**3GPP TSG-SA5 Meeting #157S5-245416**

**Hyderabad, India, 14-18 October 2024**

**Source: Nokia**

**Title: Rel-19 pCR TR 28.858 improve ML-knowledge-based transfer learning use case**

**Document for: Approval**

**Agenda Item: 6.19.1**

# 1 Decision/action requested

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

# 2 References

[1] 3GPP TR 28.858 “Study on Artificial Intelligence / Machine Learning (AI/ML) management Phase 2”.

# 3 Rationale

This pCR is to add two use cases and corresponding requirements and solutions for ML explainability aspect of trustworthy ML.

# 4 Detailed proposal

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| **Start of modification** |

#### 5 AI/ML management use cases and requirements

## 5.1 ML model training

### 5.1.1 ML-Knowledge-based Transfer Learning

Editor’s Note: The content in this clause may need to be aligned with the latest version of TS28.105 [2].

#### 5.1.1.1 Description

It is known that existing ML capability can be leveraged in producing or improving new or other ML capability. Specifically, using transfer learning knowledge contained in one or more ML models may be transferred to another ML model. Transfer learning relies on task and domain similarity to deduce whether some parts of a deployed ML model can be reused in another domain / task with some modifications. aspects of transfer learning that are appropriate in multi-vendor environments need to be supported in network management systems. However, ML models are not to be multi-vendor objects, i.e. it will not be possible to transfer an ML model from one function to another**.** Instead, the knowledge contained in the model, called ML knowledge, should be transferred instead of transferring the ML model itself.

ML knowledge represents the information (e.g., experience that indicates the recommended outputs given set of input data) gained by the MLModel through learning. This information can be in the form of (but not limited to) statistics (e.g., in a distribution) or a summary (e.g. in a table).

As an example, the knowledge contained in an ML model deployed to perform mobility optimization by day can be leveraged to produce a new ML model to perform mobility optimization by night. As such and as illustrated by figure 5.1.1.1-1, the network or its management system needs to have the required management services for ML Knowledge-based Transfer Learning (MLKTL), where ML Knowledge-based Transfer Learning refers to means to allow and support the usage and fulfilment of transfer learning between any two ML models or training functions.



**Figure 5.1.1.1-1: ML Knowledge-based Transfer Learning (MLKTL) flow between the source MLKTL
(which is the MnS producer with the pre-trained ML model), the peer MLKTL
(which is the MnS producer that shall train a new ML model) and the MLKTL MnS consumer
(which may be the operator or another management function that triggers or controls MLKTL)**

#### 5.1.1.2 Use cases

##### 5.1.1.2.1 Discovering sharable Knowledge

For the transfer learning, it is expected that the source ML Knowledge-based Transfer Learning MnS producer shares its knowledge with the target ML Training function, either simply as single knowledge transfer instance or through an interactive transfer learning process. The concept of knowledge here represents any experiences or information gathered by the MLModel in the ML Knowledge-based Transfer Learning MnS producer through training, inference, updates, or testing. This information or experiences can be in the form of - but not limited to - data statistics or other features of the underlying ML model. It may also be the output of an MLModel. The 3GPP management systems should provide means for an MnS consumer to discover this potentially shareable knowledge as well as means for the provider of MLKLT to share the knowledge with the MnS consumer.

##### 5.1.1.2.2 Knowledge sharing and transfer learning

The transfer learning may be triggered by a MnS consumer either to fulfil the learning for itself or for it to be accomplished through another ML Training function. The model containing the knowledge may be an independent managed entity (the ML model). Alternatively, the ML model may also be an entity that is not independently managed but is an attribute of a managed ML model or ML function in which case MLKLT does not involve sharing the ML model or parts thereof but may imply implementing the means and services to enable the sharing of knowledge contained within the ML model or ML-enabled function. The 3GPP management system should provide means and the related services needed to realize the ML Knowledge-based transfer learning process.

Specifically, the 3GPP management system should provide means for an MnS consumer to request and receive sharable knowledge as well as means for the provider of MLKLT to share the knowledge with the MnS consumer or any stated target ML Training function. Similarly, the 3GPP management system should provide means for an MnS consumer to manage and control the MLKLT process and the related requests associated with transfer learning between two ML models or between the two ML models and a shared knowledge repository.

The two use cases should address the four scenarios below..

Note: the use case and requirements here focus on the required management capabilities, the implementation of the knowledge transfer learning processes are implementation details that are out of the scope of the present document.

- Scenario 1 - Interactions for ML-Knowledge-based Transfer Learning (MLKLT) tosupport training at the ML knowledge-based Transfer MnS consumer as peer - ML knowledge-based Transfer MnS consumer obtains the ML knowledge which it then uses for training the new ML model based on knowledge received from the MLKLT sourceMnS producer

- Scenario 2 - interactions for ML-Knowledge-based Transfer Learning (MLKTL) to support training at the peer ML knowledge-based transfer MnS producer triggered by the MLKTL Source - the ML Knowledge-based Transfer Learning MnS consumer acting as the MLKTLSource (the source of the ML knowledge) triggers the training at the peer ML knowledge-based Transfer MnS producer by providing the ML knowledge to be used for the training, the peer ML Knowledge-based Transfer Learning MnS producer then undertakes the training

- Scenario 3 - interactions for ML-Knowledge-based Transfer Learning (MLKLT) to support training at the Peer ML knowledge-based Transfer MnS producer who is different from the ML knowledge-based Transfer MnS consumer - the ML knowledge-based Transfer MnS consumer triggers training at the MLKLT peer MnS producer. The MLKLTMnS consumer then obtains the
ML knowledge from the MLKLT source MnS producer and then uses the knowledge for training
the new ML model based on knowledge received from the MLKLT source MnS producer

- Scenario 4 - interactions for ML-Knowledge-based Transfer Learning (MLKLT) tosupport training at the Source ML knowledge-based Transfer MnS producer - the ML knowledge-based Transfer MnS consumer triggers training at the MLKLT source MnS producer. The MLKLTMnS consumer then takes its available ML knowledge and uses the knowledge for training the new ML model based

#### 5.1.1.3 Potential requirements

**REQ-MLKLT-1:** The 3GPP management systemshould have a capability enabling an authorized MnS consumer to discover the available shared knowledge from a given MLKLT MnS producer according to a stated set of criteria.

