Updates from ITU-T FG ML5G

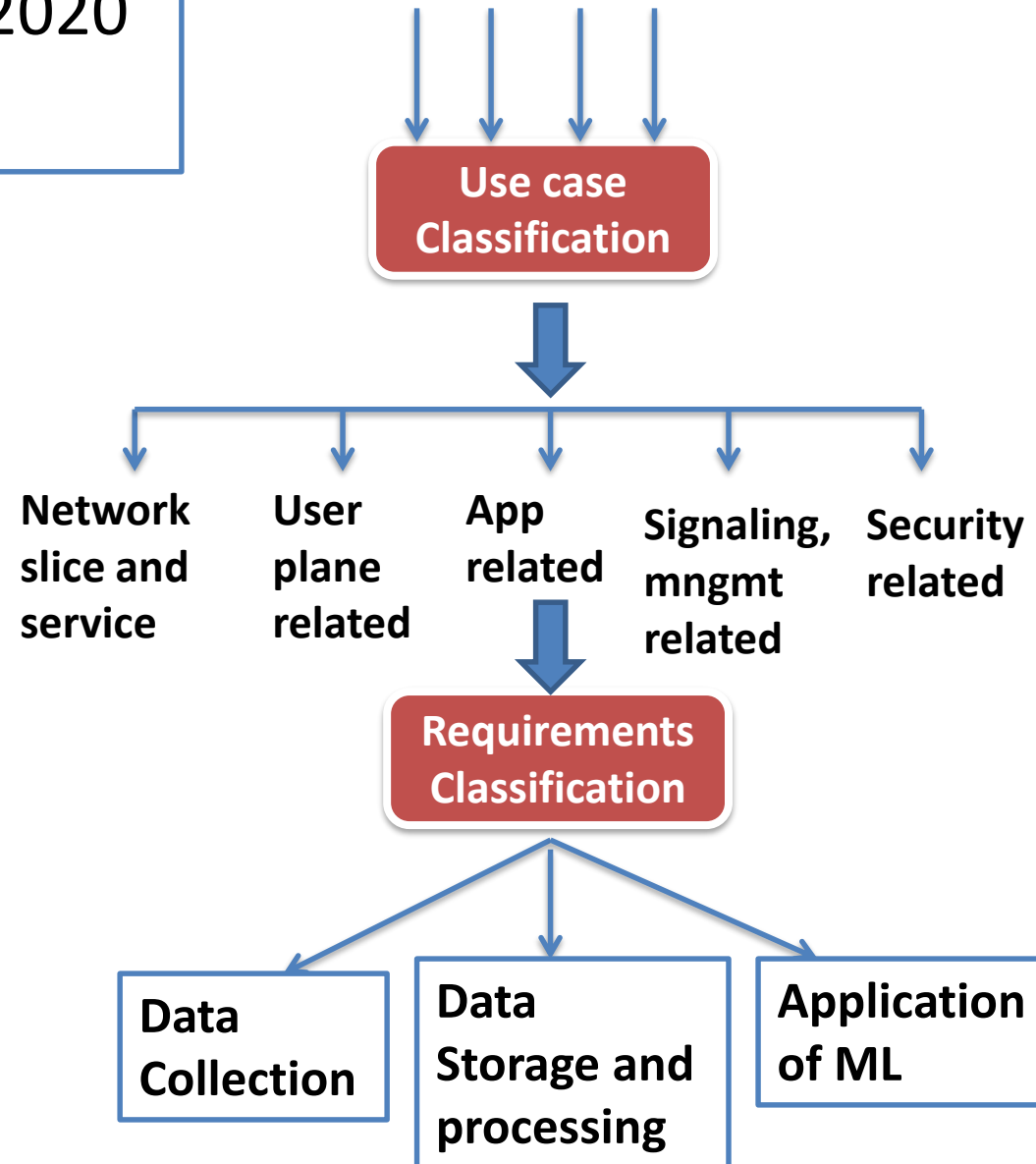Vishnu Ram

ITU-T FG ML5G

Agenda

- Use cases
- Overall architecture framework
- Data handling framework
- Integration of ML marketplace
- Model optimization
- Framework for evaluation of intelligence level
- ML Function orchestration
- student projects with FG.
- Future work: gaps and relations and liaisons

Use cases for ML in IMT-2020 and future networks

- More than 30 use cases submitted to the FG
- Requirements were analyzed for each, reviewed and compiled.
- Requirements are classified as "critical", "expected" and "added value".

