

IEICE IN/RCS/NV 研究会 2020 May 21 – 22 Online

Network control with AI/ML – Standardization progress in ITU –

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Acknowledgement:

This work was conducted as a part of the project titled "Research and development for innovative AI network integrated infrastructure technologies (JPMI00316)," supported by the Ministry of Internal Affairs and Communications, Japan.



Outline

- Overview
- FG ML5G
- ITU-T SG13
- AI/ML 5G Challenges
- AI NW in other SDOs
- Conclusion

NOTE

FG ML5G: Focus Group on Machine Learning for future networks including 5G

ITU-T SG13: Study Group 13 is responsible for standardization of network architecture

AI/ML: Artificial Intelligence/Machine Learning

AI NW: AI-based network

SDOs: Standards development organizations

Overview

ITU activities on AI/ML in 5G/IMT2020 control and management

2017

FG ML5G
establishment

2018

FG ML5G 4 meetings
& workshops, 3 drafts

2019

FG ML5G 3 deliverables
submitted to SG13, consented
as 1 Sup. and 3 Rec.

FG ML5G lifetime extended
by one year

2020

FG ML5G finalizing 7
deliverable, initiating AI in
5G challenge projects

ITU-T SG13
progressing several
drafts

Note: IMT-2020 is ITU's terminology for 5G network
Sup. = Supplement is like a ITU technical report
Rec. = Recommendation is ITU standard document.

FG ML5G activities overview

<https://www.itu.int/en/ITU-T/focusgroups/ml5g/Pages/default.aspx>

- Work scope

Study of architecture, interfaces, use cases, protocols, algorithms, data formats, interoperability, performance, evaluation, security

Three working groups (WGs):

WG1: Use cases, services and requirements

WG2: Data formats and ML technologies

WG3: ML-aware network architecture

- Meetings and workshops

- 1st : January 2018, Geneva
- 2nd : April 2018, Xian, China
- 3rd : August 2018, San Jose, USA
- 4th : November 2018, Tokyo
- ...
- 8th : March 2020, online
- 9th (Final): June 2020, online

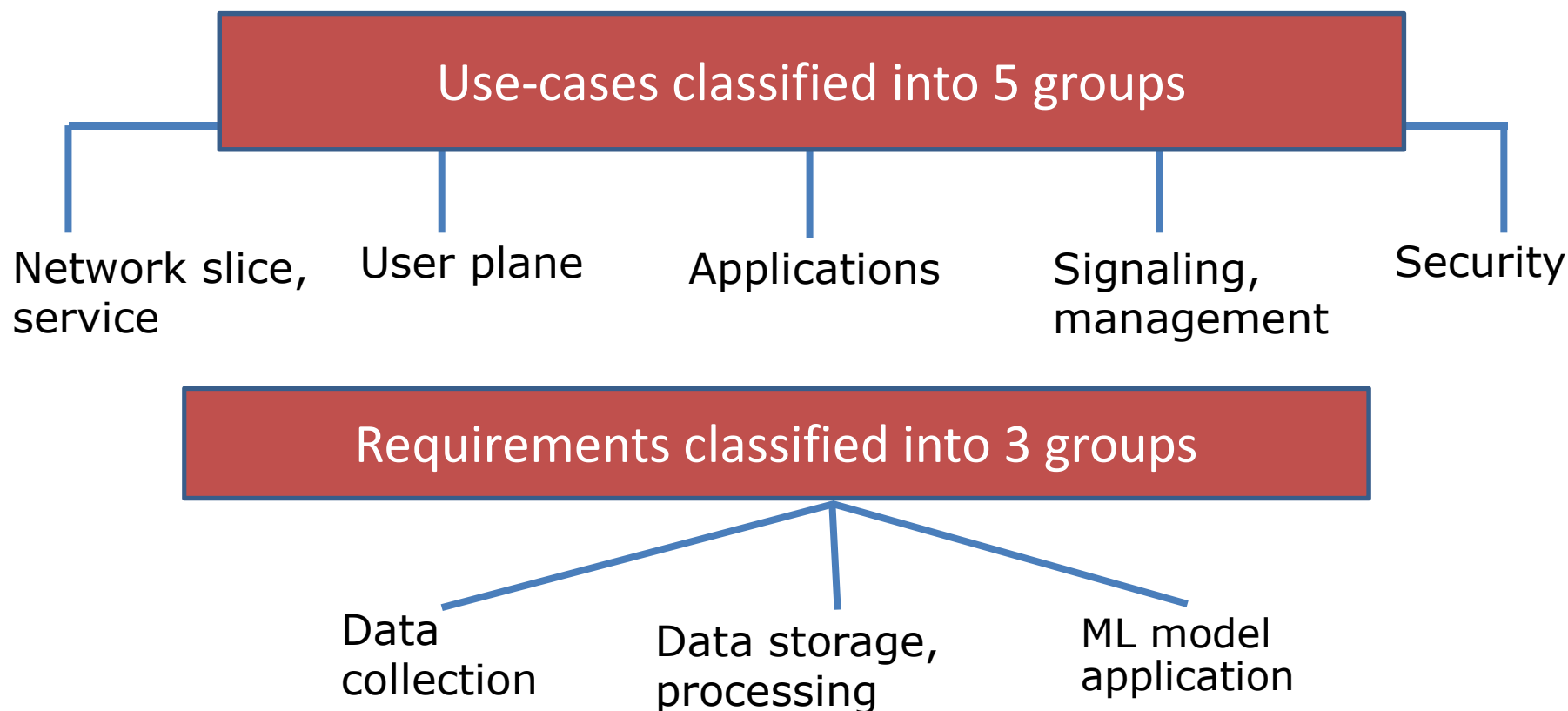
FG ML5G/ITU-T SG13 documents list



1. Y.sup55: "Machine learning in future networks including IMT-2020: use cases" (Oct 2019)
2. Y.3172: "Architectural framework for machine learning in future networks including IMT-2020" (Jan 2020)
3. Y.3173: "Framework for evaluating intelligence levels of future networks including IMT-2020" (Feb 2020)
4. Y.3174: "Framework for data handling to enable machine learning in future networks including IMT-2020" (Feb 2020)
5. Y.3175: "Functional architecture of machine learning based quality of service assurance for the IMT-2020 network" (Apr 2020)
6. Y.ML-IMT2020-MP draft: "Architecture for ML marketplace integration in future networks including IMT-2020"
7. Y.ML-IMT2020-RAFR (Resource adaptation and failure recovery),
Y.ML-IMT2020-serv-prov (Service provisioning)
8. ...

ITU-T Y.sup55: Machine learning in future networks including IMT-2020: use cases

- More than 30 use-cases and their requirements compiled



- Three levels of requirements:
 - “critical”, “expected” and “added value”

Use cases – some examples

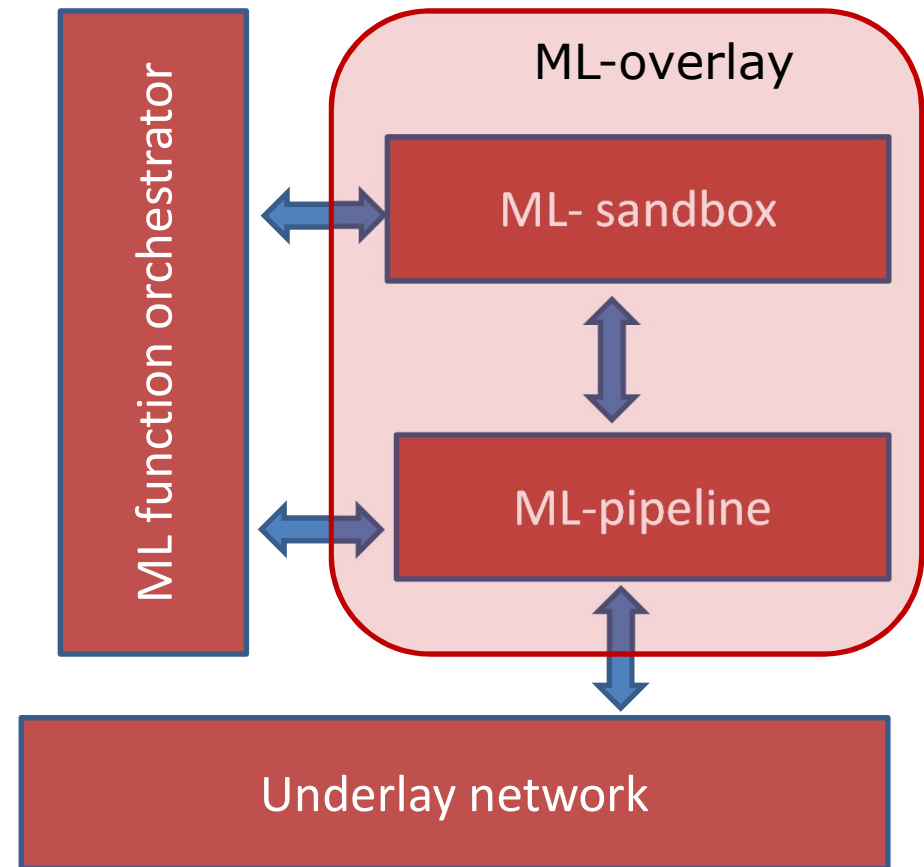


Use-case titles	Description	Requirement examples
Radio resource management for network slicing	Providing performance guarantee with high reliability, while ensuring efficient utilization of radio resources	Support the continuous collection of data, analysis of network slice behaviour and resource utilization patterns
End-to-end network service design automation	Automatically translating service requirements of application services to network parameters/requirements	Support data models to specify service requirements, integrate automated network configuration methods
End-to-end fault detection and recovery	Predictive detection and root cause analysis, and automated recovery decision making	Support collection of performance data on real-time basis, generation of training data using testing environments