**REQ-MLKLT-2:** The 3GPP management systemshould have a capability enabling an authorized MnS consumer to request a MLKLT MnS producer to provide some or all the knowledge available for sharing according to some stated criteria.

**REQ-MLKLT-3:** The 3GPP management systemshould have a capability for a MLKLT MnS producer to report to an authorized MnS consumer on the available shared knowledge according to a ReportingCriteria specified in a request for information on available Knowledge.

**REQ-MLKLT-4:** The 3GPP management systemshould have a capability enabling an authorized MnS consumer to request a MLKLT MnS producer to trigger and execute a transfer learning instance to a specified ML model or ML-enabled function.

**REQ-MLKLT-5:** The 3GPP management systemshould have a capability for an authorized MnS consumer (e.g. an operator or the function/entity that generated the request for available Knowledge or for information thereon) to manage the request for knowledge or its information and subsequent process, e.g. to suspend, re-activate or cancel the MLKnowledgeRequest; or to adjust the description of the desired knowledge.

**REQ-MLKLT-6:** The 3GPP management systemshould have a capability for an authorized MnS consumer (e.g. an operator or the function/entity that generated the request for MLKLT) to manage or control a specific MLKLTJob, e.g. to start, suspend or restart the MLKLTJob; or to adjust the transfer learning conditions or characteristics i.e. Modify MLKLTJob attributes.

Note: the MLKLTJob represents the process of knowledge-based trasfer learning.

**REQ-MLKLT-7:** The 3GPP management systemshould have a capability enabling an MLModel to register available knowledge to a shared knowledge repository, e.g. through a MLKnowledgeRegistration process.

**REQ-MLKLT-8:** The 3GPP management systemshould have a capability enabling KnowledgeRepo to act as the MLKLT MnS Producer to enable an authorized MnS consumer to request the shared knowledge repository to provide information on the available knowledge according to some given criteria.

**REQ-MLKLT-9:** The 3GPP management systemshould have a capability enabling KnowledgeRepo to act as the MLKLT MnS Producer to enable an authorized MnS consumer to request the KnowledgeRepo to provide some or all the knowledge available for sharing according to some given criteria.

**REQ-MLKLT-10:** The 3GPP management systemshould have a capability enabling KnowledgeRepo to act as the MLKLT MnS Producer to enable an authorized MnS consumer (e.g. an operator or the function/entity that generated the MLKnowledgeRequest) to manage the request, e.g. to suspend, re-activate or cancel the MLKnowledgeRequest ; or to adjust the description of the desired knowledge.

**REQ-MLKLT-11:** The 3GPP management systemshould have a capability enabling KnowledgeRepo to act as the MLKLT MnS Producer to enable an authorized MnS consumer (e.g. an operator) to manage or control a specific MLKLTJob, e.g. to start, suspend or restart the MLKLTJob; or to adjust the transfer learning conditions or characteristics.

#### 5.1.1.4 Possible solutions

Discovering sharable Knowledge

To discover sharable knowledge:

- The MnS consumer may send a request to the MLKLT MnS producer to provide information on the available sharable knowledge. In other words, the MLKLT MnS producer receives a request to report on the available sharable knowledge.

- The request may be generic or may state a set of criteria which the knowledge should fulfil.

- The request may be referred to as MLKnowledgeInfoRequest.

- The MLKnowledgeInfoRequest must have informational description (Metadata description) of the task and domain related to the required knowledge or given a network problem.

- An ML model or a function containing an ML model may register its available knowledge to a shared knowledge repository, e.g. through a MLKnowledgeRegistration process.

- The MLKnowledgeRegistration must contain informational description (Metadata description) of the task and domain related to the registered knowledge or suitable network problem.

Knowledge sharing and transfer learning

To share knowledge:

- Introduce an IOC for an ML Knowledge request. The MnS consumer may send a request to the MLKLT MnS producer to share a specific kind of knowledge. i.e. the MLKLT MnS producer receives a request to provide sharable knowledge, The request may be referred to as MLKnowledgeRequest.

- Introduce an IOC for an ML Knowledge-based transfer learning process or job which is instantiated for any request for transfer learning or ML knowledge-based transfer. The MLKLT MnS producer instantiates a ML Knowledge-based transfer learning process. The process may be referred to as MLKLTJob.

- The MLKLTJob is responsible for adapting the required knowledge into a shareable format with the MLKLT consumer.

- MLKLTJob may be a continuous process where knowledge is shared with the MLKLT consumer frequently to account for updates in the knowledge.

NOTE: It may also be the case that the consumer directly instantiates the MLKLTJob without a separate request.

#### 5.1.1.5 Evaluation

The solution described in clause 5.1.1.4 proposes simple information objects that can enable ML functions to exchange their knowledge to be used towards transfer learning but in a way that enables the vendor specific aspects of the ML models not to be exposed. Therefore, the solution described in clause 5.1.1.4 is a feasible solution to be developed further in the normative specifications.

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| **End of modifications** |