Approved by SG13 as supplement [1]

Use case contributions

Use case Classification

Network slice and service	User plane related	App related	Signaling, mngmt related	Security related

Requirements Classification

Data Collection

Data Storage and processing

Application of ML

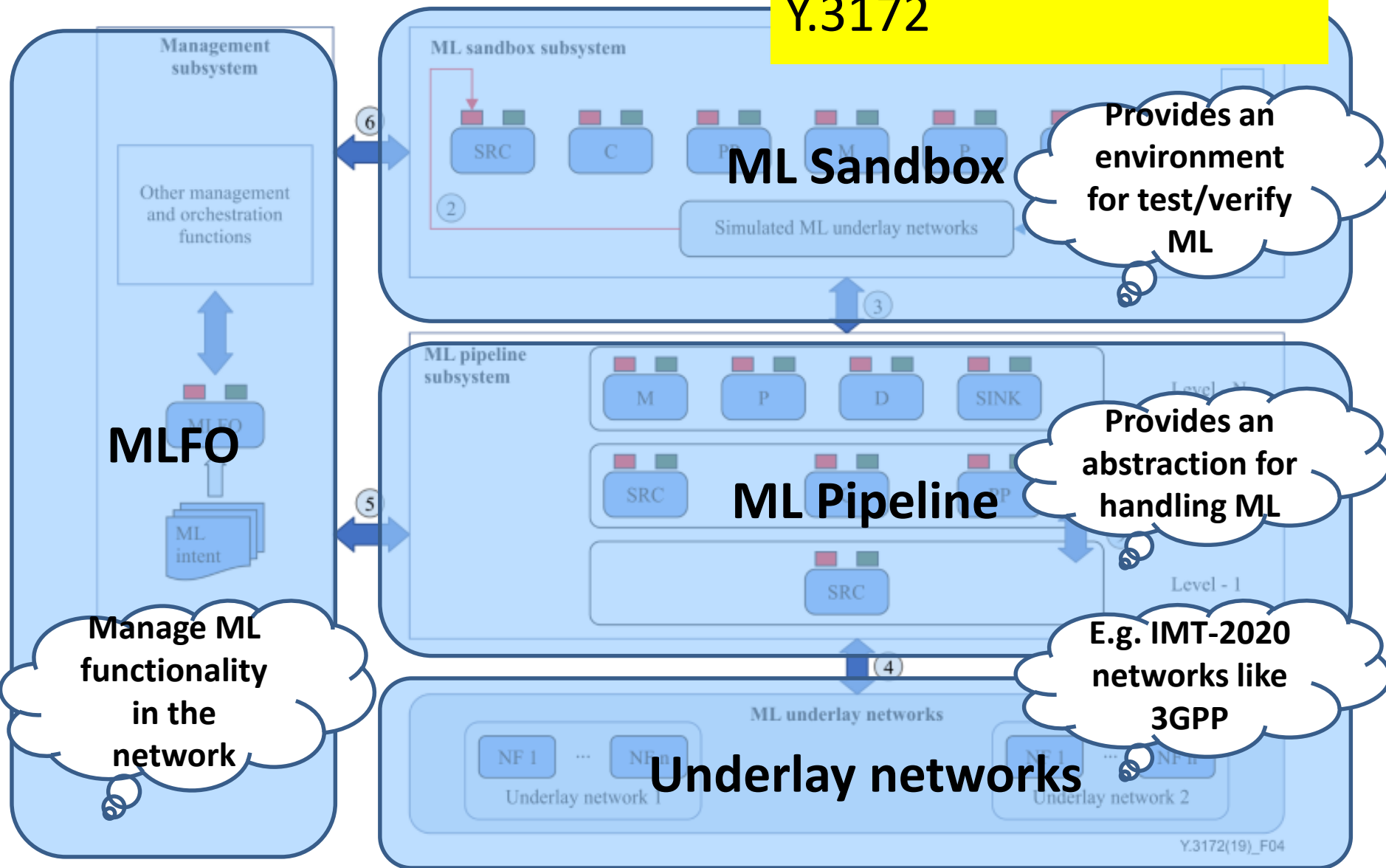# Use cases for ML in IMT-2020 and future networks

Title	Description
Traffic Classification	collect a large amount of traffic data and learn the patterns of the collected data to build traffic classification models
Mobility Pattern Prediction	to collect position estimates for coarse grain, large scale and finer grain UE mobility.
Cognitive Heterogeneous Networks	ML in Cognitive Heterogeneous Networks allow allocation of resources from different communication networks access nodes