ITU-T Y.3172: Architectural framework for machine learning in future networks including IMT-2020 (1/4)

Scope

- A set of requirements
- Architectural components needed to satisfy the requirements
- Architectural framework with the integration of components
- Guidelines for applying architectural framework in networks



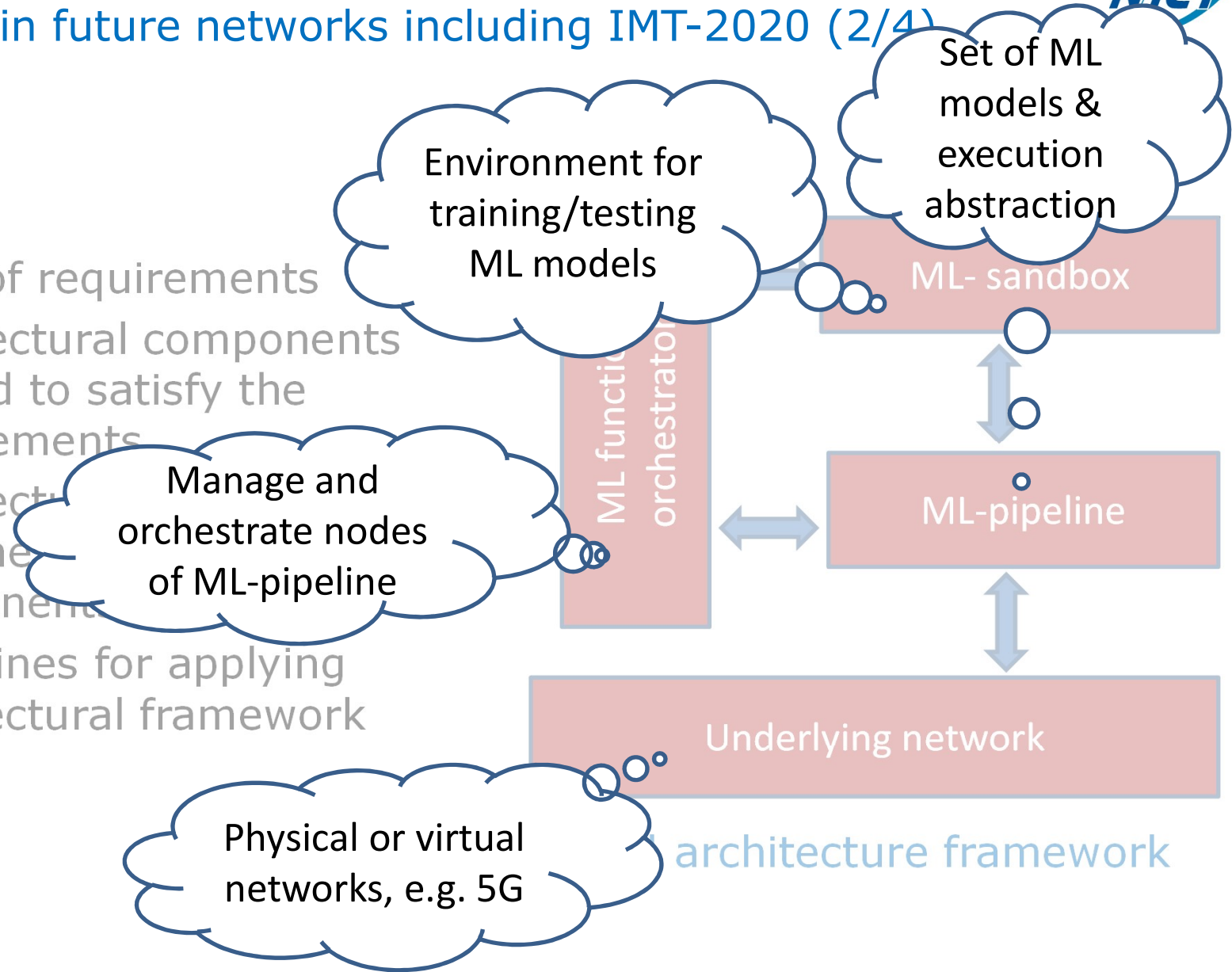
Simplified architecture framework

ITU-T Y.3172: Architectural framework for machine learning in future networks including IMT-2020 (2/4)



Scope

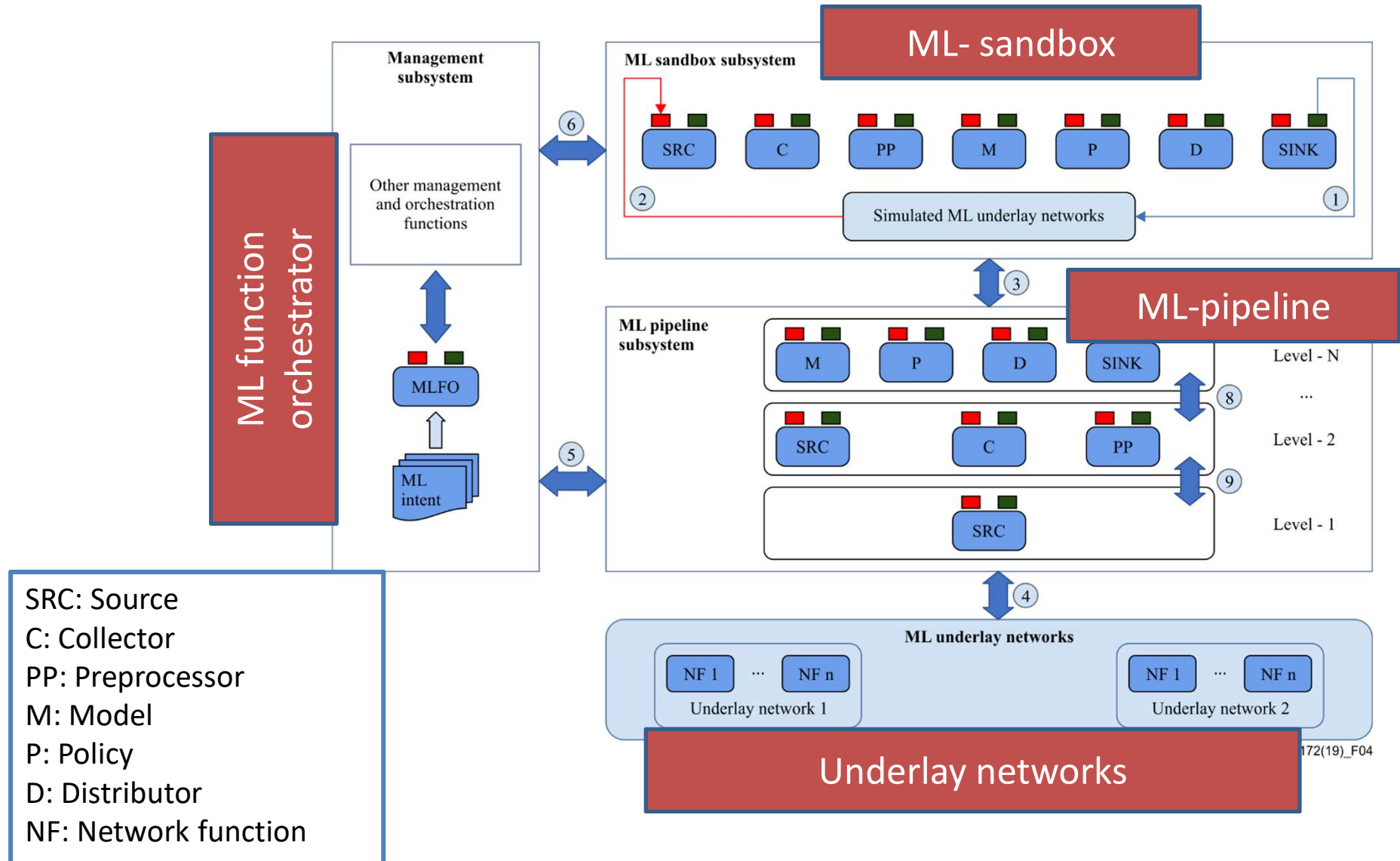
- A set of requirements
- Architectural components needed to satisfy the requirements
- Architecture with the components
- Guidelines for applying architectural framework



