". The other values are not used.
- The "timer" attribute is not used.
- When the "status" is equal to "RUNNING" the "progressStateInfo" attribute shall indicate one of the following states: "COLLECTING_DATA", "PREPARING_TRAINING_DATA", "TRAINING".
- No specifications are provided for the "resultStateInfo" attribute. Vendor specific information may be provided though.

When the training is completed with "status" equal to "FINISHED", the MLT MnS producer provides the training report, by creating an MLTrainingReport MOI, to the MLT MnS consumer.

7.3a.1.2.4.2 Attributes

Table 7.3a.1.2.4.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
priority	M	T	T	F	T
terminationConditions	M	T	T	F	T
progressStatus	M	T	F	F	T
cancelProcess	O	T	T	F	T
suspendProcess	O	T	T	F	T
Attribute related to role					
trainingRequestRef	CM	T	F	F	T
trainingReportRef	M	T	F	F	T
mLModelGeneratedRef	CM	T	F	F	T
mLModelRef	M	T	F	F	T

7.3a.1.2.4.3 Attribute constraints

Table 7.3a.1.2.4.3-1

Name	Definition
trainingRequestRef Support Qualifier	Condition: The MLTrainingReport MOI represents the report for the ML model training that was requested by the training MnS consumer (via MLTrainingRequest MOI).
mLModelGeneratedRef Support Qualifier	Condition: The MLTrainingProcess MOI is instantiated to retrain an existing MLModel.

7.3a.1.2.4.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.1b Information model definitions for ML model testing

7.3a.1b.1 Class diagram

7.3a.1b.1.1 Relationships

This clause depicts the set of classes (e.g. IOCs) that encapsulates the information relevant to ML model testing. For the UML semantics, see TS 32.156 [13].

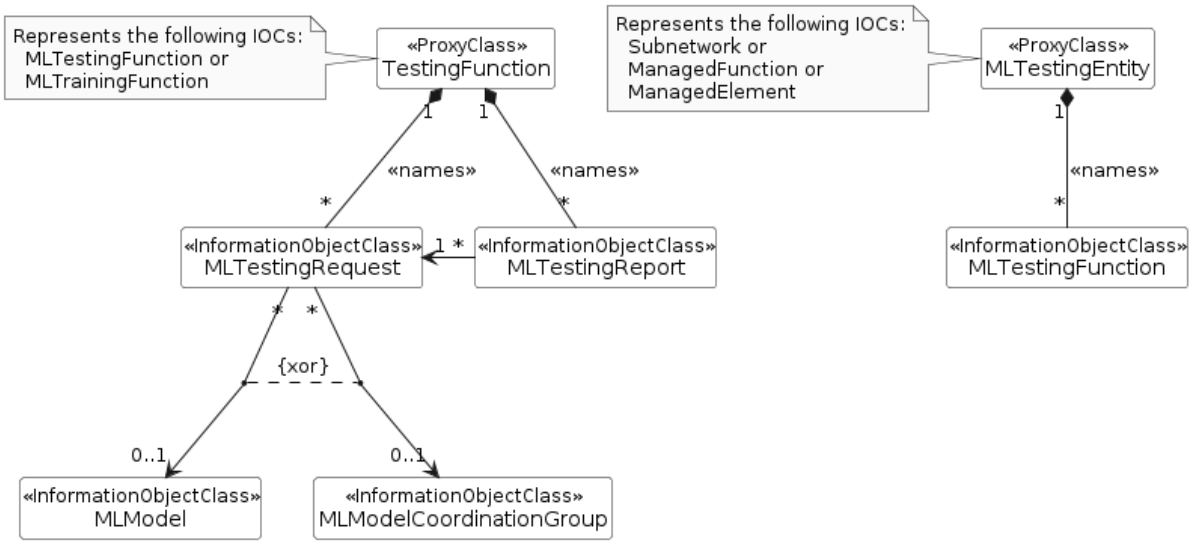


Figure 7.3a.1b.1.1-1: NRM fragment for ML model testing

7.3a.1b.1.2 Inheritance

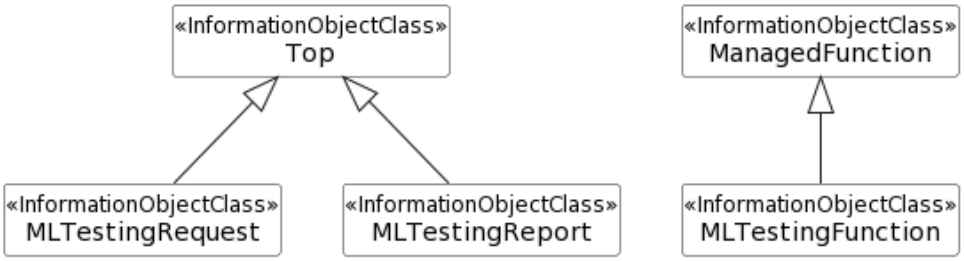


Figure 7.3a.1b.1.2-1: Inheritance Hierarchy for ML model testing related NRMs

7.3a.1b.2 Class definitions

7.3a.1b.2.1 MLTestingFunction

7.3a.1b.2.1.1 Definition

The ML model testing may be conducted by the ML training function, or by a separate function.

This `MLTestingFunction` instance is created by the system (MnS producer) or pre-installed, it can only be deleted by the system.

In case the ML model testing is conducted by a function separate from the ML training function, the IOC `MLTestingFunction` is instantiated and represents the logical function that undertakes ML model testing.

The model represented by `MLTestingFunction MOI` supports testing of one or more `MLModel(s)`.

7.3x.1b.2.1.2 Attributes

Table 7.3a.1b.2.1.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
mLModelRef	M	T	F	F	F

7.3a.1b.2.1.3 Attribute constraints

None.

7.3a.1b.2.1.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.1b.2.2 `MLTestingRequest`

7.3a.1b.2.2.1 Definition

The IOC `MLTestingRequest` represents the ML model testing request that is triggered by the ML testing MnS consumer.

To trigger the ML model testing process, ML testing MnS consumer needs to create `MLTrainingRequest`.

The `MLTestingRequest` MOI is contained under one `MLTestingFunction` MOI or `MLTrainingFunction` MOI which represents the logical function that conducts the ML model testing. Each `MLTestingRequest` is associated to at least one `MLModel.`

In case the request is accepted, the ML testing MnS producer decides when to start the ML model testing. Once the MnS producer decides to start the testing based on the request, the ML testing MnS producer:

- collects (more) data for testing, if the testing data are not available or the data are available but not sufficient for the testing;
- prepares and selects the required testing data;
- tests the `MLModel` by performing inference using the selected testing data, and
- reports the performance of the `MLModel` when it performs on the selected testing data.

The `MLTestingRequest` may have a `requestStatus` field to represent the status of the request:

- The attribute values are "NOT_STARTED", "IN_PROGRESS", "SUSPENDED", "FINISHED", and "CANCELLED".

The ML testing MnS prodcuer shall delete the corresponding `MLTestingRequest` instance in case of the status value turns to "FINISHED" or "CANCELLED". The MnS producer may notify the status of the request to MnS consumer before deleting `MLTestingRequest` instance.

7.3a.1b.2.2.2 Attributes

Table 7.3a.1b.2.2.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
requestStatus	M	T	F	F	T
cancelRequest	O	T	T	F	T
suspendRequest	O	T	T	F	T
Attribute related to role					
mLModelRef	CM	T	F	F	T
mLModelCoordinationGroupRef	CM	T	F	F	T

7.3a.1b.2.2.3 Attribute constraints

Table 7.3a.1.2.6.3-1

Name	Definition
mLModelRef Support Qualifier	Condition: The MLTestingRequest MOI represents the request for testing of a single ML model.
mLModelCoordinationGroupRef Support Qualifier	Condition: The MLTestingRequest MOI represents the request for joint testing of a group of ML models.

7.3a.1b.2.2.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.1b.2.3 MLTestingReport

7.3a.1b.2.3.1 Definition

The IOC MLTestingReport represents the ML testing report that is provided by the ML testing MnS producer.

The MLTestingReport MOI is contained under one MLTestingFunction MOI or MLTrainingFunction MOI which represents the logical function that conducts the ML model testing.

For the joint testing of a group of ML models, the ML testing report contains the testing results for every ML model in the group.

The MLTestingReport instance is created by the ML testing MnS producer and notification is sent to ML testing Consumer who has subscribed to it.

7.3a.1b.2.3.2 Attributes

Table 7.3a.1b.2.3.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
modelPerformanceTesting	M	T	F	F	T
mLTestingResult	M	T	F	F	T
Attribute related to role					
testingRequestRef	CM	T	F	F	T

7.3a.1b.2.3.3 Attribute constraints

Table 7.3a.1b.2. 3.3-1

Name	Definition
`testingRequestRef` Support Qualifier	Condition: The `MLTestingReport` MOI represents the report for the ML model testing that was requested by the MnS consumer (via `MLTestingRequest` MOI).

7.3a.1b.2.3.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.2 Information model definitions for AI/ML inference emulation

7.3a.2.1 Class diagram

7.3a.2.1.1 Relationships

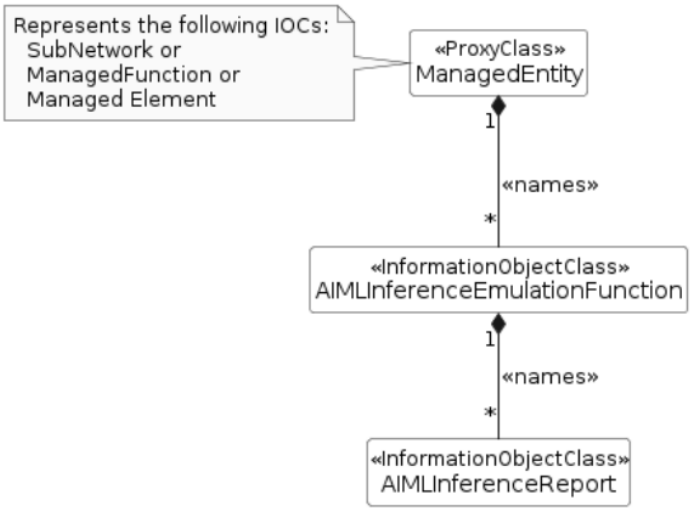


Figure 7.3a.2.1.1-1: NRM fragment for AI/ML inference emulation control

7.3a.2.1.2 Inheritance

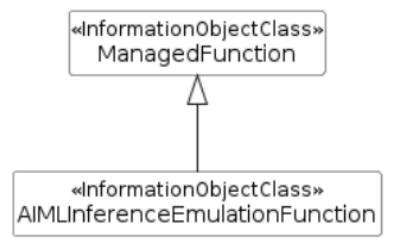


Figure 7.3a.2.1.2-1: AI/ML inference emulation Inheritance Relations

7.3a.2.2 Class definitions

7.3a.2.2.1 `AIMLInferenceEmulationFunction`

7.3a.2.2.1.1 Definition

This IOC represents the properties of a function that undertakes AI/ML Inference Emulation.

This `AIMLInferenceEmulationFunction` instance is created by the system (AI/ML inference emulation MnS producer) or pre-installed, it can only be deleted by the system.

An `AIMLInferenceEmulationFunction` may be associated with one or more `MLModel(s).AIMLInferenceFunction` is name contained with `AIMLInferenceEmulationReport(s)` that delivers the outcomes of the emulation processes.

NOTE: The way of triggering of an AI/ML inference emulation and the instantiation of the related AI/ML inference emulation process is not in the scope of the present document.

7.3a.2.2.1.2 Attributes

The `AIMLInferenceEmulationFunction` IOC includes attributes inherited from `ManagedFunction` IOC (defined in TS 28.622 [30]).

