ITU-T Y.RaaS-reqts
‘서비스형 로보틱스(RaaS) 기능 요구사항 ' 표준화 동향

ETRI 표준연구본부
지능정보표준연구실
신성필

발표 목적

- 본 과제에서 개발중인 ITU-T Y.RaaS-reqts (Cloud computing – Functional requirements for Robotics as a Service) 문서 현황 공유.
- 기존 표준 문서인 Y.3531(Cloud computing – Functional requirements for machine learning as a service)을 레퍼런스로 향후 개발 방법론 논의.
- 2021년 표준화 회의를 위한 클라우드 로보틱스 유즈케이스 논의.

ITU-T Y.3531, Y.RaaS-reqts Work Programme

[2017-2020] : [SG13] : [Q17/13]

[Declared patent(s)] - [Associated work]

Work item:	Y.3531 (ex Y.MLaaS-reqts)
Status:	Consented on 2020-07-31
Approval process:	AAP
Type of work item:	Supplement
Version:	New
Provisional name:	Y.MLaaS-reqts
Equivalent number:	-
Timing:	2020-Q4 (Medium priority)
Liaison:	ITU-T SG16, SG17, SG20, JTC 1 SC 42, ETSI, IEEE
Subject/title:	Cloud computing - Functional requirements for machine learning as a service
Summary:	This Recommendation provides cloud computing requirements for machine learning as a service (MLaaS), which addresses requirements from use cases. Machine learning as a service is a cloud service category in which the capability provided to the cloud service customer is the provision and use of machine learning framework. Machine learning framework is a set of functionalities for provisioning machine learning data as well as training, deploying, and managing machine learning model. On the perspective of cloud computing service provisioning, this Recommendation provides the functional requirements for MLaaS to identify functionalities such as machine learning data pre-processing, machine learning model training, machine learning model testing, and etc. Also, this Recommendation aligned with the cloud computing reference architecture of [ITU-T Y.3502].
Comment:	-
Base text(s):	[TD 297-PLEN]
Contact(s):	Sungpil Shin, Editor Xiaowu He, Editor
ITU-T A.5 reference(s):	-
	[Submit new A.5 reference] See guidelines for creating & submitting ITU-T A.5 justifications

First registration in the WP: 2018-01-03 13:06:04

Last update: 2020-08-05 15:40:01

클라우드 머신러닝 표준
ITU-T Y.3531(ex. Y.MLaaS-reqts)

[2017-2020] : [SG13] : [Q17/13]

[Declared patent(s)] - [Associated work]

Work item:	Y.RaaS-reqts
Status:	Under study
Approval process:	AAP
Type of work item:	Recommendation
Version:	New
Provisional name:	Y.RaaS-reqts
Equivalent number:	-
Timing:	2023-Q2 (Medium priority)
Liaison:	JTC 1/SC 42, ISO/TC 299, IEEE
Subject/title:	Cloud Computing - Functional requirements for Robotics as a Service
Summary:	This Recommendation provides the overview and functional requirements for robotics as a service (RaaS) in the cloud environment. This Recommendation addresses the following subjects: - Concept and overview of robotics service; - System context of robotics as a service; - Functional requirements for robotics as a service; - Use cases of robotics as a service.
Comment:	-
Base text(s):	[TD 612-WP2]
Contact(s):	Sungpil Shin, Editor Linze Wu, Editor
ITU-T A.5 reference(s):	-
	[Submit new A.5 reference] See guidelines for creating & submitting ITU-T A.5 justifications