Problem statements

1. ML marketplaces need to be integrated into IMT-2020 networks

2. Common arch framework needed across use cases

3. Varied data formats and data models

4. Intelligence capabilities of the underlying networks are important

ML Repos

Models | Models | Models

Model transfer

ML pipeline

Events, alarms, performance, logs

Management subsystem

AN NF | TN | CN NF

UE | UE | UE | UE

Architecture framework

ML Sandbox

Provides an environment for test/verify ML

MLFO

ML Pipeline

Provides an abstraction for handling ML

Manage ML functionality in the network

Underlay networks

E.g. IMT-2020 networks like 3GPP

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Application of ML pipeline
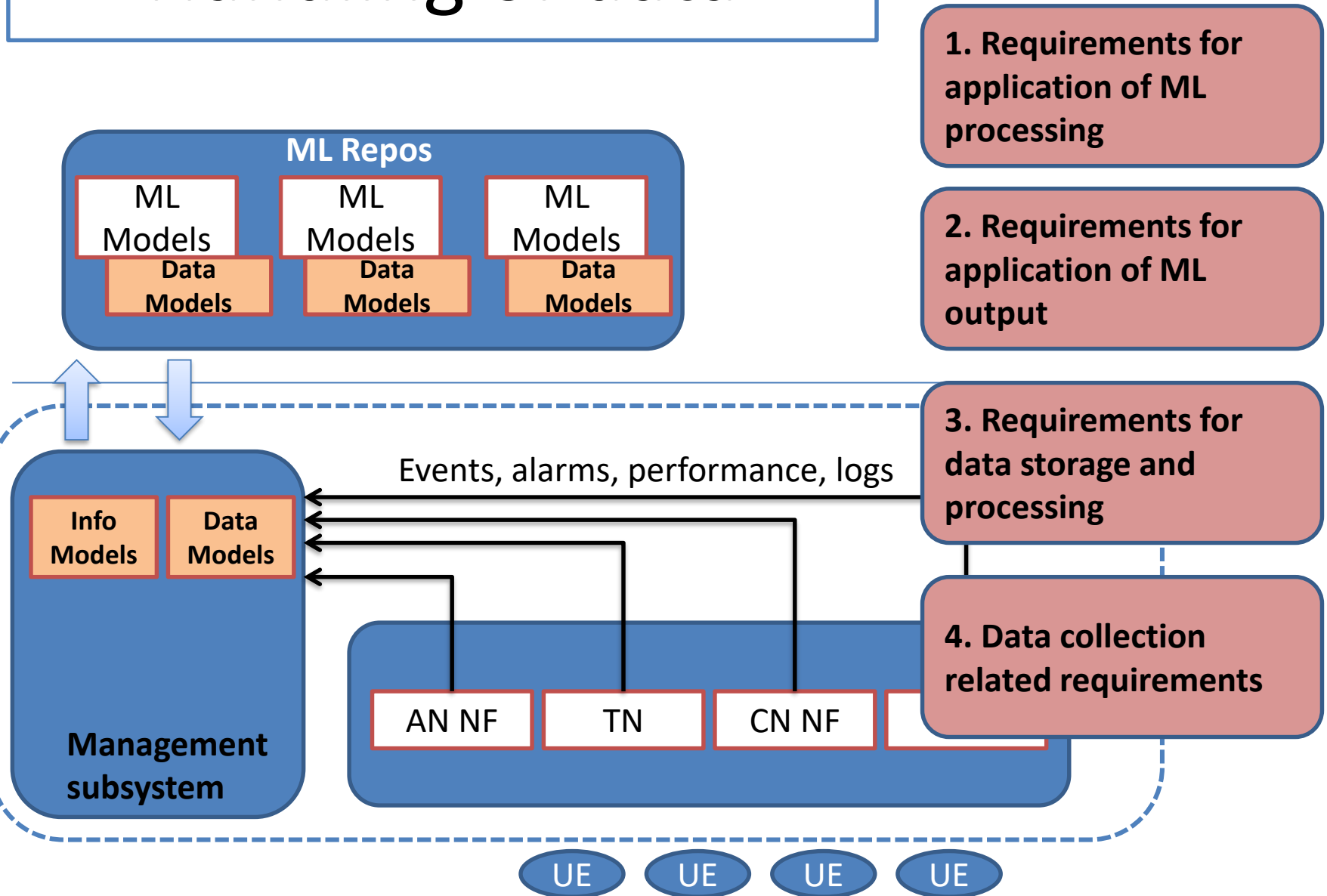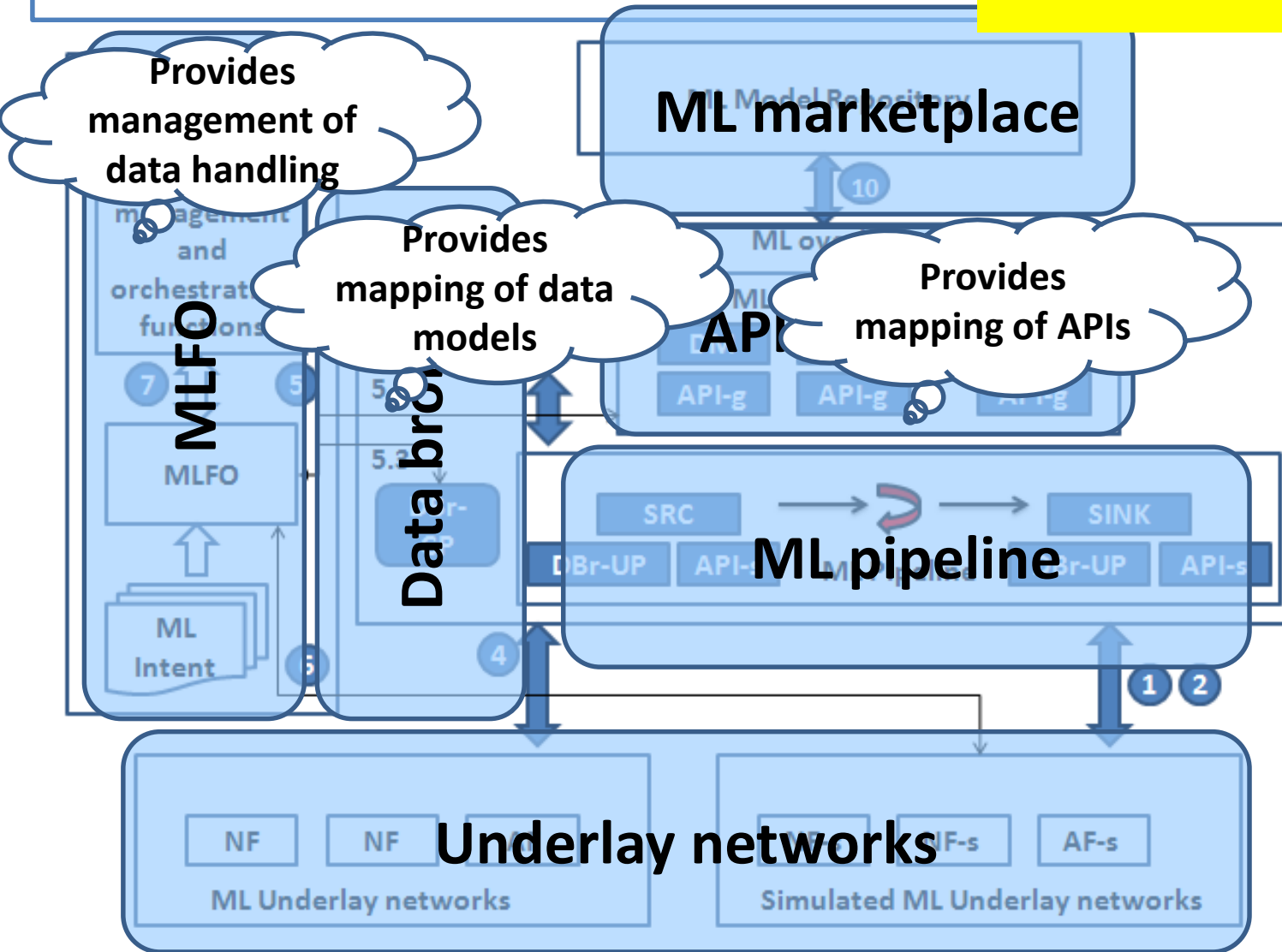
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1. Collect location information from UEs
2. Collect channel measurements reported at the AN
3. Analyse to make intelligent scheduling decisions.
4. Collect DL packet information from GW
5. Collect AN information
6. Analyse to make intelligent QoS configurations