7.3a.2.2.1.3 Attribute constraints

None.

7.3a.2.2.1.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.3 Information model definitions for ML model deployment

7.3a.3.1 Class diagram

7.3a.3.1.1 Relationships

This clause depicts the set of classes (e.g. IOCs) that encapsulates the information relevant to ML model loading. For the UML semantics, see TS 32.156 [13].

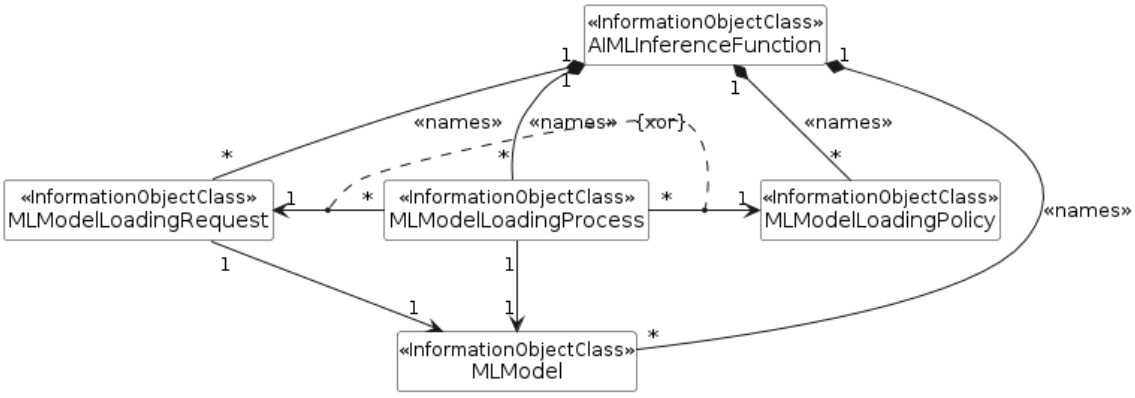


Figure 7.3a.3.1.1-1: NRM fragment for ML model loading

7.3a.3.1.2 Inheritance

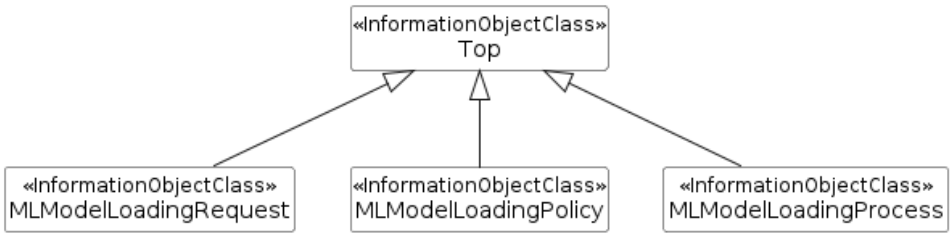


Figure 7.3a.3.1.2-1: Inheritance Hierarchy for ML model loading related NRMs

7.3a.3.2 Class definitions

7.3a.3.2.1 `MLModelLoadingRequest`

7.3a.3.2.1.1 Definition

This IOC represents the ML model loading request that is created by the MnS consumer. Using this IOC, the MnS consumer requests the MnS producer to load an ML model to the target inference function.

To trigger the ML model loading process, MnS consumer has to create `MLModelLoadingRequest` object instances on the MnS producer.

This `IOC` has a `requestStatus` field to represent the status of the request:

- The attribute value is one of "NOT_STARTED", "IN_PROGRESS", "SUSPENDED", "FINISHED_SUCCESS ", FINISHED_FAILED" and "CANCELLED".
- When value turns to "IN_PROGRESS", the MnS producer instantiates one or more `MLModelLoadingProcess` MOI(s) representing the loading process(es) being performed per the request and notifies the MnS consumer(s) who subscribed to the notification.

The MnS prodcuer shall delete the corresponding `MLModelLoadingRequest` instance in case of the status value turns to "FINISHED" or "CANCELLED".

7.3a.3.2.1.2 Attributes

Table 7.3a.3.2.1.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
`requestStatus`	M	T	T	F	T
`cancelRequest`	O	T	T	F	T
`suspendRequest`	O	T	T	F	T
Attribute related to role					
`mLModelToLoadRef`	M	T	F	F	T

7.3a.3.2.1.3 Attribute constraints

None.

7.3a.3.2.1.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.3.2.2 MLModelLoadingPolicy

7.3a.3.2.2.1 Definition

This IOC represents the ML model loading policy set by the MnS consumer to the producer for loading an ML model to the target inference function(s).

To specify ML model loading policy for one or muiltiply ML models, MnS consumer needs to create MLModelLoadingPolicy object instances.

To remove ML model loading policy for one or muiltiply ML models, MnS consumer needs to delete MLModelLoadingPolicy object instances.

This IOC is used for the MnS consumer to set the conditions for the producer-initated ML model loading. The MnS producer is only allowed to load the ML model when all of the conditions are met.

7.3a.3.2.2.2 Attributes

Table 7.3a.3.2.2.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
aIMLInferenceName	CM	T	T	F	T
policyForLoading	M	T	T	F	T
Attribute related to role					
mLModelRef	CM	T	F	F	F

7.3a.3.2.2.3 Attribute constraints

Table 7.3a.3.2.2.3-1

Name	Definition
aIMLInferenceName Support Qualifier	Condition: The ML model loading policy is related to an initially trained ML model.
mLModelRef Support Qualifier	Condition: The ML model loading policy is related to a re-trained ML model.

7.3a.3.2.2.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.3.2.3 MLModelLoadingProcess

7.3a.3.2.3.1 Definition

This IOC represents the ML model loading process.

For the consumer requested ML model loading, one or more MLModelLoadingProcess MOI(s) may be instantiated for each ML model loading request presented by the MLModelLoadingRequest MOI.

For the producer-initiated ML model loading, one or more MLModelLoadingProcess MOI(s) may be instantiated and associated with each MLModelLoadingPolicy MOI.

One MLModelLoadingProcess MOI represent the ML model loading process(es) corresponding to one or more target inference function(s).

The "progressStatus" attribute represents the status of the ML model loading process and includes information the MnS consumer can use to monitor the progress and results. The data type of this attribute is "ProcessMonitor" (see 3GPP TS 28.622 [12]). The following specializations are provided for this data type for the ML model loading process:

- The "status" attribute values are "RUNNING", "CANCELLING", "SUSPENDED", "FINISHED", and "CANCELLED". The other values are not used.

- The "timer" attribute is not used.
- When the "status" is equal to "RUNNING" the "progressStateInfo" attribute shall indicate one of the following state: "LOADING".
- No specifications are provided for the "resultStateInfo" attribute. Vendor specific information may be provided though.

When the loading is completed with "status" equal to "FINISHED", the MnS producer creates the MOI(s) of loaded MLModel under each MOI of the target inference function(s).

When a ML model loading process starts, an instance of the MLModelLoadingProcess is created by the MnS Producer and notification is sent to MnS consumers who have subscribed to it. The MnS producer can delete the MLModelLoadingProcess instance whose attribute status equals to "FINISHED" or or "CANCELLED" automatically.

7.3a.3.2.3.2 Attributes

Table 7.3a.3.2.3.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
progressStatus	M	T	F	F	T
cancelProcess	O	T	T	F	T
suspendProcess	O	T	T	F	T
Attribute related to role					
mLModelLoadingRequestRef	CM	T	F	F	T
mLModelLoadingPolicyRef	CM	T	F	F	T
loadedMLModelRef	M	T	F	F	T

7.3a.3.2.3.3 Attribute constraints

Table 7.3a.3.2.3.3-1

Name	Definition
mLModelLoadingRequestRef Support Qualifier	Condition: The MLModelLoadingProcess MOI is corresponding to the ML model loading requested by the MnS consumer.
mLModelLoadingPolicyRef Support Qualifier	Condition: The MLModelLoadingProcess MOI is corresponding to the ML model loading initiated by the MnS producer.

7.3a.3.2.3.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.4 Information model definitions for ML inference

7.3a.4.1 Class diagram

7.3a.4.1.1 Relationships

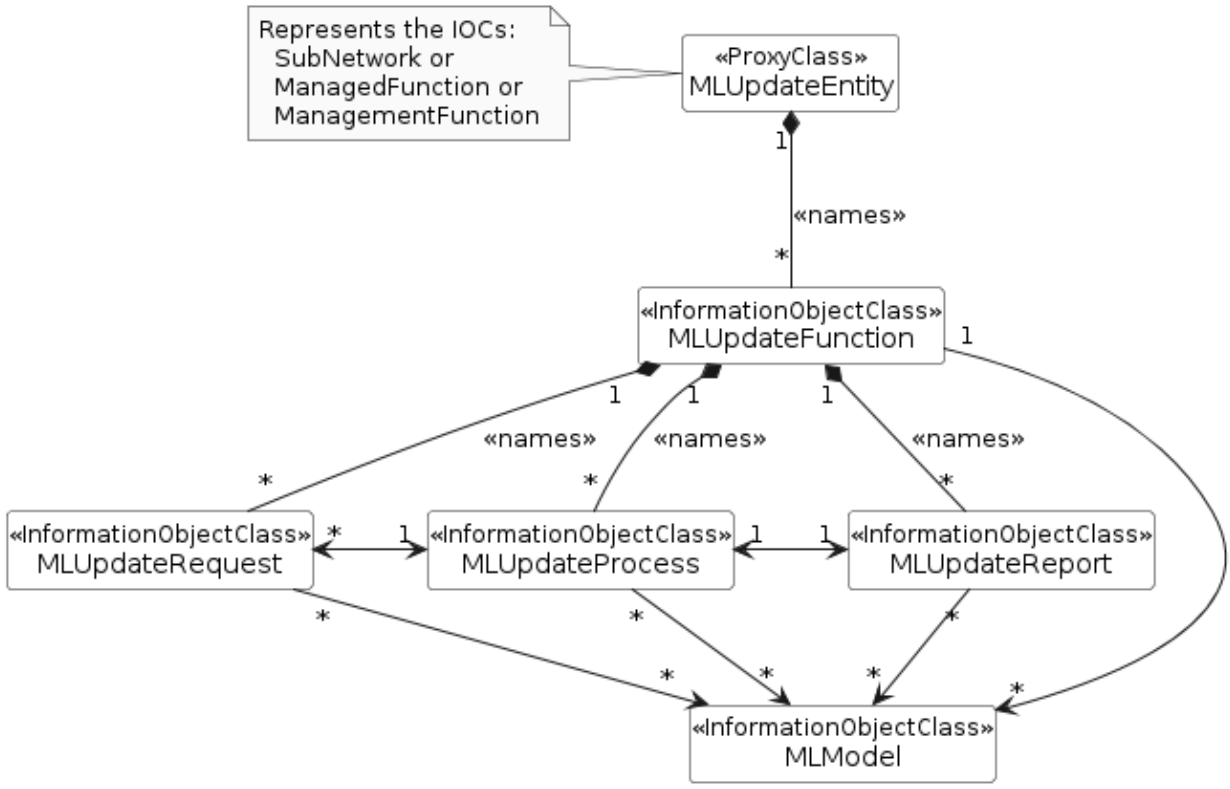
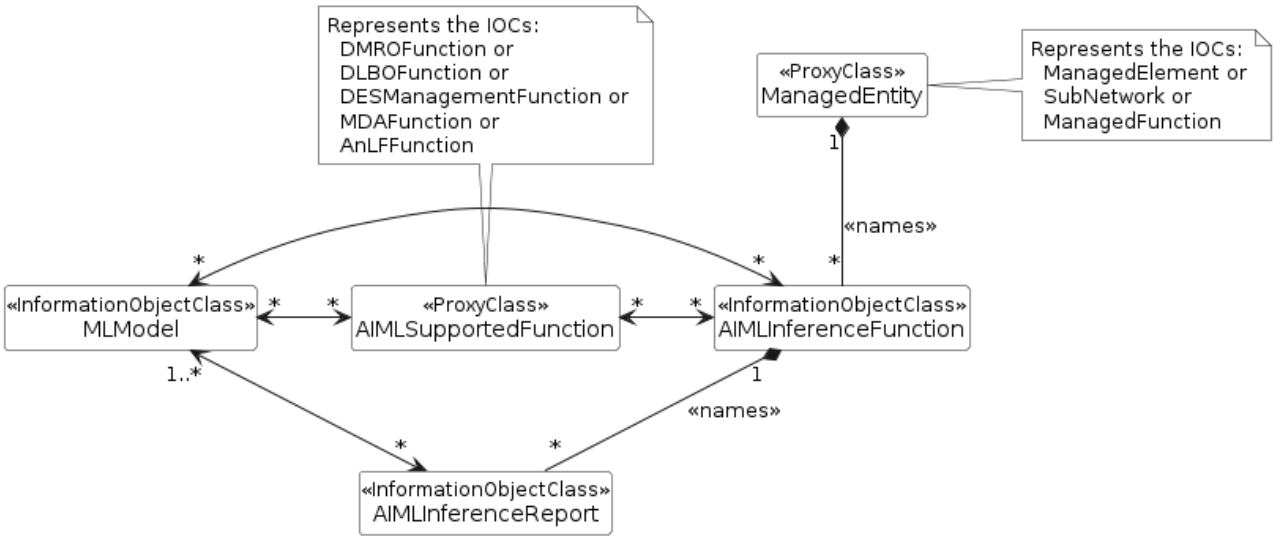