ITU-T Y.3172: Architectural framework for machine learning in future networks including IMT-2020 (3/4)

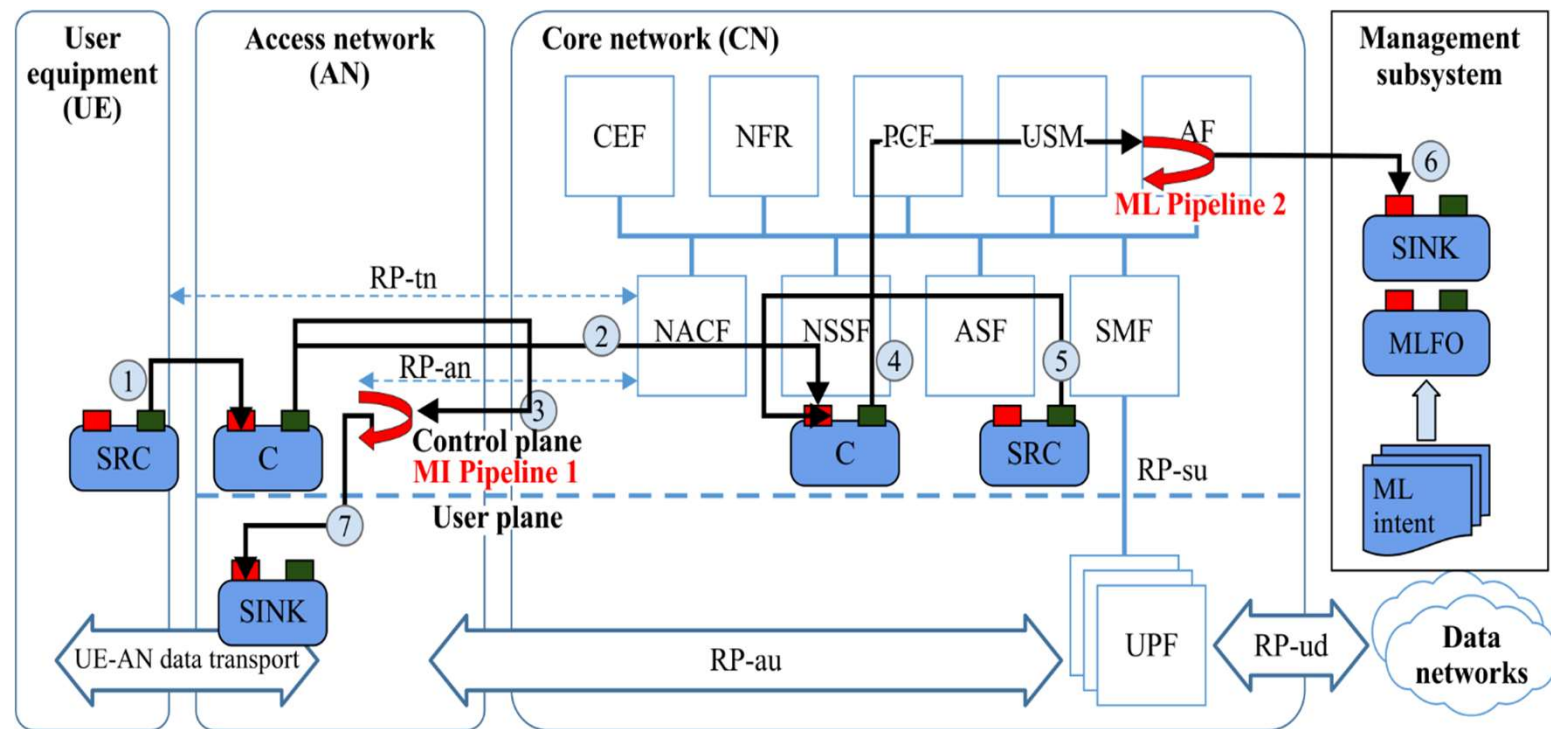


High-level architecture framework & components



ITU-T Y.3172: Architectural framework for machine learning in future networks including IMT-2020 (4/4)

Example of the high-level architecture realization in an IMT-2020 network



Y.3172(19)_FI.1

1. Collect location information from UEs
2. Collect channel measurement from AN
3. Analyze to make intelligent scheduling decisions and execute through 7.

4. Collect DL packet information from GW
5. Collect AN information
6. Analyze to make intelligent QoS configurations

ITU-T Y.3173: Framework for evaluating intelligence levels of future networks including IMT-2020 (1/4)

Scope

- Development trend for evaluating network intelligence levels
- Evaluation methods
- Architectural view

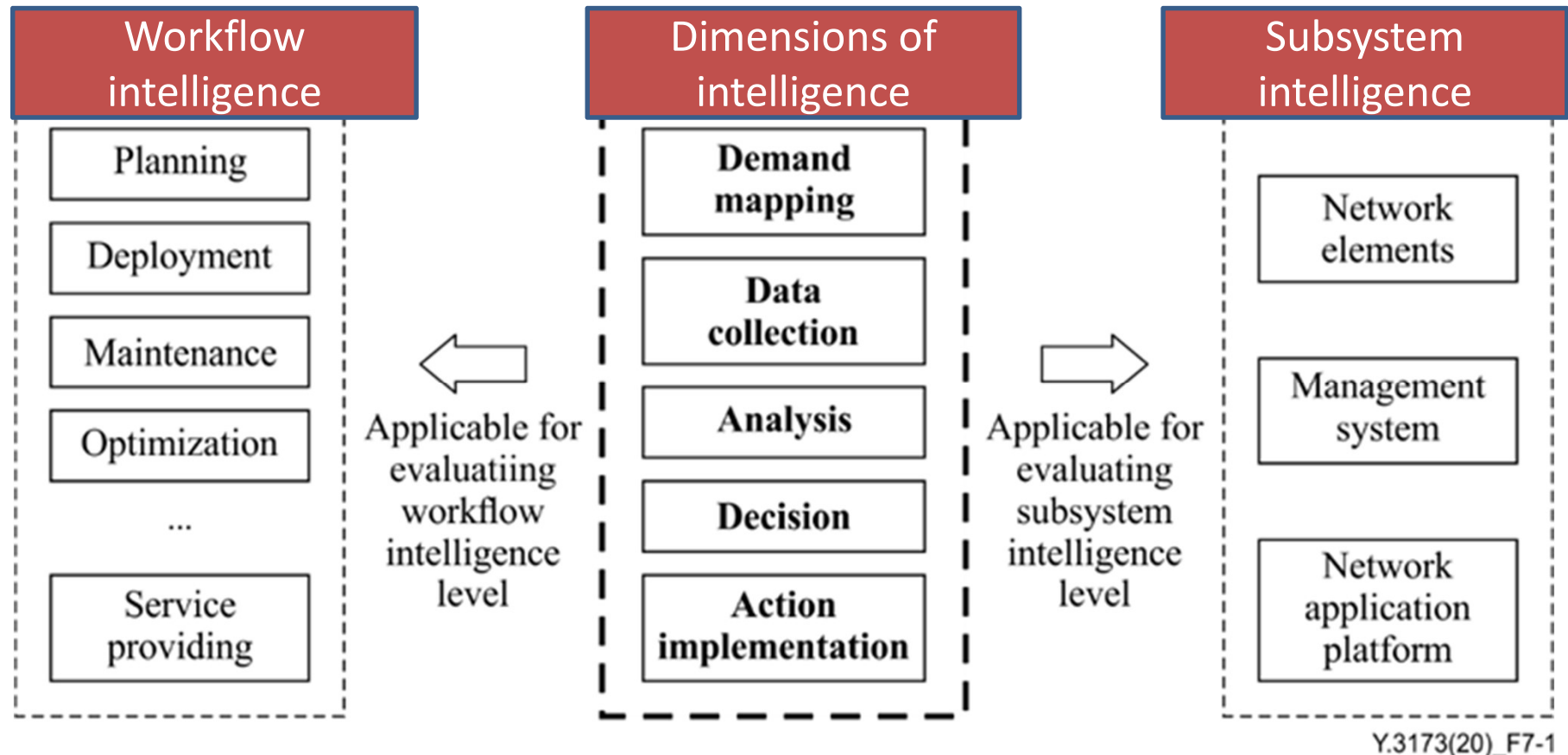
Why evaluation framework?

- To provide an evaluation basis
- To help industry to reach a consensual and unify understanding, formulate relevant strategies and development plans
- To provide decision mechanisms to operators, equipment vendors and other network industry participants for planning of network technology features and products' roadmaps

ITU-T Y.3173: Framework for evaluating intelligence levels of future networks including IMT-2020 (2/4)



Dimensions for evaluating network intelligence levels



NOTE: SAE (Society of automotive engineers) documents on methods for intelligence levels are taken as reference.