7

Handling of data

ML Repos

ML Models	ML Models	ML Models
Data Models	Data Models	Data Models

1. Requirements for application of ML processing

2. Requirements for application of ML output

3. Requirements for data storage and processing

Events, alarms, performance, logs

Info Models | **Data Models**

4. Data collection related requirements

Management subsystem

AN NF | TN | CN NF

UE   UE   UE   UE

Data handling framework

ML marketplace

MLFO

Data broker

API

ML pipeline

Underlay networks

Provides management of data handling

Provides mapping of data models

Provides mapping of APIs

MLFO DBr-CP SRC SINK ML metadata store ML underlay network ML DB ML pipeline

Intent based setup of data mapping for ML

1. ML Intent

2. DM lookup request

3. DM lookup response

Data model selection based on ML use case

Sub procedure: Create ML pipeline

4. Create DBr-Sesssion
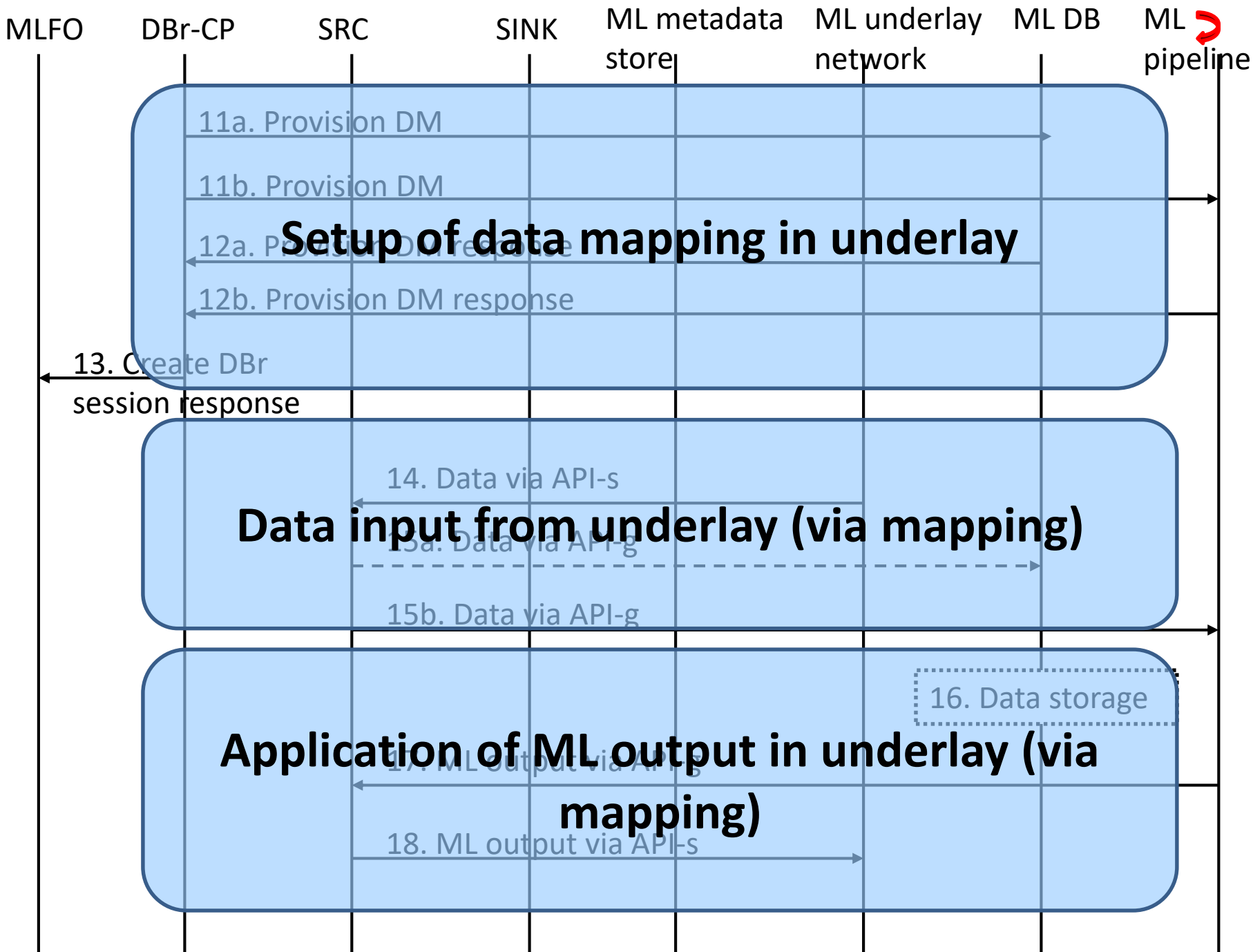
5. Provision DM

6. Create DBr-UP instance

Use ML pipeline to setup data mapping

Setup of data mapping in Pipeline

7. Provision DM response

8. Provision DM

9. Create DBr-UP instance

10. Provision DM response

MLFO | DBr-CP | SRC | SINK | ML metadata store | ML underlay network | ML DB | ML pipeline

Setup of data mapping in underlay

11a. Provision DM

11b. Provision DM

12a. Provision DM response

12b. Provision DM response

13. Create DBr session response

Data input from underlay (via mapping)

14. Data via API-s

15a. Data via API-g

15b. Data via API-g

Application of ML output in underlay (via mapping)