Figure 7.3a.4.1.1-1: NRM fragment for ML update



NOTE 1: The `ManagedEntity` and `AIMLSupportedFunction` shall not represent the same MOI.

NOTE 2: For AnLFFunction, DMROFunction, DLBOFunction, and DESManagementFunction see [18] and for MDAFunction see [2].

Figure 7.3a.4.1.1-2: NRM fragment for AI/ML inference function

7.3a.4.1.2 Inheritance

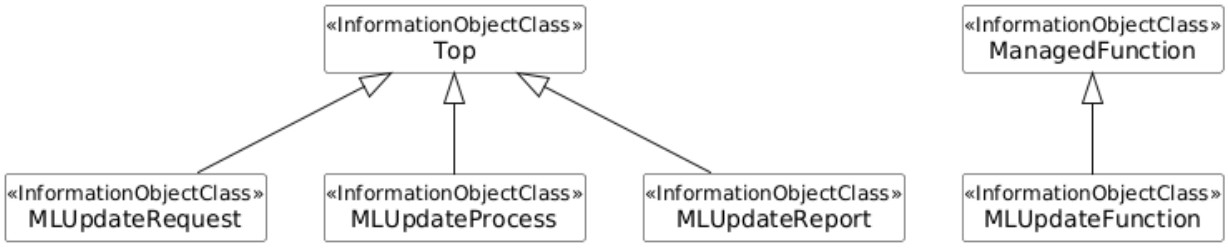


Figure 7.3a.4.1.2-1: Inheritance Hierarchy for ML update related NRMs

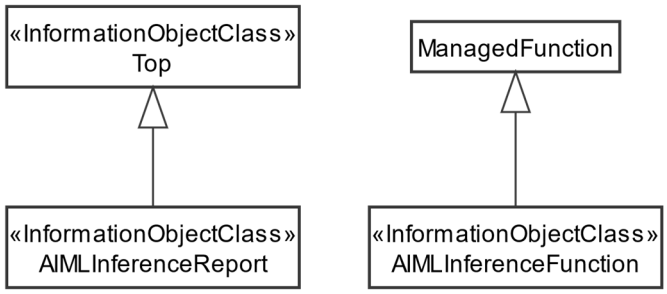


Figure 7.3a.4.1.2-2: Inheritance Hierarchy for AI/ML inference function

7.3a.4.2 Class definitions

7.3a.4.2.1 `MLUpdateFunction`

7.3a.4.2.1.1 Definition

This IOC represents the function responsible for ML update.

This `MLUpdateFunction` instance can be created by the system or pre-installed.

The MOI of `MLUpdateFunction` is name-contained in an MOI of either a `subnetwork`, a `managedFunction` or a `managementFunction`.

The `MLUpdateFunction` is be associated with one or more ML models.

The `MLUpdateFunction` contains one or more `MLUpdateRequest(s)`as well as one or more `MLUpdateProcess(s)`, where an `MLUpdateProcess` is instantiated corresponding to one received `MLUpdateRequest`.

7.3a.4.2.1.2 Attributes

The `MLUpdateFunction` IOC includes attributes inherited from `ManagedFunction` IOC (defined in TS 28.622 [12]) and the following attributes:

Table 7.3a.4.2.1.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
`availMLCapabilityReport`	M	T	F	F	F
Attributes related to Role					
`mLModelRef`	M	T	F	F	F

7.3a.4.2.1.3 Attribute constraints

None.

7.3a.4.2.1.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.4.2.2 `MLUpdateRequest`

7.3a.4.2.2.1 Definition

This IOC represents the properties of `MLUpdateRequest`.

For each request to update the ML capabilities, a consumer creates a new MOI of `MLUpdateRequest` on the `MLUpdateFunction`, i.e., `MLUpdateRequest` is instantiated for each request for updating ML capabilities:

- Each `MLUpdateRequest` is associated to at least one `MLModel`
- Each `MLUpdateRequest` may have a `RequestStatus` field that is used to track the status of the specific `MLUpdateRequest` or the associated `MLUpdateProcess`. The `RequestStatus` is updated by MnS producer when there is a change in status of the update progress. The `RequestStatus` is an enumeration with the values: NOT_STARTED, IN_PROGRESS, CANCELLING, SUSPENDED, FINISHED, and CANCELLED
- Each `MLUpdateRequest` may contain specific reporting requirements including an `mLUpdateReportingPeriod` that defines the time duration upon which the MnS consumer expects the ML update is reported. The reporting requirements contained in the `MLUpdateRequest` are mapped to an existing `MLUpdateProcess` instance.
- The `MLUpdateRequest` may specify a `performanceGainThreshold` which defines the minimum performance gain that shall be achieved with the capability update. This implies that the difference in the performances between the existing capabilities and the new capabilities needs to be at least `performanceGainThreshold`, otherwise the new capabilities shall not be applied. A threshold of `performanceGainThreshold`=0% implies that the capabilities should be applied even if there is no noticeable performance gain.
- The `MLUpdateRequest` may indicates the maximum time that should be taken to complete the update.

To trigger the ML update process, MnS consumer needs to create `MLUpdateRequest` instances on the MnS producer.

The MnS prodcuer shall delete the corresponding `MLUpdateRequest` instance in case of the status value turns to "FINISHED" or "CANCELLED".

7.3a.4.2.2.2 Attributes

The `MLUpdateRequest` IOC includes attributes inherited from `Top` IOC (defined in TS 28.622 [30]) and the following attributes:

Table 7.3a.4.2.2.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
performanceGainThreshold	O	T	T	T	F
newCapabilityVersionId	O	T	T	T	F
updateTimeDeadline	O	T	T	T	F
requestStatus	M	T	T	F	T
mLUpdateReportingPeriod	O	T	T	F	T
cancelRequest	O	T	T	F	T
suspendRequest	O	T	T	F	T
Attributes related to Role					
mLUpdateProcessRef	M	T	F	F	F
mLModelRefList	M	T	F	F	F

7.3a.4.2.2.3 Attribute constraints

None.

7.3a.4.2.2.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.4.2.3 MLUpdateProcess

7.3a.4.2.3.1 Definition

This IOC represents the ML update process.

For each MLUpdateRequest to update the ML capabilities, the MLUpdateProcess is instantiated for the MLUpdateRequest unless the MLUpdateRequest is associated with an ongoing MLUpdateProcess if the MLUpdateProcess is updating the same MLModel(s) as stated in the MLUpdateRequest i.e., the MLUpdateProcess is associated with at least one MLUpdateRequest. Relatedly, the MLUpdateProcess is associated with at least one MLModel.

- Each MLUpdateProcess may have a status attribute (i.e., progressStatus) used to indicate progress status of theupdate process.
- The MLUpdateProcess has the capability of compiling and delivering reports and notifications relating to the ML update request or process.

When a ML update process starts, an instance of the MLUpdateProcess is created by the MnS Producer and informed to MnS consumer who has subscribed to it. The MnS producer can delete the MLUpdateProcess instance whose attribute status equals to "FINISHED" or or "CANCELLED".

7.3a.4.2.3.2 Attributes

The MLUpdateProcess IOC includes attributes inherited from Top IOC (defined in TS 28.622 [30]) and the following attributes:

Table 7.3a.4.2.3.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
cancelProcess	O	T	T	F	T
suspendProcess	O	T	T	F	T
progressStatus	M	T	F	F	T
Attributes related to Role					
mLModelRefList	M	T	F	F	T
mLUpdateRequestRefList	M	T	F	F	T
mLUpdateReportRef	M	T	F	F	T

7.3a.4.2.3.3 Attribute constraints

None.

7.3a.4.2.3.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.4.2.4 MLUpdateReport

7.3a.4.2.4.1 Definition

This IOC represents the properties of MLUpdateReport.

- The ML update process may generate one or more MLUpdateReport(s).
- Each MLUpdateReport is associated to one or more MLModel (s) to indicate ML models that have been updated.
- The MLUpdateReport may indicate the achieved performance gain for the specific ML capability update, which is the gain in performance of the new capabilities compared with the original capabilities.
- MLUpdateReport provides reports about MLModel (s) or MLUpdateProcess(s) that themselves are associated with MLModel (s) for which update is requested and/or executed. Correspondingly, both the MLUpdateRequest(s) and the MLUpdateProcess(s) are conditionally mandatory in that at least one of them must be associated with an instance of MLUpdateReport.

The MLUpdateReport instance can be created by the MnS producer when creating an MLUpdateRequest instance.

When the MnS producer delete a MLUpdateRequest instance, the corresponding MLUpdateReport instance is also deleted by MnS producer.

7.3a.4.2.4.2 Attributes

Table 7.3a.4.2.4.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
updatedMLCapability	M	T	F	F	F
Attributes related to Role					
mLModelRefList	M	T	F	F	F
mLUpdateProcessRef	M	T	F	F	F

7.3a.4.2.4.3 Attribute constraints

None.

7.3a.4.2.4.4 Notifications

The notifications specified for the IOC using this <<datatype>> for its attribute(s), shall be applicable.

7.3a.4.2.5 AIMLInferenceFunction

7.3a.4.2.5.1 Definition

This IOC represents the common properties of the AI/ML inference function.

This AIMLInferenceFunction instance can be created by the system or pre-installed.

The AIMLInferenceFunction MOI may be associated with one or more MOIs that represent the functions/functionalities (Note) provided by the subject AIMLInferenceFunction MOI.

The AIMLInferenceFunction MOI can be only created by the MnS producer but not consumer.

The MOI of AIMLInferenceFunction or the MOI of the IOC inheriting from the AIMLInferenceFunction IOC contains one or more MOI(s) of MLModel.

NOTE: The IOCs representing the functions/functionalities (Note) that use the AI/ML inference function include MDAFunction, AnLFFunction, DMROFunction, DLBOFunction, and DESManagementFunction.

The AIMLInferenceFunction MOI may be contained by either a SubNetwork MOI, a ManagedElement MOI, or an MOI of ManagedFunction's subclass, and it is allowed for an MnS producer to support multiple AIMLInferenceFunction MOIs contained in different superordinated MOIs among SubNetwork, ManagedElement and the ManagedFunction's subclass.