ITU-T Y.3173: Framework for evaluating intelligence levels of future networks including IMT-2020 (3/4)



Actors for classifying dimensions of network intelligence capability levels

Actors in network intelligence capability level	Roles
Human	Rules definition, decision and action implementation all carried out by human
Human and system	Rules definition by human, decision and actions implementation carried out by system automatically
System	Rules definition, decision and action implementation all carried out automatically by system

ITU-T Y.3173: Framework for evaluating intelligence levels of future networks including IMT-2020 (4/4)



Network intelligence level chart

Network intelligence levels		Dimensions of intelligence				
		Action implementation	Data collection	Analysis	Decision	Demand mapping
L0	Manual operation	Human	Human	Human	Human	Human
L1	Assisted operation	Human and 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

ITU-T Y.3174: Framework for data handling to enable machine learning in future networks including IMT-2020 (1/2)



Scope:

- High-level requirements of data handling and data models
- Framework for data handling
- Guidelines and example usage

Challenges addressed:

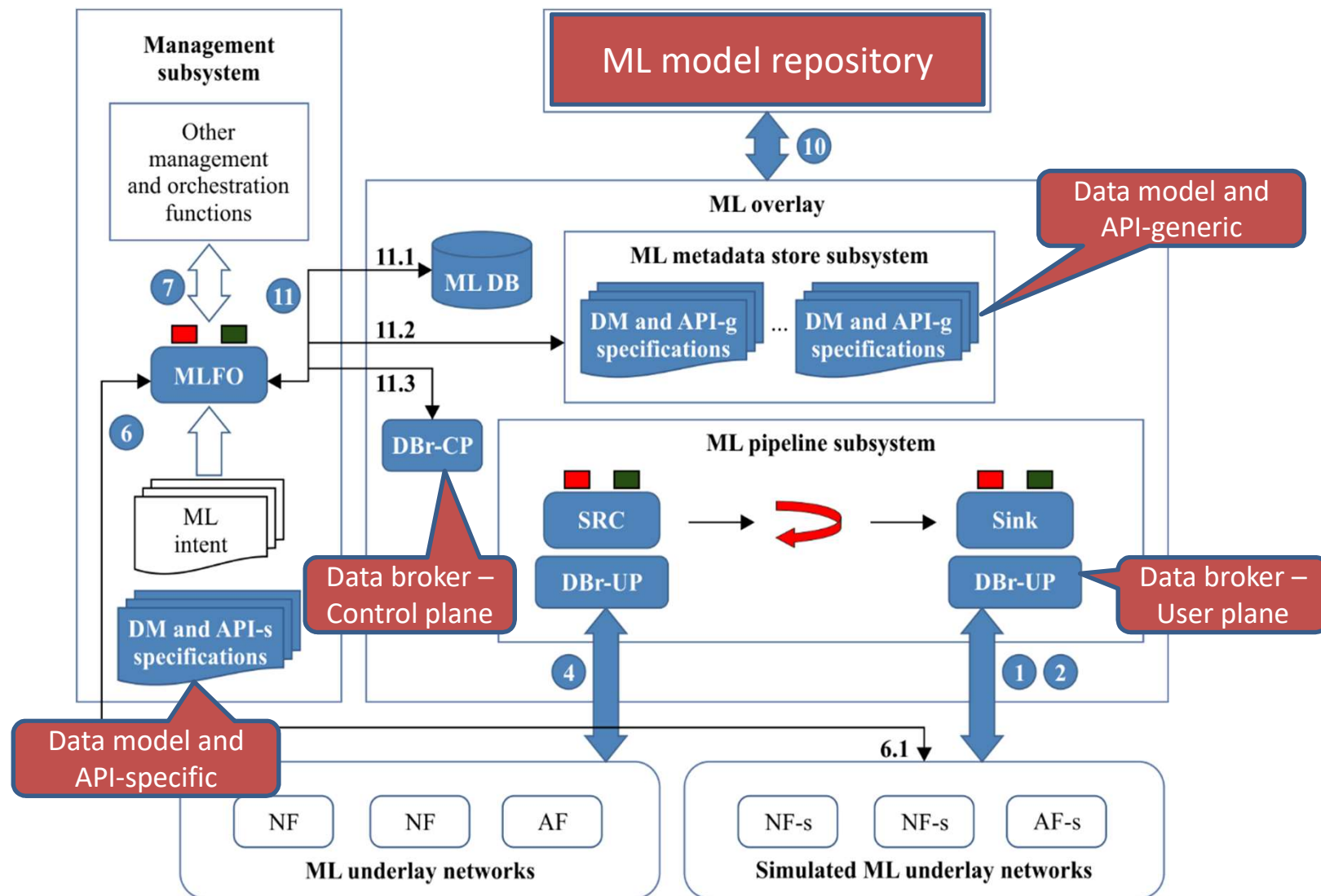
- Diversity in data produced by various components
 - Increased flexibility and agility leading to complicate configuration, dynamically evolving sources of data and applicable network configuration parameters and policy

Requirements listed:

- 56 requirements captured, analyzed and classified into 3 groups
 - ML data collection
 - ML processing
 - ML data output

ITU-T Y.3174: Framework for data handling to enable machine learning in future networks including IMT-2020 (2/2)

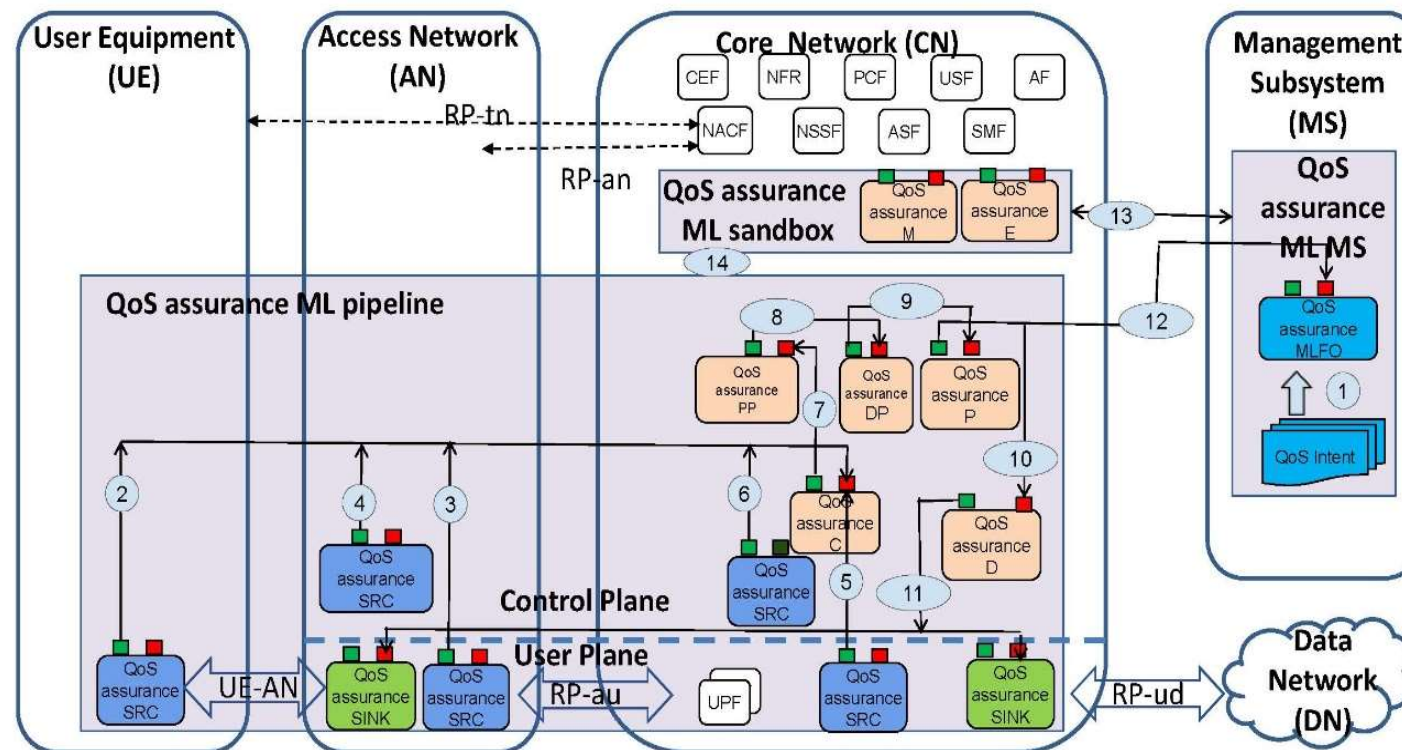
High-level architecture of data handling



ITU-T Y.3175: Functional architecture of ML based QoS assurance

Scope:

- Architecture framework
- Procedures



- | | | |
|-------------------------------------|--|-----------------------------------|
| ■ QoS assurance Service for egress | PP: QoS data pre-processor | P: QoS policy |
| ■ QoS assurance Service for ingress | DP: QoS anomaly detection and prediction | D: QoS policy distributor |
| SRC: QoS source of data | SINK: QoS assurance target of ML output | M: QoS assurance ML modelling |
| C: QoS data collector | | E: QoS assurance model evaluating |

ITU-T Y.ML-IMT2020-MP draft: Architecture for ML marketplace integration in networks (1/2)



* **ML marketplace**: a repository of ML, interoperable AI models

Scope:

- Challenges and motivations
- High level requirements
- Architecture and interfaces

Challenges to address:

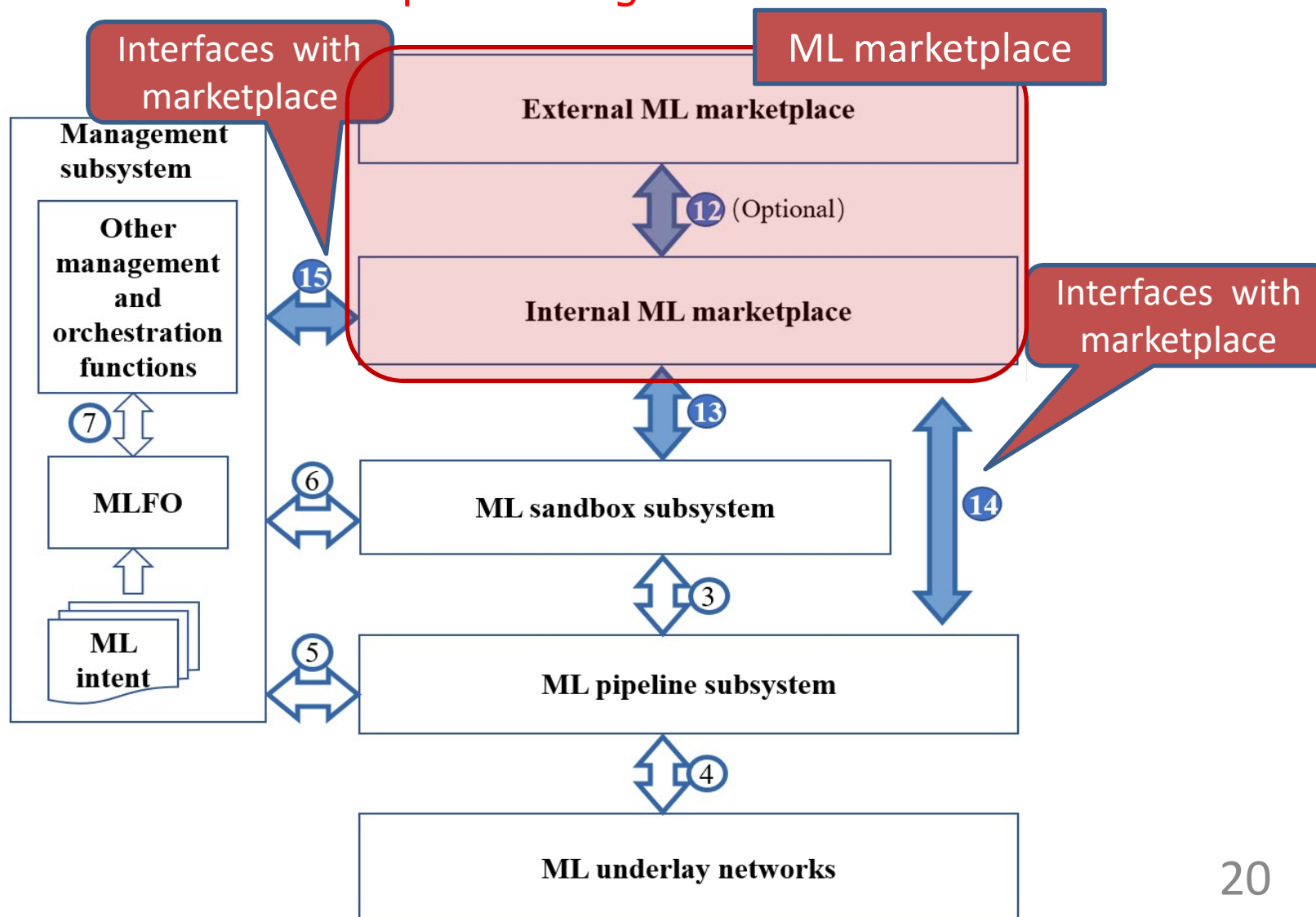
- Need of interoperable mechanisms for ML model identification, selection, chaining, testing and deployment from various ML marketplaces into the operators' networks.

Approach used:

- ML Intent and MLFO used to select ML models from marketplace
- Standard metadata used to interface between MLFO and ML marketplace
- Interfaces to push ML models from ML marketplace to ML-sandbox/ML-pipeline

ITU-T Y.ML-IMT2020-MP draft: Architecture for ML marketplace integration in networks (2/2)

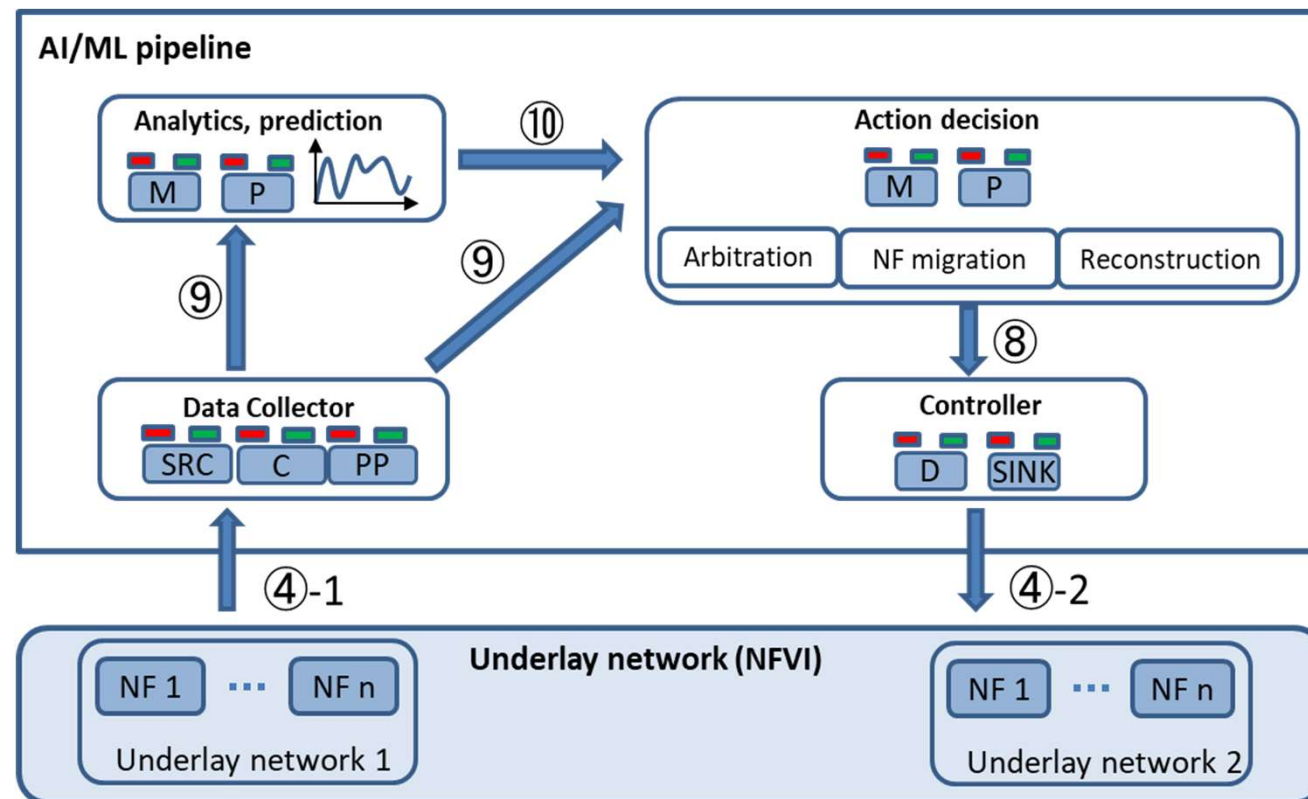
Architecture for ML marketplace integration in network



Scope:

- Architecture framework of AI-based network automation for resource adaptation and failure recovery