16. Data storage

17. ML output via API-g

18. ML output via API-s

ML Marketplace integration
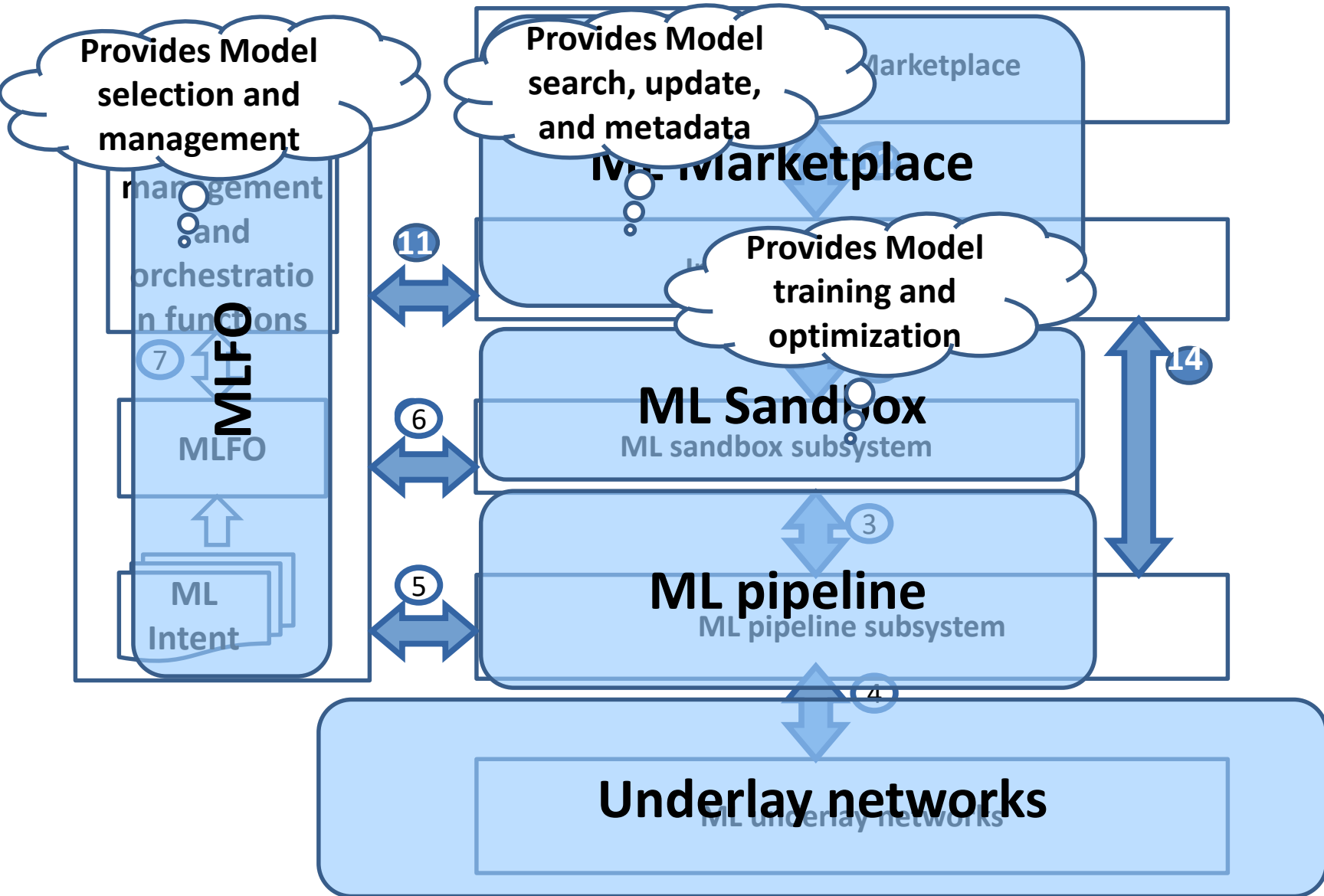
Model search

MLFO   Internal ML marketplace   External ML marketplace

Intent based query of ML model

1. ML Intent

0. Federation setup

2. Decide the query to the ML marketplace (based on use case requirements)

3. Model query

4. Search the ML models based on the metadata from ML internal and external marketplace. Arrive at search results (models).

ML model search

5. Model query response
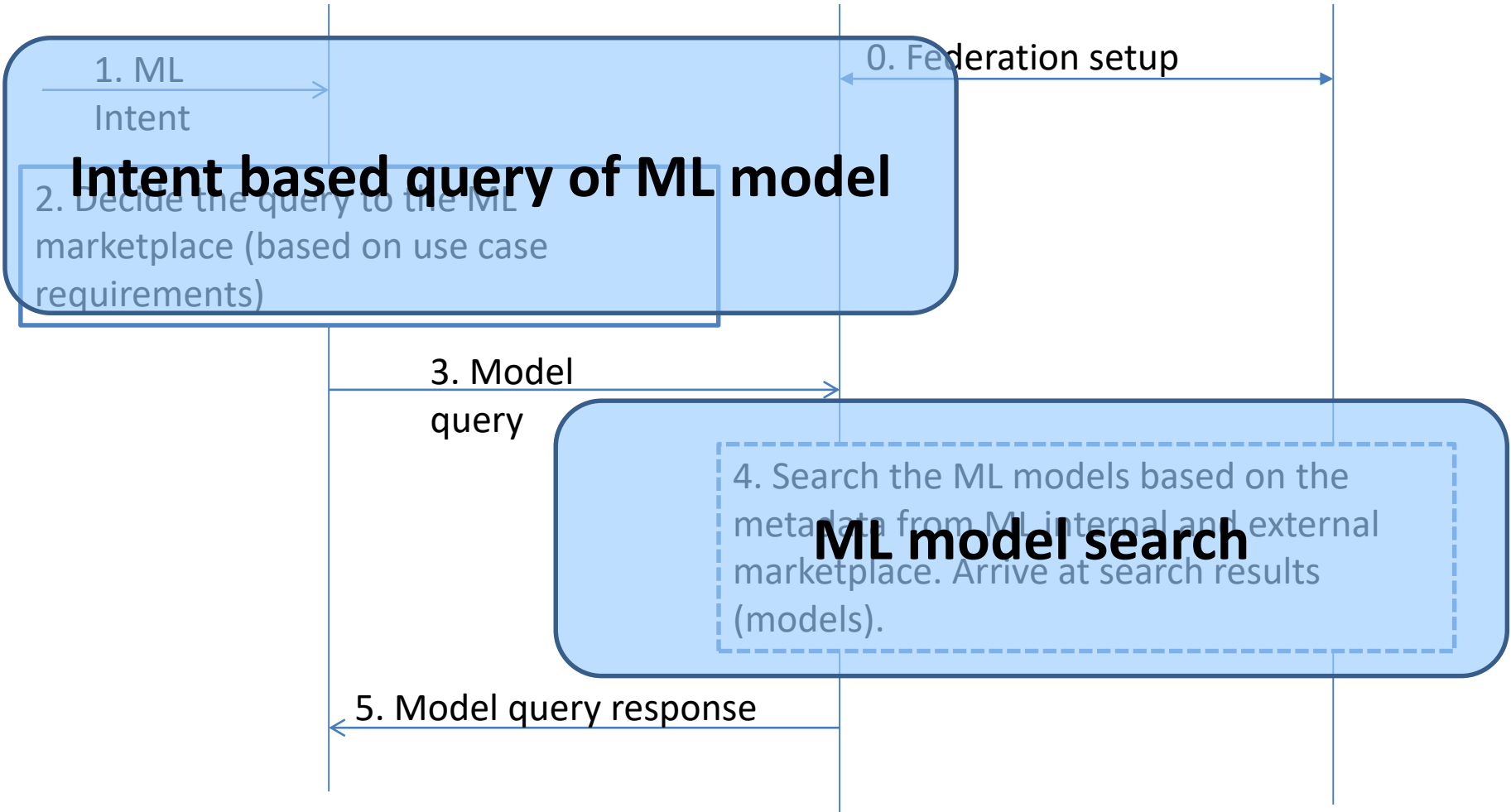
Participants: MLFO | Internal ML marketplace | External ML | ML sandbox