The generation of inference outputs is based on the configuration of inference, e.g., to start a stated time, or to be executed at all times. The observations of the inference function and information on derived Outputs is registered in the inference report.

7.3a.4.2.5.2 Attributes

Table 7.3a.4.2.5.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
activationStatus	M	T	T	F	T
managedActivationScope	O	T	T	F	T
Attributes related to role					
usedByFunctionRefList	M	T	F	F	T
mLModelRefList	M	T	F	T	T

7.3a.4.2.5.3 Attribute constraints

None.

7.3a.4.2.5.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.3a.4.2.6 AIMLInferenceReport

7.3a.4.2.6.1 Definition

This IOC represents a report from a AI/ML Inference.

An AIMLInferenceFunction may generate one or more AIMLInferenceReport(s).

Each AIMLInferenceReport provides information about inference outputs from one or more MLModel.

The AIMLInferenceReport also provides historical inference outputs for a series of time stamps.

The AIMLInferenceReport instance can be created by the MnS producer when creating an AIMLInferenceFunction instance.

7.3a.4.2.6.2 Attributes

The AIMLInferenceReport includes inherited attributes from Top IOC (defined in TS28.622 [12]) and the following attributes:

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
inferenceOutputs	M	T	F	F	T
Attributes related to role					
mLModelRef	M	T	F	F	T

7.3a.4.2.6.3 Attribute constraints

None.

7.3a.4.2.6.4 Notifications

The common notifications defined in clause 7.6 are valid for this IOC, without exceptions or additions.

7.4 Data type definitions

7.4.1 ModelPerformance <<dataType>>

7.4.1.1 Definition

This data type specifies the performance of an ML model when performing training and inference. The performance score is provided for each inference output.

7.4.1.2 Attributes

Table 7.4.1.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
inferenceOutputName	M	T	T/F (NOTE)	F	T
performanceScore	M	T	T/F (NOTE)	F	T
performanceMetric	M	T	T/F (NOTE)	F	T
decisionConfidenceScore	O	T	F	F	T
NOTE: The isWritable qualifier is “T” if the attribute is used in MLTrainingRequest. The isWritable qualifier is "F" otherwise.					

7.4.1.3 Attribute constraints

None.

7.4.1.4 Notifications

The notifications specified for the IOC using this <<dataType>> for its attribute(s), shall be applicable.

7.4.2 Void

7.4.3 MLContext <<dataType>>

7.4.3.1 Definition

The `MLContext` represents the status and conditions related to the `MLModel`. There are three types of context - the `ExpectedRunTimeContext`, the `trainingContext` and the `RunTimeContext,` see clause 7.5.1 for details of each type.

7.4.3.2 Attributes

Table 7.4.3.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
`inferenceEntityRef`	CM	T	F	F	F
`dataProviderRef`	M	T	F	F	F

7.4.3.3 Attribute constraints

Table 7.4.3.3-1

Name	Definition
inferenceEntityRef Support Qualifier	Condition: The `MLContext` is used for `expectedRunTimeContext`, `trainingContext` or `runTimeContext`.

7.4.3.4 Notifications

The notifications specified for the IOC using this <<dataType>> for its attribute(s), shall be applicable.

7.4.4 SupportedPerfIndicator <<dataType>>

7.4.4.1 Definition

This data type specifies a Performance indicator of an ML model. The data type may be used to indicate which performance indicators shall be applicable to either of training, testing or inference.

7.4.4.2 Attributes

Table 7.4.4.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
performanceIndicatorName	M	T	F	F	T
isSupportedForTraining	CM	T	F	F	T
isSupportedForTesting	CM	T	F	F	T

7.4.4.3 Attribute constraints

Table 7.4.4.3-1

Name	Definition
isSupportedForTraining Support Qualifier	Condition: if the performance indicator named performanceIndicatorName is applicable for training, the isSupportedforTraining must be stated
isSupportedForTesting Support Qualifier	Condition: if the performance indicator named performanceIndicatorName is applicable for testing, the isSupportedForTesting must be stated

7.4.4.4 Notifications

The notifications specified for the IOC using this <<dataType>> for its attribute(s), shall be applicable.

7.4.5 AvailMLCapabilityReport <<dataType>>

7.4.5.1 Definition

This dataType represents the the report of available ML capabilities following the update for specific ML capability(es).

- The ML update process may generate one or more availMLCapabilityReport (s), which indicate to the consumer that new ML capability(es) is/are available and can be applied.

- Each availMLCapabilityReport is associated to one or more MLModel(s) and may indicate the one or more MLModel(s) to which it applies.

- The availMLCapabilityReport may include CapabilityVersions which indicate that there are multiple candidate sets of available ML capabilities with a different version number for each set.

- The availMLCapabilityReport may include the expectedPerformanceGains, which provides information on the expected performance gain if/when the ML capabilities of the respective network function are updated with/to the specific set of newly available ML capabilities.

7.4.5.2 Attributes

The AvailMLCapabilityReport includes the following attributes:

Table 7.4.5.2-1Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
availMLCapabilityReportID	M	T	F	F	T
mLCapabilityVersionId	M	T	F	F	T
expectedPerformanceGains	O	T	F	F	T
Attributes related to Role					
mLModelRef	M	T	F	F	T

7.4.5.3 Attribute constraints

None.

7.4.5.4 Notifications

The notifications specified for the IOC using this <<datatype>> for its attribute(s), shall be applicable.

7.4.6 AIMLManagementPolicy <<dataType>>

7.4.6.1 Definition

This data type represents the properties of a policy for AI/ML management.

7.4.6.2 Attributes

Table 7.4.6.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
thresholdList	M	T	T	F	T
managedActivationScope	M	T	T	F	T

7.4.6.3 Attribute constraints

None.

7.4.6.4 Notifications

The notifications specified for the IOC using this <<dataType>> for its attribute(s), shall be applicable.

7.4.7 ManagedActivationScope <<choice>>

7.4.7.1 Definition

This <<choice>> defines the scopes for activating or deactivating the ML Inference function. It is a choice between the scopes parameter required for the activation or deactivation.

7.4.7.2 Attributes

Table 7.4.7.2-1

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
CHOICE_1.1 dNList	CM	T	T	F	T
CHOICE_1.2 timeWindow	CM	T	T	F	T
CHOICE_1.3 geoPolygon	CM	T	T	F	T

7.4.7.3 Attribute constraints

Table 7.4.7.3-1

Name	Definition
dNList Support Qualifier CM	Condition: if the sub scope is per list of managed elements (e.g., DN list)
timeWindow Support Qualifier CM	Condition: if the sub scope is per list of time window.
geoPolygon Support Qualifier CM	Condition: if the sub scope is per list of GeoArea.

7.4.7.4 Notifications

The notifications specified for the IOC using this <<dataType>> for its attribute(s), shall be applicable.

7.4.8. MLCapabilityInfo <<dataType>>

7.4.8.1. Definition

This dataType represents information about what the ML model can make inference for. The capabilityName is used as the identifier for the ML capability.

7.4.8.2 Attributes

The MLCapabilityInfo <<dataType>> includes the following attributes:

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
aIMLInferenceName	M	T	F	F	T
capabilityName	O	T	F	F	T
mLCapabilityParameters	O	T	F	F	T

7.4.8.3 Attribute constraints

None.

7.4.8.4 Notifications

The notifications specified for the IOC using this <<dataType>> for its attribute(s), shall be applicable.

7.4.9 InferenceOutput <<dataType>>

7.4.9.1 Definition

This dataType represents the properties of the content of an inference output.

The inference output contains a time stamp which indicates the time at which the inference output is generated.

7.4.9.2 Attributes

The InferenceOutput includes the following attributes:

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
inferenceOutputId	M	T	F	F	T
aIMLInferenceName	M	T	F	F	T
inferenceOutputTime	M	T	F	F	T
inferencePerformance	O	T	F	F	T
outputResult	M	T	F	F	T

NOTE: The relation between the Output and Outputs of other instances like MDA is not addressed in the present document

7.4.9.3 Attribute constraints

None.

7.4.9.4 Notifications

The notifications specified for the IOC using this <<datatype>> for its attribute(s), shall be applicable.

7.4.10 AIMLInferenceName <<choice>>

7.4.10.1 Definition

This <<choice>> represents the type of inference that the ML model supports.

7.4.10.2 Attributes

Attribute name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
CHOICE_1.1 mDAType	M	T	T	F	T
CHOICE_2.1 nwdafAnalyticsType	M	T	T	F	T
CHOICE_3.1 ngRanInferenceType	M	T	T	F	T
CHOICE_4.1 vSExtensionType	O	T	T	F	T

7.4.10.3 Attribute constraints

Name	Definition
CHOICE_1.1 mDAType	This attribute shall be supported, when the MnS producer supports management of AI/ML inference for MDA
CHOICE_2.1 nwdafAnalyticsType	This attribute shall be supported, when the MnS producer supports management of AI/ML inference for NWDAF
CHOICE_3.1 ngRanInferenceType	This attribute shall be supported, when the MnS producer supports management of AIML inference for NG-RAN
CHOICE_4.1 vSExtensionType	This attribute shall be supported, when the MnS producer supports a management activity for an ML model with inference name is vendor's specific extensions

7.4.10.4 Notifications

The notifications specified for the IOC using this <<datatype>> for its attribute(s), shall be applicable.

7.4a Enumerations

7.4a.1 NgRanInferenceType <<enumeration>>

Table 7.4a.1-1: <<enumeration>> NgRanInferenceType

Enumeration value	Description
"NG_RAN_NETWORK_ENERGY_SAVING"	Indicates that the NgRanInferenceType for the Network Energy Saving defined in TS 38.300 [16]
"NG_RAN_LOAD_BALANCING"	Indicates that the NgRanInferenceType for Load Balancing defined in TS 38.300 [16]
"NG_RAN_ MOBILITY_OPTIMIZATION"	Indicates that the NgRanInferenceType for the Mobility Optimization defined in TS 38.300 [16]