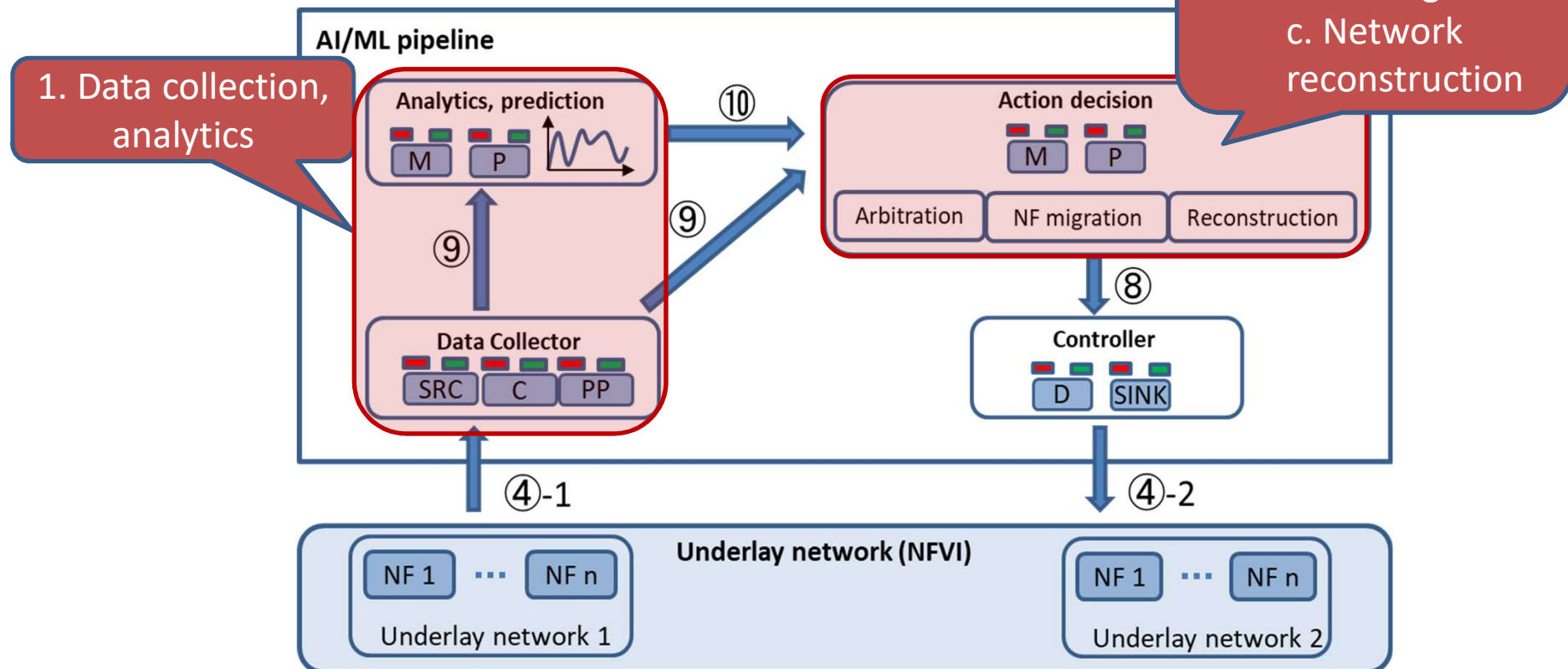
AI-based resource adaptation framework



Scope:

- Architecture framework of AI-based network automation **for resource adaptation and failure recovery**

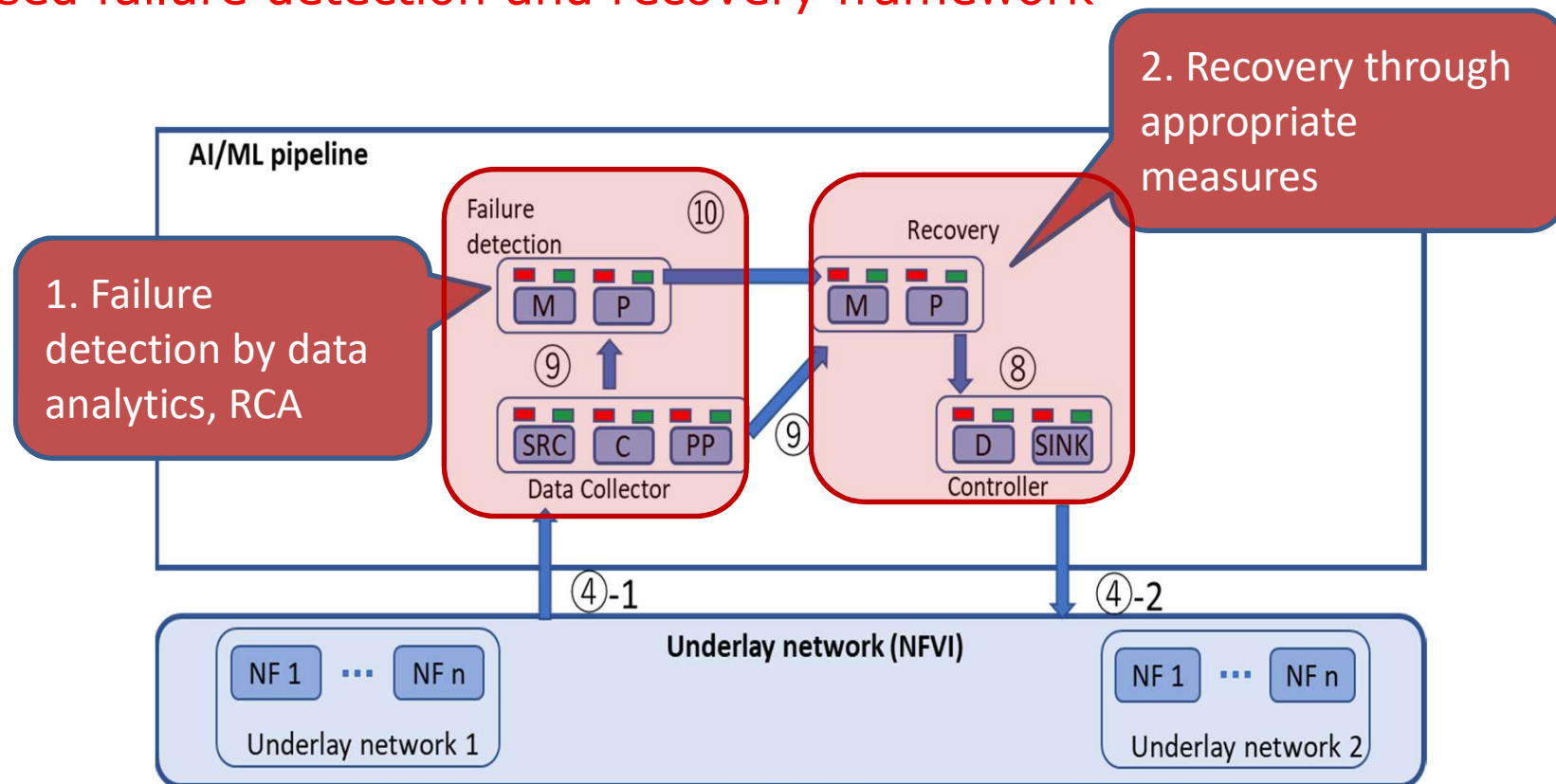
AI-based resource adaptation major components



ITU-T Y.ML-IMT2020-RAFR draft: Architecture framework of resource adaptation and failure recovery (3/4)