0. Prerequisite: "Model search" is done.

A set of 10+ APIs are defined in ML5G-I-167R5

1. Select Model (based on ML intent and other parameters)

Intent based selection of ML model

2. Model selection

3. Use the ML model id to pick the ML model

4. Use the federated object and ML model id to pick the ML model from external marketplace.

5. ML model onboarding(optional, it happens when the selected model belongs to the external marketplace)

Push ML model to sandbox for training/optimization

6. ML model push request

7. Model push response

8. Model selection response (candidate models)

Model optimization (in the ML sandbox)

MLFO   ML sandbox   Internal ML Marketplace

0. Prerequisite: "Model training" is done.

1. Model deployment in Sandbox for optimization and evaluation

2. Model optimization (e.g. weight quantization)

Model optimization based on various requirements

3. Model monitoring (report)

Model optimization and monitoring

4. Accept monitoring report

5. Model update trigger

6. Model update request

Update optimized ML model to marketplace

7. Model update response

8. Model update trigger response

MLFO NFVO

ML Intent

Intelligence level evaluation

Intent based creation of ML pipeline

1. Parse and decide the ML functions for this ML use case

2. Parse NSD and instantiate NS (using existing methods)

3. Instantiate ML functions

4. Instantiate ML functions

5. Parse and decide monitoring requirements as defined in the ML intent

Monitoring of ML pipeline
Based on the dimensions

6. Monitoring configuration

7. Monitoring report [Data collection]

8. Monitoring report [Analysis]

9. Monitoring report [Action implementation]

10. Measure intelligence level

Intelligence capability level
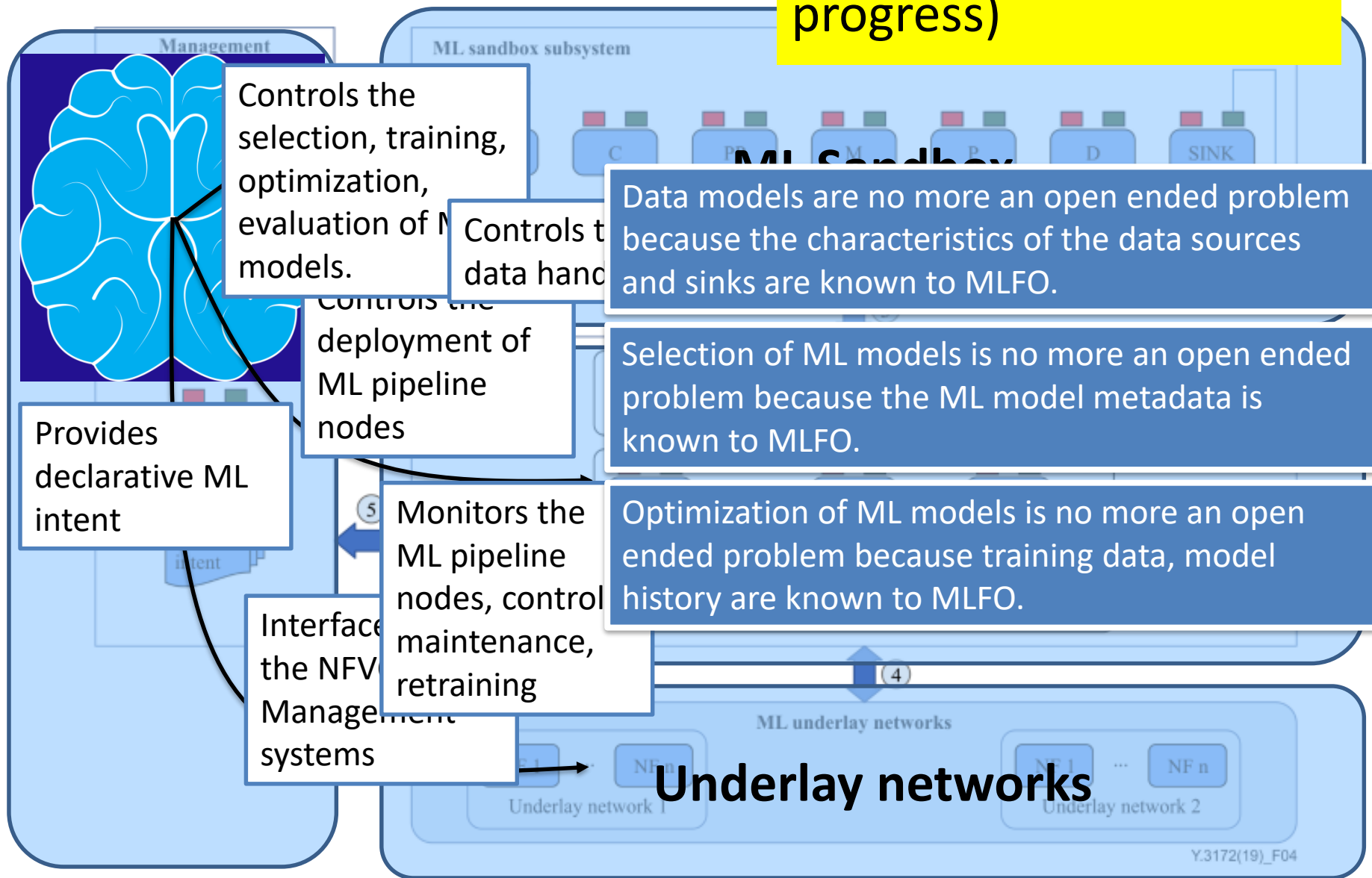
Table 7-2 Network intelligence level evaluation

Network intelligence level		Dimensions				
		Action Implementation	Data Collection	Analysis	Decision	Demand Mapping
L0	Manual network operation	Human	Human	Human	Human	Human
L1	Assisted network operation	Human & System	Human & System	Human	Human	Human
L2	Preliminary intelligence	System	Human & System	Human & System	Human	Human
L3	Intermediate intelligence	System	System	Human & System	Human & System	Human
L4	Advanced intelligence	System	System	System	System	Human & System
L5	Full intelligence	System	System	System	System	System