7.5 Attribute definitions

7.5.1 Attribute properties

Table 7.5.1-1

Attribute Name	Documentation and Allowed Values	Properties
mLModelId	It identifies the ML model. It is unique in each MnS producer. allowedValues: N/A.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
candidateTrainingDataSource	It provides the address(es) of the candidate training data source provided by MnS consumer. The detailed training data format is vendor specific. allowedValues: N/A.	type: String multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
aIMLInferenceName	It indicates the type of inference that the ML model supports. allowedValues: see clause 7.4.10	type: AIMLInferenceName multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
mDAType	It indicates the type of inference that the ML model for MDA supports. The detailed definition and corresponding allowed values for mDAType see TS 28.104 [2].	type: MDAType (TS 28.104 [2]) multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
nwdafAnalyticsType	It indicates the type of inference that the ML model for NWDAF supports. The detailed definition and corresponding allowed values for nwdafAnalyticsID see NwdafEvent in TS 29.520 [20].	type: NwdafEvent (TS 29.520 [20]) multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
ngRanInferenceType	It indicates the type of inference that the ML model for NG-RAN supports. The detailed definition and corresponding allowed values for ngRanInferenceType see clause 7.4a.1	type: NgRanInferenceType multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
vSExtensionType	It indicates the type of inference that is vendor's specific extension. allowedValues: N/A.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
usedConsumerTrainingData	It provides the address(es) where lists of the consumer-provided training data are located, which have been used for the ML model training. allowedValues: N/A.	type: String multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
trainingRequestRef	It is the DN(s) of the related MLTrainingRequest MOI(s).	type: DN multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
trainingProcessRef	It is the DN(s) of the related MLTrainingProcess MOI(s) that produced the MLTrainingReport.	type: DN multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
trainingReportRef	It is the DN of the MLTrainingReport MOI that represents the reports of the ML model training.	type: DN multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
lastTrainingRef	It is the DN of the MLTrainingReport MOI that represents the reports for the last training of the ML model(s).	type: DN multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
modelConfidenceIndication	It indicates the average confidence value (in unit of percentage) that the ML model would perform for inference on the data with the same distribution as training data. Essentially, this is a measure of degree of the convergence of the trained ML model. allowedValues: { 0..100 }.	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
trainingRequestSource	It identifies the entity that requested to instantiate the MLTrainingRequest MOI. This attribute is the DN of a managed entity, otherwise, it is a String.	type: <<Choice>> multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
MLTrainingRequest.requestStatus	It describes the status of a particular ML model training request. allowedValues: NOT_STARTED, IN_PROGRESS, CANCELLING, SUSPENDED, FINISHED, and CANCELLED.	type: Enum multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mLTrainingProcessId	It identifies the training process. It is unique in each instantiated process in the MnS producer. allowedValues: N/A.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
priority	It indicates the priority of the training process. The priority may be used by the ML model training to schedule the training processes. Lower value indicates a higher priority. allowedValues: { 0..65535 }.	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: 0 isNullable: False
terminationConditions	It indicates the conditions to be considered by the ML training MnS producer to terminate a specific training process. allowedValues: N/A.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
progressStatus	It indicates the status of the process. allowedValues: N/A.	type: ProcessMonitor multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
MLUpdateProcess.cancelProcess	It allows the ML update MnS consumer to cancel the ML update process. Setting this attribute to "TRUE" cancels the ML update process. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
MLUpdateProcess.suspendProcess	It allows the ML update MnS consumer to suspend the ML update process. Setting this attribute to "TRUE" suspends the ML update process. The process can be resumed by setting this attribute to “FALSE” when it is suspended. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
mLModelVersion	It indicates the version number of the ML model. allowedValues: N/A.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
performanceRequirements	It indicates the expected performance for a trained ML model when performing on the training data. allowedValues: N/A.	type: ModelPerformance multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
modelPerformanceTraining	It indicates the performance score of the ML model when performing on the training data. allowedValues: N/A.	type: ModelPerformance multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
MLTrainingProcess.progressStatus.progressStateInfo	It provides the following specialization for the "progressStateInfo" attribute of the "ProcessMonitor" data type for the "MLTrainingProcess.progressStatus". When the ML model training is in progress, and the " mLTrainingProcess.progressStatus.status " is equal to "RUNNING", it provides the more detailed progress information. allowedValues for " mLTrainingProcess.progressStatus.status " = "RUNNING": - "COLLECTING_DATA" - "PREPARING_TRAINING_DATA" - "TRAINING" + DN of the MLModel being trained The allowed values for " mLTrainingProcess.progressStatus.status " = "CANCELLING" are vendor specific. The allowed values for " mLTrainingProcess.progressStatus.status " = "NOT_STARTED" are vendor specific.	type: String multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
inferenceOutputName	It indicates the name of an inference output of an ML model. allowedValues: the name of the MDA output IEs (see 3GPP TS 28.104 [2]), name of analytics output IEs of NWDAF (see TS 23.288 [3]), RAN inference output IE name(s), and vendor's specific extensions.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
performanceMetric	It indicates the performance metric used to evaluate the performance of an ML model, e.g. "accuracy", "precision", "F1 score", etc. allowedValues: N/A.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
performanceScore	It indicates the performance score (in unit of percentage) of an ML model when performing inference on a specific data set (Note). The performance metrics may be different for different kinds of ML models depending on the nature of the model. For instance, for numeric prediction, the metric may be accuracy; for classification, the metric may be a combination of precision and recall, like the "F1 score". allowedValues: { 0..100 }.	type: Real multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
MLTrainingRequest.cancelRequest	It allows the ML training MnS consumer to cancel the ML model training request. Setting this attribute to "TRUE" cancels the ML model training request. The request can be resumed by setting this attribute to "FALSE" when it is suspended. Cancellation is possible when the requestStatus is the "NOT_STARTED", " IN_PROGRESS", and "SUSPENDED" state. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
MLTrainingRequest.suspendRequest	It allows the ML training MnS consumer to suspend the ML model training request. Setting this attribute to "TRUE" suspends the ML model training process. Suspension is possible when the requestStatus is not the "FINISHED" state. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
MLTrainingProcess.cancelProcess	It allows the ML training MnS consumer to cancel the ML model training process. Setting this attribute to “TRUE“ cancels the ML model training process. Cancellation is possible when the “mLTrainingProcess.progressStatus.status“ is not the “FINISHED“ state. Setting the attribute to “FALSE“ has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
MLTrainingProcess.suspendProcess	It allows the ML training MnS consumer to suspend the ML model training process. Setting this attribute to "TRUE" suspends the ML model training process. The process can be resumed by setting this attribute to “FALSE” when it is suspended. Suspension is possible when the " mLTrainingProcess.progressStatus.status" is not the "FINISHED", "CANCELLING" or "CANCELLED" state. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
inferenceEntityRef	It describes the target entities that will use the ML model for inference.	type: DN multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
dataProviderRef	It describes the entities that have provided or should provide data needed by the ML model e.g. for training or inference	type: DN multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
areNewTrainingDataUsed	It indicates whether new training data are used for the ML model training. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
trainingDataQualityScore	It indicates numerical value that represents the dependability/quality of a given observation and measurement type. The lowest value indicates the lowest level of dependability of the data, i.e. that the data is not usable at all. allowedValues: { 0..100 }.	type: Real multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
decisionConfidenceScore	It is the numerical value that represents the dependability/quality of a given decision generated by the AI/ML inference function. The lowest value indicates the lowest level of dependability of the decisions, i.e. that the data is not usable at all. allowedValues: { 0..100 }.	type: Real multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
expectedRuntimeContext	This describes the context where an MLModel is expected to be applied. allowedValues: N/A	type: MLContext multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
trainingContext	This specifies the context under which the MLModel has been trained. allowedValues: N/A	type: MLContext multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
runTimeContext	This specifies the context where the MLmodel or model is being applied. allowedValues: N/A	type: MLContext multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
MLTrainingRequest.mLModelRef	It identifies the DN of the MLModel requested to be trained.	type: DN multiplicity: 0..1 isOrdered: False isUnique: True defaultValue: None isNullable: False
MLTrainingReport.mLModelGeneratedRef	It identifies the DN of the MLModel generated by the ML model training.	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mLModelRepositoryRef	It identifies the DN of the MLModelRepository.	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mLRepositoryId	It indicates the unique ID of the ML repository.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
modelPerformanceValidation	It indicates the performance score of the ML model when performing on the validation data. allowedValues: N/A	type: ModelPerformance multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
dataRatioTrainingAndValidation	It indicates the ratio (in terms of quantity of data samples) of the training data and validation data used during the training and validation process. It is represented by the percentage of the validation data samples in the total training data set (including both training data samples and validation data samples). The value is an integer reflecting the rounded number of percent * 100. allowedValues: { 0 .. 100 }.	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
MLTestingRequest.requestStatus	It describes the status of a particular ML testing request. allowedValues: NOT_STARTED, IN_PROGRESS, CANCELLING, SUSPENDED, FINISHED, and CANCELLED.	type: Enum multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
MLTestingRequest.cancelRequest	It allows the ML testing MnS consumer to cancel the ML testing request. Setting this attribute to "TRUE" cancels the ML testing request. Cancellation is possible when the requestStatus is the "NOT_STARTED", " IN_PROGRESS", and "SUSPENDED" state. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
MLTestingRequest.suspendRequest	It allows the ML testing MnS consumer to suspend the ML testing request. Setting this attribute to "TRUE" suspends the ML testing request. The request can be resumed by setting this attribute to “FALSE” when it is suspended. Suspension is possible when the requestStatus is not the "FINISHED" state. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
MLTestingRequest.mLModelRef	It identifies the DN of the MLModel requested to be tested.	type: DN Multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
modelPerformanceTesting	It indicates the performance score of the ML model when performing on the testing data. allowedValues: N/A.	type: ModelPerformance multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
mLTestingResult	It provides the address where the testing result (including the inference result for each testing data example) is provided. The detailed testing result format is vendor specific. allowedValues: N/A.	type: String multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
testingRequestRef	It identifies the DN of the MLTestingRequest MOI.	type: DN multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
supportedPerformanceIndicators	This parameter lists specific PerformanceIndicator(s) of an ML model. allowedValues: N/A.	type: SupportedPerfIndicator multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
performanceIndicatorName	It indicates the identifier of the specific performance indicator. allowedValues: N/A	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
isSupportedForTraining	It indicates whether the specific performance indicator is supported a performance metric of ML model training for the ML model. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
isSupportedForTesting	It indicates whether the specific performance indicator is supported a performance metric of ML model testing for the ML model. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
mLUpdateProcessRef	It is the DN of the mLUpdateProcess MOI that represents the process of updating an ML model.	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mLUpdateRequestRefList	It is the list of DN of the MLUpdateRequest MOI that represents an ML update request.	type: DN multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
mLUpdateReportRef	It is the DN of the MLUpdateReport MOI that represents an ML update report.	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mLUpdateReportingPeriod	It specifies the time duration upon which the MnS consumer expects the ML update is reported.	type: TimeWindow multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
availMLCapabilityReport	It represents the available ML capabilities. allowedValues: N/A.	type: AvailMLCapabilityReport multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
updatedMLCapability	It represents the updated ML capabilities. allowedValues: N/A.	type: AvailMLCapabilityReport multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
availMLCapabilityReportID	It identifies the available ML capability report. allowedValues: N/A.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
newCapabilityVersionId	It indicates the specific version of AI/ML capabilities to be applied for the update. It is typically the one indicated by the MLCapabilityVersionID in a newCapabilityVersion	type: String multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
mlCapabilityVersionId	It indicates the version of ML capabilities that is available for the update.	type: String multiplicity: * isOrdered: False isUnique: True

Attribute Name	Documentation and Allowed Values	Properties
		defaultValue: None isNullable: False
performanceGainThreshold	It defines the minimum performance gain as a percentage that shall be achieved with the capability update, i.e., the difference in the performances between the existing capabilities and the new capabilities should be at least performanceGainThreshold otherwise the new capabilities should not be applied. Allowed value: float between 0.0 and 100.0	type: ModelPerformance multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
expectedPerformanceGains	It indicates the expected performance gain if/when the AI/ML capabilities of the respective network function are updated with/to the specific set of newly available AI/ML capabilities.	type: ModelPerformance multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
updateTimeDeadline	It indicates the maximum as stated in the MLUpdate request that should be taken to complete the update	type: TimeWindow multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
MLUpdateReport.mLModelModelRef	It indicates the DN of MLModel instances that can be updated.	type: DN multiplicity: 1 .. * isOrdered: False isUnique: True defaultValue: None isNullable: False
MLUpdateRequest.requestStatus	It describes the status of a particular ML update request. allowedValues: NOT_STARTED, IN_PROGRESS, CANCELLING, SUSPENDED, FINISHED, and CANCELLED.	type: Enum multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
MLUpdateRequest.cancelRequest	It allows the MnS consumer to cancel the ML update request. Setting this attribute to "TRUE" cancels the ML update request. Cancellation is possible when the requestStatus is the "NOT_STARTED", " IN_PROGRESS", and "SUSPENDED" state. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
MLUpdateRequest.suspendRequest	It allows the MnS consumer to suspend the ML update request. Setting this attribute to "TRUE" suspends the ML update request. The request can be resumed by setting this attribute to “FALSE” when it is suspended. Suspension is possible when the requestStatus is not the "FINISHED" state. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
memberMLModelRefList	It identifies the list of member ML models within an ML model coordination group.	type: DN multiplicity: 2..* isOrdered: True isUnique: True defaultValue: None isNullable: False
MLTrainingRequest.mLModelCoordinationGroupRef	It identifies the DN of the MLModelCoordinationGroup requested to be trained.	type: DN multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None