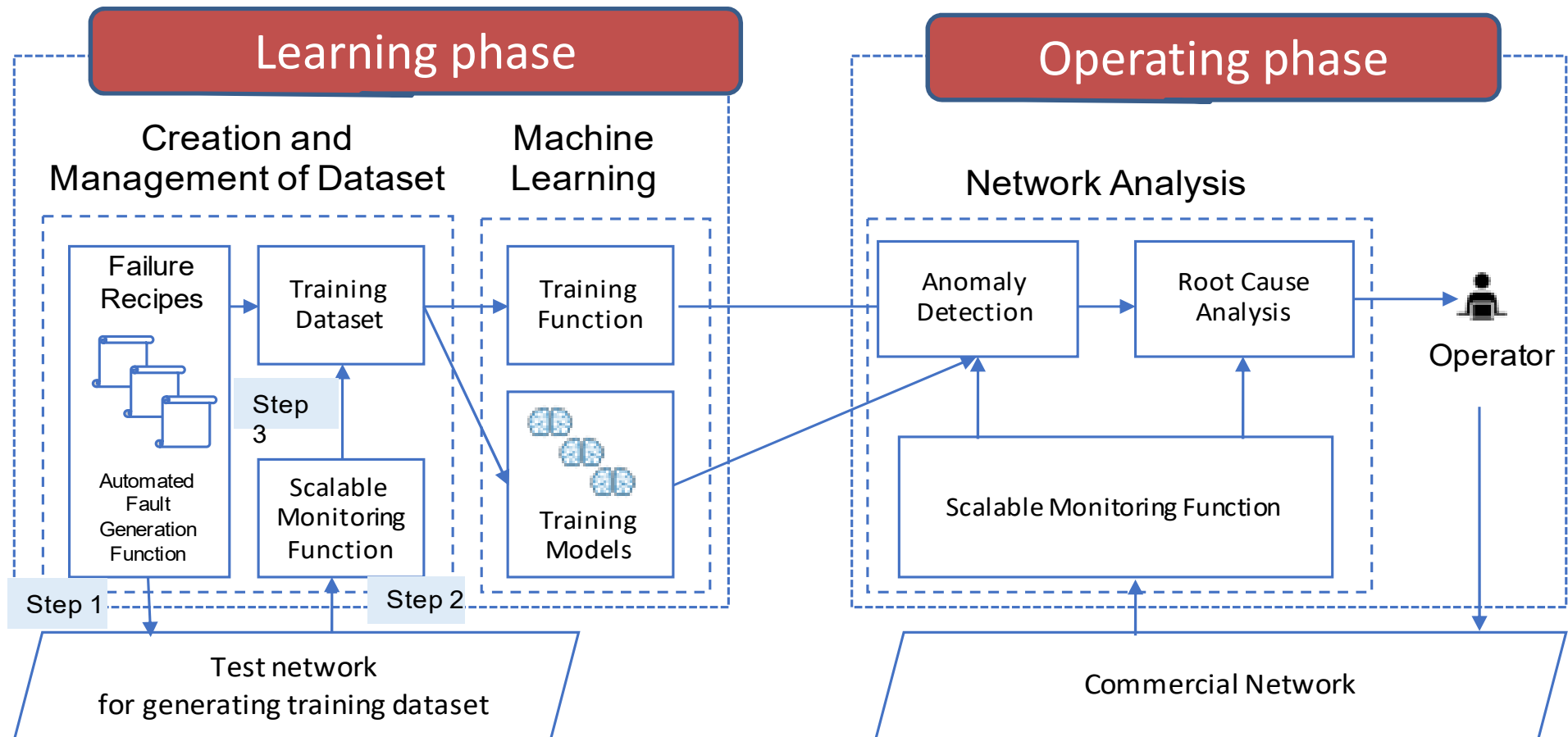
AI-based failure detection and recovery framework



*RCA: Root cause analysis

ITU-T Y.ML-IMT2020-RAFR draft: Architecture framework of resource adaptation and failure recovery (4/4)

Failure detection and route cause analysis



ITU-T Y.ML-IMT2020-serv-prov draft: Architecture framework of user-oriented network service provisioning (1/3)



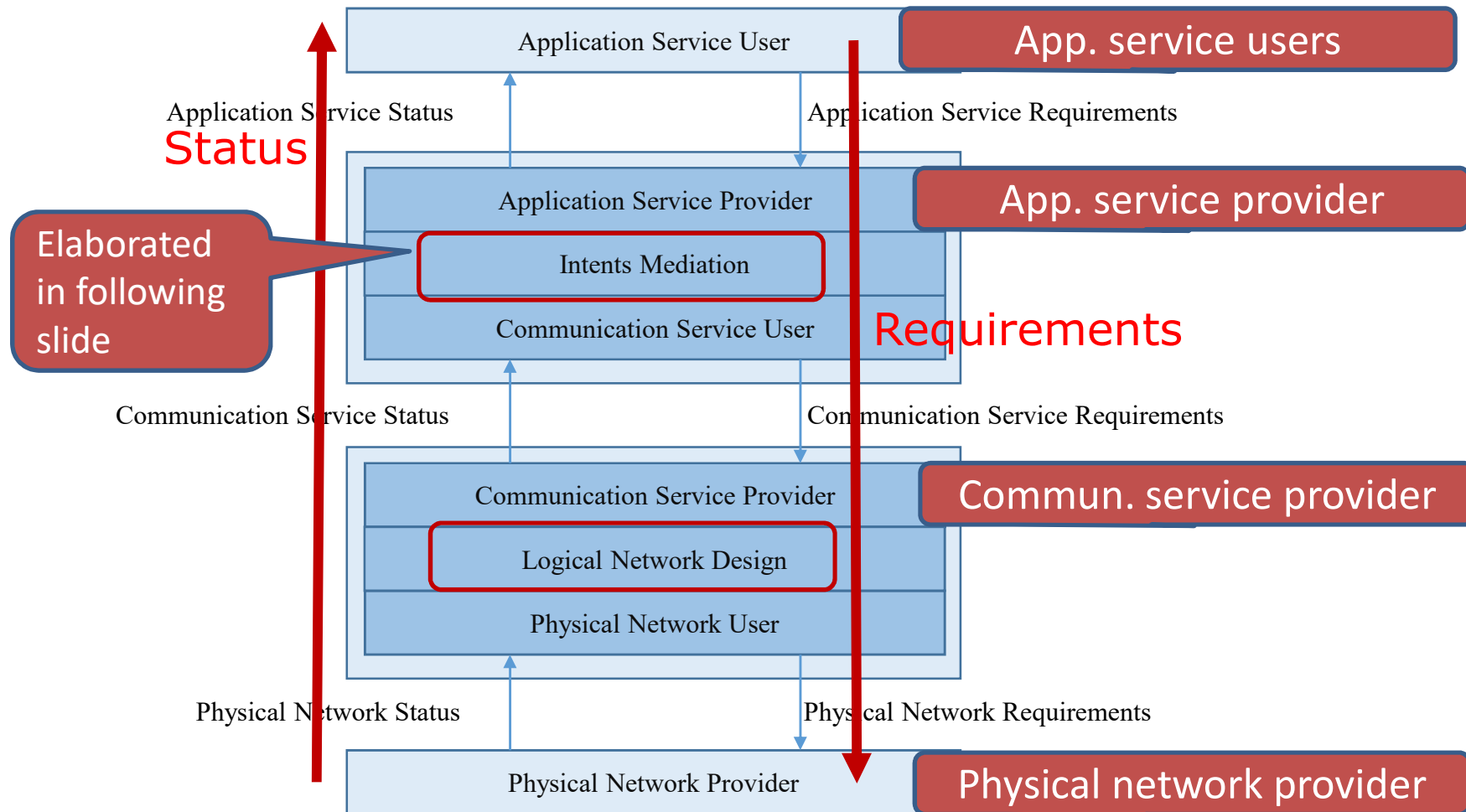
Scope:

- Architecture framework of user-oriented network service provisioning with AI-based automatic generation of
 - network requirements,
 - configuration and workflow
- AI-based framework for network/user interaction

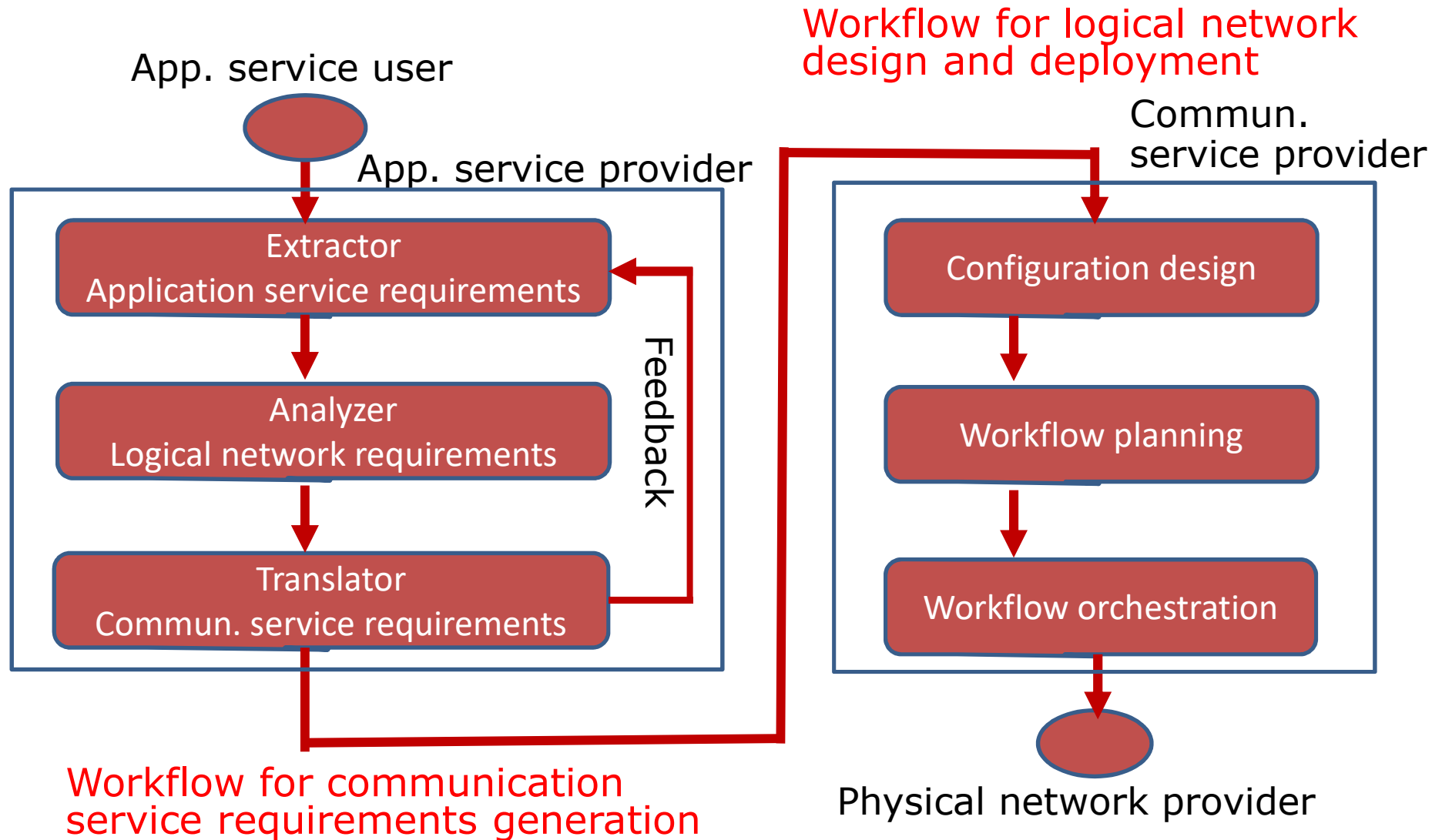
ITU-T Y.ML-IMT2020-serv-prov draft: Architecture framework of user-oriented network service provisioning (2/3)