NOTE 1- The decision process in each level has to support human intervention, i.e. human reviewed decision and execution instructions have the highest authority.

NOTE 2- In certain implementations of the evaluation of network intelligence levels, the dimensions may be independently evaluated.

MLFO

ML Sandbox

Underlay networks

Controls the selection, training, optimization, evaluation of ML models.

Controls the data handling

Controls the deployment of ML pipeline nodes

Provides declarative ML intent

Monitors the ML pipeline nodes, control maintenance, retraining

Interfaces the NFV Management systems

Data models are no more an open ended problem because the characteristics of the data sources and sinks are known to MLFO.

Selection of ML models is no more an open ended problem because the ML model metadata is known to MLFO.

Optimization of ML models is no more an open ended problem because training data, model history are known to MLFO.

Management

ML sandbox subsystem

ML underlay networks

Underlay network 1

Underlay network 2

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Student projects: PoCs

FG is offering guidance to uni students for doing relevant projects.
List of projects is described in ML5G-I-174

How to join:

fgml5g-students@lists.itu.int

- 15-20 students actively contributing at any point of time
- Across 4-5 countries

Student (Nigeria):
- *Future netwo*
- *How to save*
- *Using ML to*
- *nodes*
- *How to distribute ML tasks across UEs, edge devices and IoT devices*
- *Working with edge computers to communicate over servers in the cloud "*

Mentor (Spain): "*the student was very involved in the project, and willing to learn about the application of ML to networks. The knowledge acquired during the project seems also to complement the main academic activities of the student*".

Liaisons + colla

LS are published in ML5G website

1. MPEG (on model compression)
2. IRTF NMRG (on AI/ML use cases)
3. Linux Foundation for AI (on model optimization)
4. ETSI ENI (on Intelligence level)
5. ORAN (on ML model metadata)
6. 3GPP

And you!!

Danke!

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https://extranet.itu.int/sites/itu-t/focusgroups/ML5G/SitePages/Home.aspx

References

[1] Supplement 55 to Y.3170-series: Y.ML-IMT2020-Use-Cases "Machine learning in future networks including IMT-2020: use cases"
[2] ITU-T Y.3172
[3] ITU-T Y.3173
[4] ITU-T Y.3174
[5] ITU-T Y.3173
[6] ML5G-I-167R5
[7] ML5G-I-171R2
[8] ML5G-I-172R2
[9] ML5G-I-174