Attribute Name	Documentation and Allowed Values	Properties
		isNullable: False
MLTrainingReport.mLModelCoordinationGroupGeneratedRef	It identifies the DN of the MLModelCoordinationGroup generated by ML model joint training.	type: DN multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
MLTestingRequest.mLModelCoordinationGroupRef	It identifies the DN of the MLModelCoordinationGroup requested to be tested.	type: DN multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
retrainingEventsMonitorRef	It indicates the DN of the ThresholdMonitor MOI that indicates the performance measurements and its corresponding thresholds to be used by MnS producer to initiate the re-training of the MLModel.	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
MLModelLoadingRequest.requestStatus	It describes the status of a particular ML model loading request. allowedValues: NOT_STARTED, IN_PROGRESS, CANCELLING, SUSPENDED, FINISHED, and CANCELLED.	type: Enum multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
MLModelLoadingRequest.cancelRequest	It allows the MnS consumer to cancel the ML model loading request. Setting this attribute to "TRUE" cancels the ML model loading. Cancellation is possible when the requestStatus is the "NOT_STARTED", " IN_PROGRESS", and "SUSPENDED" state. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
MLModelLoadingRequest.suspendRequest	It allows the MnS consumer to suspend the ML model loading request. Setting this attribute to "TRUE" suspends the ML model loading request. The request can be resumed by setting this attribute to “FALSE” when it is suspended. Suspension is possible when the requestStatus is not the "FINISHED" state. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
mLModelToLoadRef	It identifies the DN of a trained MLModel requested to be loaded to the target inference function(s).	type: DN multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
policyForLoading	It provides the policy for controlling ML model loading triggered by the MnS producer. This policy contains two thresholds in the thresholdList attribute. The first threshold is related to the ML model to be loaded, and the second threshold is related to the existing ML model being used for inference.	type: AIMLManagementPolicy multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
thresholdList	It provides the list of threshold.	type: ThresholdInfo multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
MLModelLoadingProcess.progressStatus.progressStateInfo	It provides the following specialization for the "progressStateInfo" attribute of the "ProcessMonitor" data type for the "MLModelLoadingProcess.progressStatus". When the ML model loading is in progress, and the "MLModelLoadingProcess.progressStatus.status " is equal to "RUNNING", it provides the more detailed progress information. allowedValues for "MLModelLoadingProcess.progressStatus.status " = "RUNNING": The allowed values for "MLModelLoadingProcess.progressStatus.status " = "CANCELLING" are vendor specific. The allowed values for "MLModelLoadingProcess.progressStatus.status " = "NOT_STARTED" are vendor specific.	type: String multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
MLModelLoadingProcess.cancelProcess	It allows the MnS consumer to cancel the ML model loading process. Setting this attribute to "TRUE" cancels the process. Cancellation is possible when the "MLModelLoadingProcess.progressStatus.status" is not the "FINISHED" state. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
MLModelLoadingProcess.suspendProcess	It allows the MnS consumer to suspend the ML model loading process. Setting this attribute to "TRUE" suspends the process. The process can be resumed by setting this attribute to "FALSE" when it is suspended. Suspension is possible when the "MLModelLoadingProcess.progressStatus.status" is not the "FINISHED", "CANCELLING" or "CANCELLED" state. Setting the attribute to "FALSE" has no observable result. allowedValues: TRUE, FALSE.	type: Boolean multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: FALSE isNullable: False
mLModelLoadingRequestRef	It identifies the DN of the associated MLModelLoadingRequest.	type: DN multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mLModelLoadingPolicyRef	It identifies the DN of the associated MLModelLoadingPolicyRef.	type: DN multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
loadedMLModelRef	It identifies the DN of the MLModel that has been loaded to the inference function.	type: DN multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
activationStatus	It describes the activation status. allowedValues: ACTIVATED, DEACTIVATED.	type: Enum multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
AIMLManagementPolicy.managedActivationScope	It provides a list of sub scopes for which ML inference is activated as triggered by a policy on the MnS producer. For example, the sub scopes may be a list of cells or of geographical areas. The list is an ordered list indicating the inference is activated for the first sub scope and gradually extended to the next sub scope if the policy evaluates to true. allowedValues: N/A	type: ManagedActivationScope multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
AIMLInferenceFunction.managedActivationScope	It provides a list of sub scopes for which ML inference is activated as triggered by a policy on the MnS producer. For example, the sub scopes may be a list of cells or of geographical areas. The list is an ordered list indicating the inference is activated for the first sub scope and gradually extended to the next sub scope if the policy evaluates to true. allowedValues: N/A	type: AIMLManagementPolicy multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
ManagedActivationScope.dNList	It indicates the list of DN, the list is an ordered list indicating the inference is activated for the first sub scope and gradually extended to the next sub scope. allowedValues: N/A	type: DN multiplicity: * isOrdered: True isUnique: True defaultValue: None isNullable: False
ManagedActivationScope.timeWindow	It indicates the list of time window; the list is an ordered list indicating the inference is activated for the first sub scope and gradually extended to the next sub scope. allowedValues: N/A	type: TimeWindow multiplicity: * isOrdered: True isUnique: True defaultValue: None isNullable: False
ManagedActivationScope.geoPolygon	It indicates the list of GeoArea, the list is an ordered list indicating the inference is activated for the first sub scope and gradually extended to the next sub scope. allowedValues: N/A	type: GeoArea multiplicity: * isOrdered: True isUnique: True defaultValue: None isNullable: False
usedByFunctionRefList	It provides the DNs of the functions supported by the AIMLInferenceFunction. allowedValues: N/A	type: DN multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
inferenceOutputId	It identifies an inference output within an AIMLinferenceReport.	type: String multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
inferenceOutputs	It indicates the Outputs that have been derived by the AIMLInferenceFunction instance from a specific ML model. Each ML model, inferenceOutputs may be a set of values. allowedValues: N/A.	type: InferenceOutput multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
inferencePerformance	It indicates the performance score of the ML model during Inference. allowedValues: N/A.	type: ModelPerformance multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
inferenceOutputTime	It indicates the time at which the inference output is generated. allowedValues: N/A	type: DateTime multiplicity: * isOrdered: True isUnique: True defaultValue: None isNullable: False
outputResult	It indicates the result of an inference.	type: AttributeValuePair multiplicity: * isOrdered: False isUnique: True defaultValue: Null isNullable: False
mLCapabilitiesInfoList	It indicates information about what an ML model can generate inference for. allowedValues: N/A.	type: MLCapabilityInfo multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: False
capabilityName	It indicates the name of a capability for which an ML model can generate inference. The capability is defined by Mns producer which can be traffic analysis capability, coverage analysis capability, mobility analysis capability or vendor specific extensions. allowedValues: N/A.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
mLCapabilityParameters	It indicates a set of optional parameters that apply for an aIMLInferenceName and capabilityName. allowedValues: N/A	type: AttributeValuePair multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
aIMLInferenceReportRefList	It indicates a list of DN of the AIMLInferenceReport MOI that represents an AIML inference report.	type: DN multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
mLModelRefList	It identifies the list of MLModel DN.	type: DN multiplicity: * isOrdered: False isUnique: True defaultValue: None isNullable: False
NOTE: When the performanceScore is to indicate the performance score for ML model training, the data set is the training data set. When the performanceScore is to indicate the performance score for ML validation, the data set is the validation data set. When the performanceScore is to indicate the performance score for ML model testing, the data set is the testing data set.		

7.5.2 Constraints

None.

7.6 Common notifications

7.6.1 Configuration notifications

This clause presents a list of notifications, defined in 3GPP TS 28.532 [11], that an MnS consumer may receive. The notification header attribute objectClass/objectInstance shall capture the DN of an instance of a class defined in the present document.

Table 7.6.1-1

Name	Qualifier	Notes
notifyMOICreation	O	--
notifyMOIDeletion	O	--
notifyMOIAttributeValueChanges	O	--
notifyEvent	O	--

8 Service components

8.0 General

The operations for generic provisioning management service refer to clause 11.1.1 of TS 28.532 [11]. For notifications, see clause 7.6.

8.1 Lifecycle management operations for AI/ML management MnS

The components for ML model training MnS are listed in table 8.1-1.

Table 8.1-1: Components for ML model training

ML model training management capability	Management service component type A	Management service component type B	Management service component type C
Create an ML model training request	createMOI operation	MLTrainingRequest	N/A
Modify an ML model training request	modifyMOIAttributes operation		
Query an ML model training report	getMOIAttributes operation	MLTrainingReport	
Modify an ML model training process	modifyMOIAttributes operation	MLTrainingProcess	
Query an ML model training process	getMOIAttributes operation		
Create, Delete, and Update ML model training	changeMOIs operation	MLTrainingRequest MLTrainingReport MLTrainingProcess	

The components for ML model testing are listed in table 8.1-2.

Table 8.1-2: Components for ML model testing

ML model testing management capability	Management service component type A	Management service component type B	Management service component type C
Create an ML model testing request	createMOI operation	MLTestingRequest	N/A
Modify an ML model testing request	modifyMOIAttributes operation		
Query an ML model testing report	getMOIAttributes operation	MLTestingReport	
Subscribe an ML model testing report	createMOI operation		
Unsubscribe an ML model testing report	deleteMOI operation		
Query an ML model testing report subscription	getMOIAttributes operation		
Create, Delete, and Update ML model testing	changeMOIs operation	MLTestingRequest MLTestingReport	

The components for ML model deployment are listed in table 8.1-3

Table 8.1-3: Components for ML model deployment

ML model deployment management capability	Management service component type A	Management service component type B	Management service component type C
Create an ML model loading request	createMOI operation	MLModelLoadingRequest	N/A
Modify an ML model loading request	modifyMOIAttributes operation		
Create an ML model loading policy	createMOI operation	MLModelLoadingPolicy	
Delete an ML model loading policy	deleteMOI operation		
Modify an ML model loading policy	modifyMOIAttributes operation		
Query an ML model loading policy	getMOIAttributes operation		
Modify an ML model loading process	modifyMOIAttributes operation	MLModelLoadingProcess	
Query an ML model loading process	getMOIAttributes operation		
Create, Delete, and Update ML model Loading	changeMOIs operation	MLModelLoadingRequest MLModelLoadingPolicy MLModelLoadingPolicy	

The components for ML model inference are listed in table 8.1-4

Table 8.1-4: Components for AI/ML inference

AI/ML Inference management capability	Management service component type A	Management service component type B	Management service component type C
Create an ML model update request	createMOI operation	MLUpdateRequest	N/A
Modify an ML model update request	modifyMOIAttributes operation		
Modify an ML model update process	modifyMOIAttributes operation	MLUpdateProcess	
Query an ML model update process	getMOIAttributes operation		
Query an ML model update report	getMOIAttributes operation	MLUpdateReport	
Query an AI/ML inference report	getMOIAttributes operation	AIMLInferenceReport	
Create, Delete, and Update ML model Update and ML Inference Report	changeMOIs operation	MLUpdateRequest MLUpdateProcess MLUpdateProcess AIMLInferenceReport	

The components for AI/ML inference emulation are listed in table 8.1-5.