Stakeholders involved in network service and their roles



ITU-T Y.ML-IMT2020-serv-prov draft: Architecture framework of user-oriented network service provisioning (3/3)



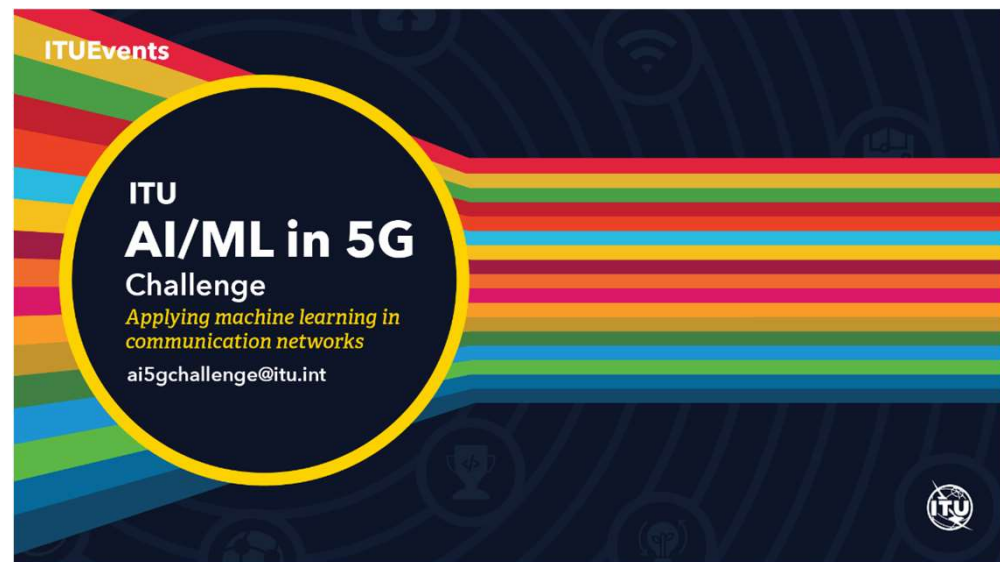
Related ITU program: AI/ML in 5G Challenge (1/2)



- Objective: explore real world use-cases of best applications of ITU's AI/ML architecture in 5G networks
- Call for projects that enable, create, train and deploy ML models and apply in 5G functions

- Four technical tracks:
 - Network-track
 - Enablers-track
 - Verticals-track
 - Social-good-track
- Four types of data to be used:
 - Real data (secured)
 - Open data
 - Synthetic data
 - No data

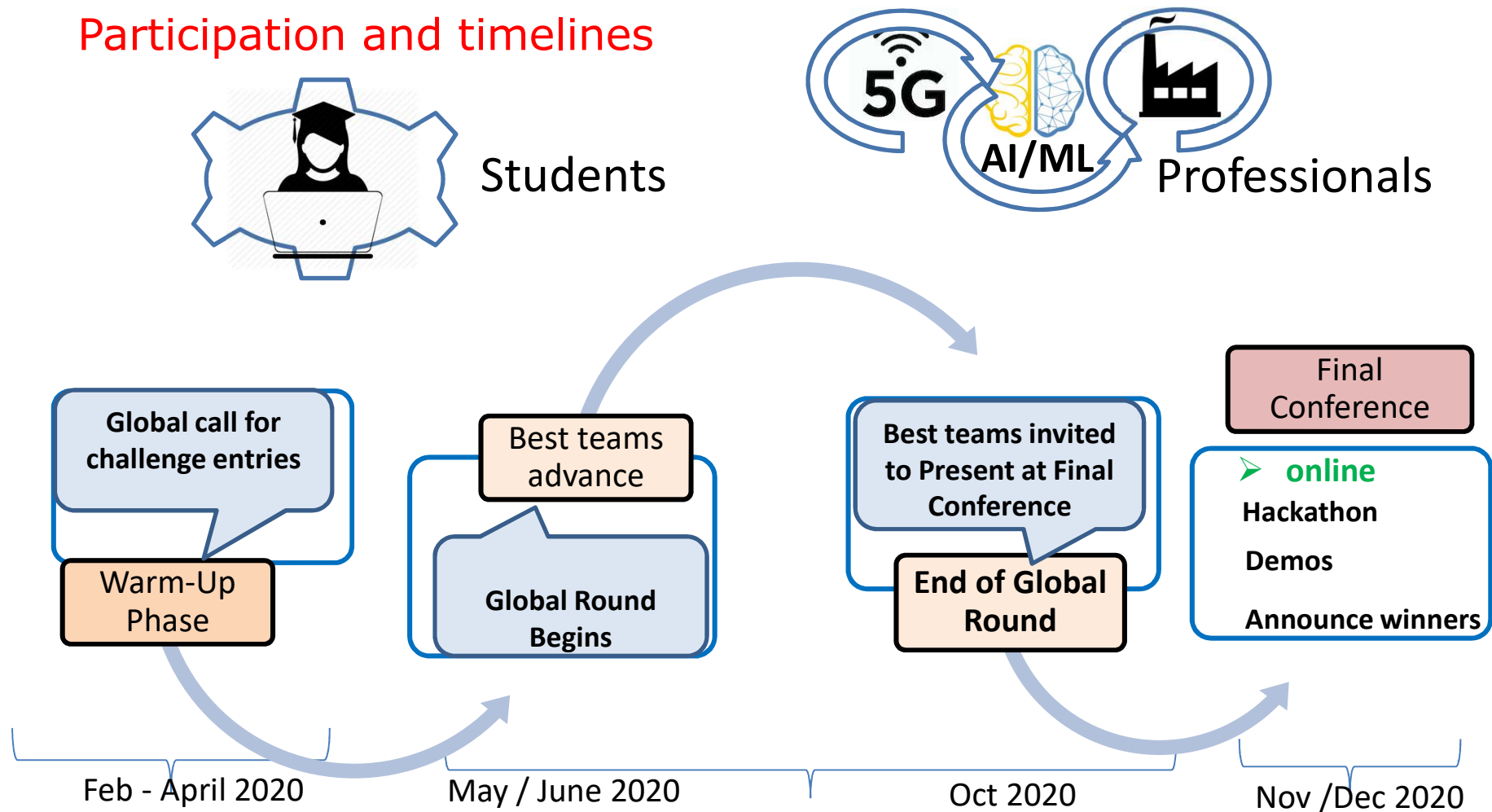
<https://www.itu.int/en/ITU-T/AI/challenge/2020/Pages/default.aspx>



Related ITU program: AI/ML in 5G Challenge (2/2)



Participation and timelines



Project registration deadline: June 30

ITU Liaisons on AI/ML networks



Industry Specification Group (ISG)

- ZSM (Zero-touch network & service management)
- ENI (Experiential Networked Intelligence)

Linux Foundation



[ISO/IEC JTC 1/SC 42](#)
Artificial intelligence



Conclusion

- ITU-T standardizing mainly requirements, frameworks, architectures of AI/ML supported network control and management.
- Architectural functional details and interface specifications are developed in other SDOs: ETSI, 3GPP, IETF, Linux Foundation, forums and open source software communities.
- Japan's academic and industry communities require to involve more actively in AI/ML in network R&D. **AI/ML in 5G Challenge** projects call may be a good opportunity.



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*Thank
You*