Table 8.1-5: Components for AI/ML inference emulation MnS

ML model emulation management capability	Management service component type A	Management service component type B	Management service component type C
Query an AI/ML inference emulation report	getMOIAttributes operation	AIMLInferenceReport	N/A

9 Solution Set (SS)

The present document defines the following NRM Solution Set definitions for ML management:

The OpenAPI/YAML definitions are specified in 3GPP Forge, refer to clause 4.3 of TS 28.623 [19] for the Forge location. An example of Forge location is: "https://forge.3gpp.org/rep/sa5/MnS/-/tree/Tag_Rel18_SA104/".

Directory: OpenAPI

File: TS28105_AiMlNrm.yaml

Annex A (informative): PlantUML source code for NRM class diagrams

A.1 General

This annex contains the PlantUML source code for the NRM diagrams defined in clause 7.2a of the present document.

A.2 PlantUML code for Figure 7.3a.1.1.1-1: NRM fragment for ML model training

```
@startuml
skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250
skinparam nodesep 60

class ManagedEntity <<ProxyClass>>
class MLModel <<InformationObjectClass>>
class MLModelCoordinationGroup <<InformationObjectClass>>
class MLTrainingFunction <<InformationObjectClass>>
class MLTrainingRequest <<InformationObjectClass>>
class MLTrainingReport <<InformationObjectClass>>
class MLTrainingProcess <<InformationObjectClass>>
class MLModelRepository <<InformationObjectClass>>

ManagedEntity "1" *-- "*" MLTrainingFunction: <<names>>
MLTrainingFunction "1" *-- "*" MLTrainingProcess: <<names>>
MLTrainingFunction "1" *-- "*" MLTrainingRequest: <<names>>
MLTrainingFunction "1" *-- "*" MLTrainingReport: <<names>>
MLTrainingFunction "1" *-- "*" ThresholdMonitor : <<names>>

MLTrainingFunction "*" --> "1" MLModelRepository
MLTrainingProcess "1" -r-> "1" MLTrainingReport
MLTrainingProcess "*" <-l- "*" MLTrainingRequest
MLTrainingRequest "1" --> "0..1" MLModel
MLTrainingRequest "1" -r-> "0..1" MLModelCoordinationGroup
MLTrainingReport "1" --> "0..1" MLModel
MLTrainingReport "1" --> "0..1" MLModelCoordinationGroup
MLTrainingProcess "1" --> "0..1" MLModel
MLTrainingProcess "1" --> "0..1" MLModelCoordinationGroup
MLModel"*" -l-> "1" ThresholdMonitor
MLTrainingReport "1" -r-> "1" MLTrainingReport


note left of ManagedEntity
  This represents the following IOCs:
    SubNetwork or
    ManagedFunction or
    ManagedElement
  end note

@enduml
```

A.3 PlantUML code for Figure 7.3a.1.1.2-1: Inheritance Hierarchy for ML model training related NRMs

```
@startuml

skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250

class Top <<InformationObjectClass>>
class ManagedFunction <<InformationObjectClass>>
class MLTrainingFunction <<InformationObjectClass>>
class MLTrainingRequest <<InformationObjectClass>>
class MLTrainingProcess <<InformationObjectClass>>
class MLTrainingReport <<InformationObjectClass>>

ManagedFunction <|-- MLTrainingFunction
Top <|-- MLTrainingRequest
Top <|-- MLTrainingProcess
Top <|-- MLTrainingReport

@enduml
```

A.4 PlantUML code for Figure 7.2a.1.2-1: Inheritance Hierarchy for common information models for AI/ML management

```
@startuml

skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250

class Top <<InformationObjectClass>>
class MLModelRepository <<InformationObjectClass>>
class MLModel <<InformationObjectClass>>
class MLModelCoordinationGroup <<InformationObjectClass>>

Top <|-- MLModelRepository
Top <|-- MLModel
Top <|-- MLModelCoordinationGroup

@enduml
```

A.5 PlantUML code for Figure 7.2a.1.1-1: Relationships for common information models for AI/ML management

```
@startuml
skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250
skinparam nodesep 60

class ManagedEntity <<ProxyClass>>
class MLModelRepository <<InformationObjectClass>>
class MLModel <<InformationObjectClass>>
class MLModelCoordinationGroup <<InformationObjectClass>>


ManagedEntity "1" *-- "*" MLModelRepository : <<names>>
MLModelRepository "1" *-- "*" MLModel: <<names>>
MLModelRepository "1" *-- "*" MLModelCoordinationGroup: <<names>>


MLModelCoordinationGroup "*" -r-> "2..*" MLModel

note left of ManagedEntity
  This represents the following IOCs:
    ManagedElement or
    SubNetwork
  end note

@enduml
```

A.6 PlantUML code for Figure 7.3a.1.1.1-2: NRM fragment for ML model testing

```
@startuml
```

```
skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250

class MLTestingEntity <<ProxyClass>>
class TestingFunction <<ProxyClass>>
class MLModel <<InformationObjectClass>>
class MLModelCoordinationGroup <<InformationObjectClass>>
class MLTestingFunction <<InformationObjectClass>>
class MLTestingRequest <<InformationObjectClass>>
class MLTestingReport <<InformationObjectClass>>

MLTestingEntity "1" *-- "*" MLTestingFunction: <<names>>

TestingFunction "1" *-- "*" MLTestingRequest : <<names>>
TestingFunction "1" *-- "*" MLTestingReport : <<names>>

MLTestingRequest "*" --> "0..1" MLModel
MLTestingRequest "*" --> "0..1" MLModelCoordinationGroup
MLTestingReport "*" -l-> "1" MLTestingRequest

(MLTestingRequest, MLModel) ... (MLTestingRequest, MLModelCoordinationGroup) : {xor}


note left of MLTestingEntity
  Represents the following IOCs:
    Subnetwork or
    ManagedFunction or
    ManagedElement
  end note

note left of TestingFunction
  Represents the following IOCs:
    MLTestingFunction or
    MLTrainingFunction
  end note

@enduml
```

A.7 PlantUML code for Figure 7.3a.1.1.2-2: Inheritance Hierarchy for ML model testing related NRMs

```
@startuml

skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250

class Top <<InformationObjectClass>>
class ManagedFunction <<InformationObjectClass>>
class MLTestingFunction <<InformationObjectClass>>
class MLTestingRequest <<InformationObjectClass>>
class MLTestingReport <<InformationObjectClass>>

ManagedFunction <|-- MLTestingFunction
Top <|-- MLTestingRequest
Top <|-- MLTestingReport

@enduml
```

A.8 PlantUML code for Figure 7.3a.4.1.1-1: NRM fragment for ML update

```
@startuml
```

```
skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250
skinparam nodesep 60

class MLUpdateEntity <<ProxyClass>>
class MLUpdateFunction <<InformationObjectClass>>
class MLUpdateRequest <<InformationObjectClass>>
class MLUpdateProcess <<InformationObjectClass>>
class MLUpdateReport <<InformationObjectClass>>
class MLModel <<InformationObjectClass>>

MLUpdateEntity "1" *-- "*" MLUpdateFunction:<<names>>
MLUpdateFunction "1" *-- "*" MLUpdateRequest:<<names>>
MLUpdateFunction "1" *-- "*" MLUpdateProcess:<<names>>
MLUpdateFunction "1" *-- "*" MLUpdateReport:<<names>>

MLUpdateFunction "1" --> "*" "MLModel"
MLUpdateRequest "*" <-r-> "1" "MLUpdateProcess"
MLUpdateProcess "1" <-r-> "1" "MLUpdateReport"
MLUpdateProcess "*" --> "*" "MLModel"
MLUpdateReport "*" --> "*" "MLModel"
MLUpdateRequest "*" --> "*" "MLModel"


note left of MLUpdateEntity
 Represents the IOCs:
   SubNetwork or
   ManagedFunction or
   ManagementFunction
 end note

@enduml
```

A.9 PlantUML code for Figure 7.3a.4.1.2-1: Inheritance Hierarchy for ML update related NRMs

```
@startuml

skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250

class Top <<InformationObjectClass>>
class ManagedFunction <<InformationObjectClass>>
class MLUpdateFunction <<InformationObjectClass>>
class MLUpdateRequest <<InformationObjectClass>>
class MLUpdateProcess <<InformationObjectClass>>
class MLUpdateReport <<InformationObjectClass>>

ManagedFunction <|-- MLUpdateFunction
Top <|-- MLUpdateRequest
Top <|-- MLUpdateProcess
Top <|-- MLUpdateReport

@enduml
```

A.10 PlantUML code for Figure 7.3a.3.1.1-1: NRM fragment for ML model loading

```
@startuml
skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
```

```
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250

class AIMLInferenceFunction <<InformationObjectClass>>
class MLModel <<InformationObjectClass>>
class MLModelLoadingRequest <<InformationObjectClass>>
class MLModelLoadingPolicy <<InformationObjectClass>>
class MLModelLoadingProcess <<InformationObjectClass>>

AIMLInferenceFunction"1" *-- "*" MLModelLoadingRequest : <<names>>
AIMLInferenceFunction "1" *-- "*" MLModelLoadingPolicy : <<names>>
AIMLInferenceFunction "1" *-- "*" MLModelLoadingProcess : <<names>>


MLModelLoadingRequest  "1" <-r- "*" MLModelLoadingProcess
MLModelLoadingProcess  "*" -r-> "1" MLModelLoadingPolicy

MLModelLoadingRequest "1" --> "1" MLModel
MLModelLoadingProcess "1" --> "1" MLModel

AIMLInferenceFunction "1" *-- "*" MLModel : <<names>>

(MLModelLoadingProcess, MLModelLoadingRequest) ... (MLModelLoadingProcess, MLModelLoadingPolicy) :
{xor}


@enduml
```

A.11 PlantUML code for Figure 7.3a.3.1.2-1: Inheritance Hierarchy for ML model loading related NRMs

```
@startuml

skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250

class Top <<InformationObjectClass>>

class MLModelLoadingRequest <<InformationObjectClass>>
class MLModelLoadingPolicy <<InformationObjectClass>>
class MLModelLoadingProcess <<InformationObjectClass>>

Top <|-- MLModelLoadingRequest
Top <|-- MLModelLoadingPolicy
Top <|-- MLModelLoadingProcess

@enduml
```

A.12 PlantUML code for Figure 7.3a.4.1.1-2: NRM fragment for AI/ML inference function

```
@startuml
skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250
skinparam nodesep 60

class AIMLInferenceFunction <<InformationObjectClass>>
class AIMLInferenceReport <<InformationObjectClass>>
```

```
class MLModel <<InformationObjectClass>>
class ManagedEntity <<ProxyClass>>
class AIMLSupportedFunction <<ProxyClass>>

ManagedEntity  "1" *-- "*" AIMLInferenceFunction : <<names>>
AIMLInferenceFunction  "*" <-l-> "*" AIMLSupportedFunction
MLModel  "*" <-r-> "*" AIMLSupportedFunction
MLModel  "*" <-r-> "*" AIMLInferenceFunction
AIMLInfeModelEntity "1..*" <--> "*" AIMLInferenceReport


note right of ManagedEntity #white
 Represents the IOCs:
   ManagedElement or
   SubNetwork or
   ManagedFunction
 end note

note top of AIMLSupportedFunction #white
 Represents the IOCs:
   DMROFunction or
   DLBOFunction or
   DESManagementFunction or
   MDAFunction or
   AnLFFunction
 end note

@enduml
```

A.13 PlantUML code for Figure 7.3a.4.1.2-2: Inheritance Hierarchy for AI/ML inference function

```
@startuml
skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250

class Top <<InformationObjectClass>>
class AIMLInferenceFunction << InformationObjectClass >>
class AIMLInferenceReport <<InformationObjectClass>>

ManagedFunction <|-- AIMLInferenceFunction
Top <|-- AIMLInferenceReport

@enduml
```

A.14 PlantUML code for Figure 7.3a.2.1.1-1: NRM fragment for AI/ML inference emulation Control

```
@startuml
scale max 350 height
skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250

class ManagedEntity <<ProxyClass>>
class AIMLInferenceEmulationFunction <<InformationObjectClass>>
class AIMLInferenceReport << InformationObjectClass >>

ManagedEntity "1" *-- "*" AIMLInferenceEmulationFunction: <<names>>
AIMLInferenceEmulationFunction "1" *-- "*" AIMLInferenceReport : <<names>>

note left of ManagedEntity
```

```
  Represents the following IOCs:
    SubNetwork or
    ManagedFunction or
    Managed Element
  end note
@enduml
```

A.15 PlantUML code for Figure 7.3a.2.1.2-1: AI/ML inference emulation Inheritance Relations

```
@startuml
skinparam ClassStereotypeFontStyle normal
skinparam ClassBackgroundColor White
skinparam shadowing false
skinparam monochrome true
hide members
hide circle
'skinparam maxMessageSize 250


class ManagedFunction <<InformationObjectClass>>
class AIMLInferenceEmulationFunction << InformationObjectClass >>


ManagedFunction <|-- AIMLInferenceEmulationFunction
@enduml
```

Annex B (normative): OpenAPI definition of the AI/ML NRM

B.1 General

This annex contains the OpenAPI definition of the AI/ML NRM in YAML format.

The information models of the AI/ML NRM are defined in clause 7.

Mapping rules to produce the OpenAPI definition based on the information model are defined in 3GPP TS 32.160 [14].

B.2 Solution Set (SS) definitions

B.2.1 OpenAPI document "TS28105_AiMlNrm.yaml"

Note that clause 9 includes the location of TS28105_AiMlNrm.yaml.

Annex C (informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2022-06	SA#96					Upgrade to change control version	17.0.0
2022-09	SA#97e	SP-220851	0003	-	F	Corrections to the terms and definition description and corresponding updates	17.1.0
2022-09	SA#97e	SP-220850	0004	1	F	fix incorrect yaml file name in TS28.105	17.1.0
2022-09	SA#97e	SP-220851	0005	1	F	Clarifications and corrections of Use cases	17.1.0
2022-09	SA#97e	SP-220851	0006	1	F	Clarifications and corrections into the Class definitions and Attribute properties	17.1.0
2022-09	SA#97e	SP-220851	0007	1	F	Correction and clarifications of the Requirements	17.1.0
2022-09	SA#97e					Alignment with content with FORGE	17.1.1
2022-12	SA#98e	SP-221166	0008	2	F	Adding missing attributes	17.2.0
2022-12	SA#98e	SP-221166	0009	-	F	Correction of stage 3 openAPI	17.2.0
2023-03	SA#99	SP-230193	0011	-	F	Adding the missing definition of attributes Stage 2 and Stage 3	17.3.0
2023-03	SA#99	SP-230193	0013	1	F	Correcting the attribute properties	17.3.0
2023-03	SA#99	SP-230193	0014	1	F	Correction of the Handling errors in data and ML decisions	17.3.0
2023-03	SA#99	SP-230193	0015	1	F	Correction of terminologies	17.3.0
2023-03	SA#99	SP-230193	0017	1	F	Correct AI/ML related terms	17.3.0
2023-03	SA#99	SP-230193	0018	1	F	Correct formatting and spelling errors	17.3.0
2023-03	SA#99	SP-230193	0019	1	F	Correct attribute definitions	17.3.0
2023-06	SA#100	SP-230655	0022	1	F	Correcting the attribute properties	17.4.0
2023-06	SA#100	SP-230649	0024	1	F	Grammatical Corrections	17.4.0
2023-06	SA#100	SP-230655	0030	-	F	Removal of SW loading from training phase	17.4.0
2023-06	SA#100	SP-230655	0031	1	F	Correction of the figure for ML training function	17.4.0
2023-06	SA#100	SP-230668	0023	1	C	Not implemented due to violation of drafting rules. It will be modified and included in a future CR (MCC).	18.0.0
2023-09	SA#101	SP-230948	0023	3	C	Modelling ML Entity	18.1.0
2023-09	SA#101	SP-230948	0035		A	Clarify ML models as proprietary	18.1.0
2023-09	SA#101	SP-230948	0039	1	A	Restore the wrongly voided clause “5 Service and functional framework”	18.1.0
2023-12	SA#102	SP-231459	0041	1	F	Rel-18 CR TS 28.105 Adding the missing relation between ML entity and ML process – Partially implemented (1st change could not be implemented due to a clash with CR 066)	18.2.0
2023-12	SA#102	SP-231467	0043	1	A	Correction on ModelPerformance	18.2.0
2023-12	SA#102	SP-231490	0045	-	A	Rel-18 CR TS 28.105 Corrections of ML training related use cases description	18.2.0
2023-12	SA#102	SP-231490	0047	-	A	Rel 18 CR TS 28.105 Remove unused decision entity term	18.2.0
2023-12	SA#102	SP-231490	0049	-	A	Rel 18 CR TS 28.105 Clarify the description of confidenceIndication attribute	18.2.0
2023-12	SA#102	SP-231467	0061	-	A	Rel 18 CR TS 28.105 Remove unused attribute mLEntityList	18.2.0
2023-12	SA#102	SP-231467	0063	1	A	CR TS 28.105 Rel-18 Correction of IOC name	18.2.0
2023-12	SA#102	SP-231467	0065	1	A	TS 28.105 Rel-18 Correction of attribute properties	18.2.0
2023-12	SA#102	SP-231459	0066	1	F	TS 28.105 Rel-18 Correction of MLTrainingFunction constraints – Partially implemented (1st change could not be implemented due to a clash with CR 041)	18.2.0
2023-12	SA#102	SP-231467	0068	1	A	Rel 18 CR TS 28.105 Resolve issues related to the usage of confidenceIndication attribute	18.2.0
2023-12	SA#102	SP-231490	0069	-	A	Rel 18 CR TS 28.105 Fix incorrect figure label	18.2.0
2023-12						Alignment with the Forge	18.2.0
2024-03	SA#103	SP-240186	0073	-	F	TS28.105 Rel18 correction to Schema definition Issues for SubNetwork and ManagedElement of OpenAPI SS	18.3.0
2024-03	SA#103	SP-240155	0075	-	A	Rel-18 Correct trainingRequestSource attribute type	18.3.0
2024-03	SA#103	SP-240155	0076	1	B	Enhancements for AI-ML management	18.3.0
2024-03	SA#103	SP-240162	0080	1	A	Rel 18 CR TS 28.105 Add additional reference related to NWDAF	18.3.0
2024-03	SA#103	SP-240162	0082	1	A	Rel 18 CR TS 28.105 Add missing abbreviations	18.3.0
2024-06	SA#104	SP-240830	0126	-	F	TS28.105 Rel18 correction to Schema definition Issues for SubNetwork of OpenAPI SS	18.4.0
2024-06	SA#104	SP-240808	0140	-	F	TS28.105 Rel18 Moving normative stage 3 to Forge	18.4.0
2024-06	SA#104	SP-240804	0142	1	A	Rel-18 CR TS 28.105 correct the AI/ML technique overview	18.4.0
2024-06	SA#104	SP-240830	0146	-	F	Rel 18 Input to draftCR TS 28.105 correct terminationConditions attribute	18.4.0
2024-06	SA#104	SP-240830	0147	-	F	Rel18 TS 28.105 stage 3 changes for stage 2 corrections	18.4.0
2024-06	SA#104	SP-240830	0151	-	F	CR Rel-18 TS28.105 AI/ML management	18.4.0
2024-09	SA#105	SP-241181	0152	1	F	TS28.105 Rel18 correction to attribute name of attribute related to role for different cardinality	18.5.0
2024-09	SA#105	SP-241181	0153	1	F	Rel18 TS 28.105 corrections to misalignment between stage 3 and stage 2	18.5.0
2024-09	SA#105	SP-241181	0154	1	F	Rel-18 CR TS 28.105 correct the ML model related attributes	18.5.0
2024-09	SA#105	SP-241181	0155	1	F	Rel-18 CR TS 28.105 correct the description of ML model lifecycle and ML entity	18.5.0
2024-09	SA#105	SP-241181	0156	-	F	Rel-18 CR TS 28.105 Correct InferenceType to aIMLInferenceName	18.5.0

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2024-09	SA#105	SP-241181	0157	1	F	Rel-18 CR TS 28.105 Correct MLEntity to MLModel	18.5.0
2024-09	SA#105	SP-241181	0160	2	F	Rel-18 CR TS 28.105 Clarification of scope	18.5.0
2024-09	SA#105	SP-241181	0161	1	F	Rel-18 CR TS28.105 corrections to ML model lifecycle figure and corresponding description	18.5.0
2024-09	SA#105	SP-241181	0163	-	F	Rel 18 CR TS 28.105 Fix training definitions	18.5.0
2024-09	SA#105	SP-241181	0164	-	F	Rel 18 CR TS 28.105 Fix remaining entity to model	18.5.0
2024-09	SA#105	SP-241181	0168	1	A	Rel-18 CR TS 28.105 Correction to using data types	18.5.0
2024-09	SA#105	SP-241181	0176	1	F	Rel-18 CR TS 28.105 Corrections including editorial fixes	18.5.0
2024-12	SA#106	SP-241644	0179	-	F	Rel-18 CR TS 28.105 AIML Terminology Alignment	18.6.0
2024-12	SA#106	SP-241644	0182	1	F	Rel-18 CR TS 28.105 correct the areNewTrainingDataUsed attributes	18.6.0
2024-12	SA#106	SP-241634	0188	1	A	Rel 18 CR TS 28.105 Make decisionConfidenceScore attr applicable for Training	18.6.0
2024-12	SA#106	SP-241644	0190	2	F	Rel 18 CR TS 28.105 Fix modelPerformanceValidation attribute	18.6.0
2024-12	SA#106	SP-241644	0194	1	F	CR Rel-18 TS 28.105 add missing terms	18.6.0
2024-12	SA#106	SP-241644	0196	2	F	Rel-18 CR TS28.105 Correct stage2 and stage3 definition for aIMLInferenceName	18.6.0
2024-12	SA#106	SP-241644	0198	1	F	Rel-18 CR TS 28.105 Clarify the Usage of mLModelRef and mLModelCoordinationGroupRef	18.6.0
2024-12	SA#106	SP-241634	0203		A	Rel-18 CR TS 28.105 Fix trainingRequestSource attribute	18.6.0
2024-12	SA#106	SP-241643	0205		F	correction to stage 3 implementation issues	18.6.0
2024-12	SA#106	SP-241644	0210	1	F	Rel 18 CR TS 28.105 Correct information model definitions for ML model deployment	18.6.0
2024-12	SA#106	SP-241643	0212	1	F	Rel-18 CR TS 28.105 Correct description of MLModelCoordinationGroup	18.6.0
2024-12	SA#106	SP-241644	0213	1	F	Rel 18 CR TS 28.105 Corrections for aiml inference history	18.6.0
2024-12	SA#106	SP-241644	0215		F	Rel 18 CR TS 28.105 Remove allowedValues from attribute definitions where value is same as type	18.6.0
2024-12	SA#106	SP-241644	0218	1	F	Rel-18 CR TS 28.105 Add missing attribute to MLModelRepository	18.6.0
2024-12	SA#106	SP-241644	0220	1	F	Rel-18 CR TS 28.105 correction of attribute descriptions and legal values	18.6.0
2024-12	SA#106	SP-241644	0222	1	F	Rel-18 CR TS 28.105 Correction of not used attribute and attribute properties	18.6.0

History

Document history		
V18.3.0	May 2024	Publication
V18.4.0	July 2024	Publication
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