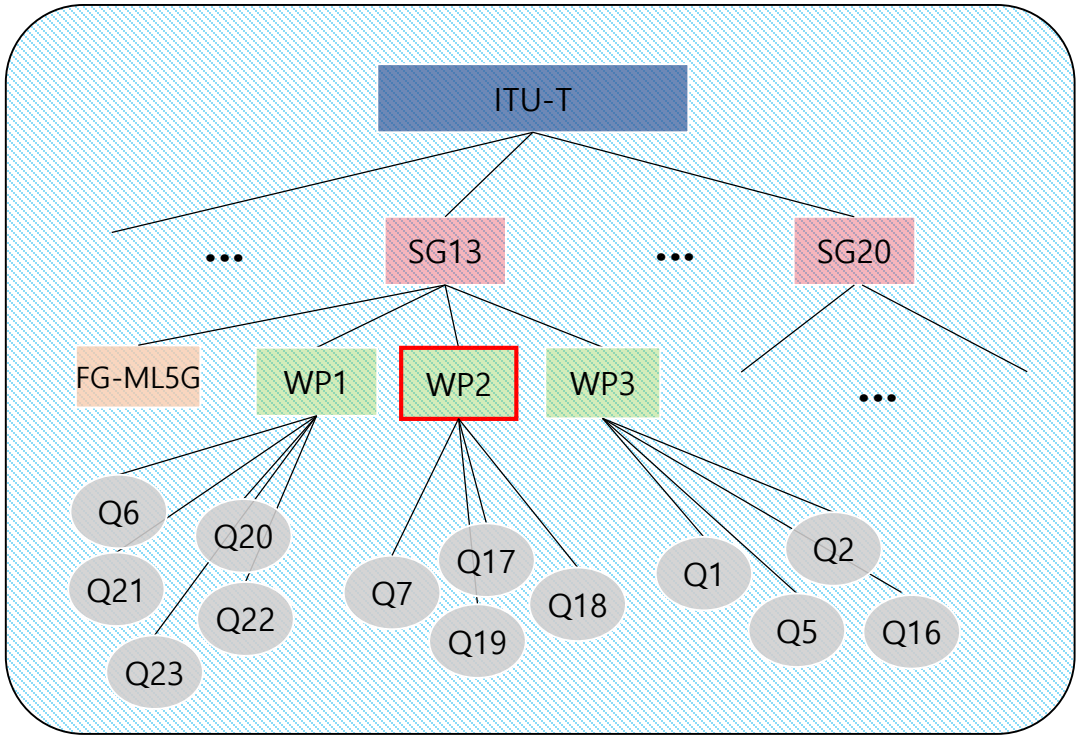
First registration in the WP: 2020-08-05 20:33:55

Last update: 2020-08-05 20:36:38

클라우드 로보틱스 표준
ITU-T Y.RaaS-reqts

ITU-T 표준 그룹 구조

ITU-T : 국제 표준 기구인 ITU(International Telecommunication Union)에서 전기통신 표준화부문(Telecommunication Standardization Sector)을 담당하는 기구



- ITU-T 산하의 SG은 그룹별로 다양한 분야 및 산업 영역의 국제표준을 개발 중

  * ex) **SG13(Future network, Cloud computing)**, SG16(Multimedia), SG20(IoT, smart cities)

- ITU-T SG13 WP2는 클라우드 컴퓨팅을 표준을 담당하며, ISO/IEC JTC 1 SC 38와 교류하며 클라우드 컴퓨팅 표준 개발

  - Y.3500, ISO/IEC 17788 - 클라우드 컴퓨팅 용어 및 정의
  - Y.3501 – 클라우드 컴퓨팅 프레임워크 및 요구사항
  - Y.3502, ISO/IEC 17789 - 클라우드 컴퓨팅 참조구조

- **2020년 ITU-T SG13 WP2에 Y.RaaS-reqts를 신규 제안하여 승인. 현재 개발 진행중.**

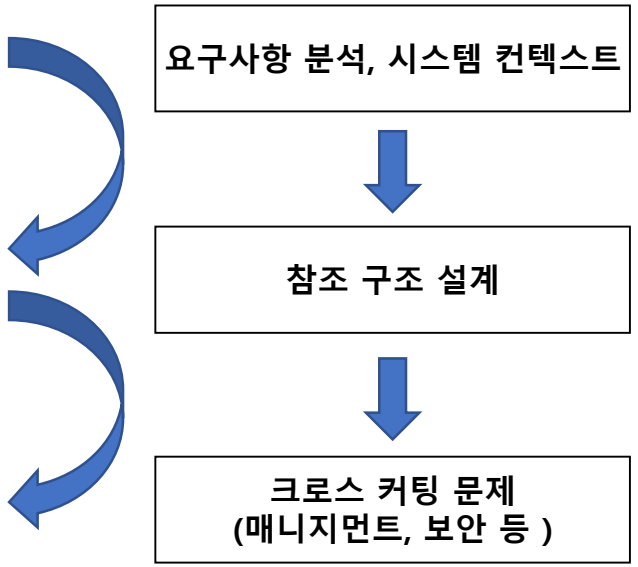
ITU-T SG13 WP2 (Cloud computing & Big data)

WP2 **Cloud Computing & Big Data**

Q17 **Requirements, ecosystem, and general capabilities for cloud computing and big data**

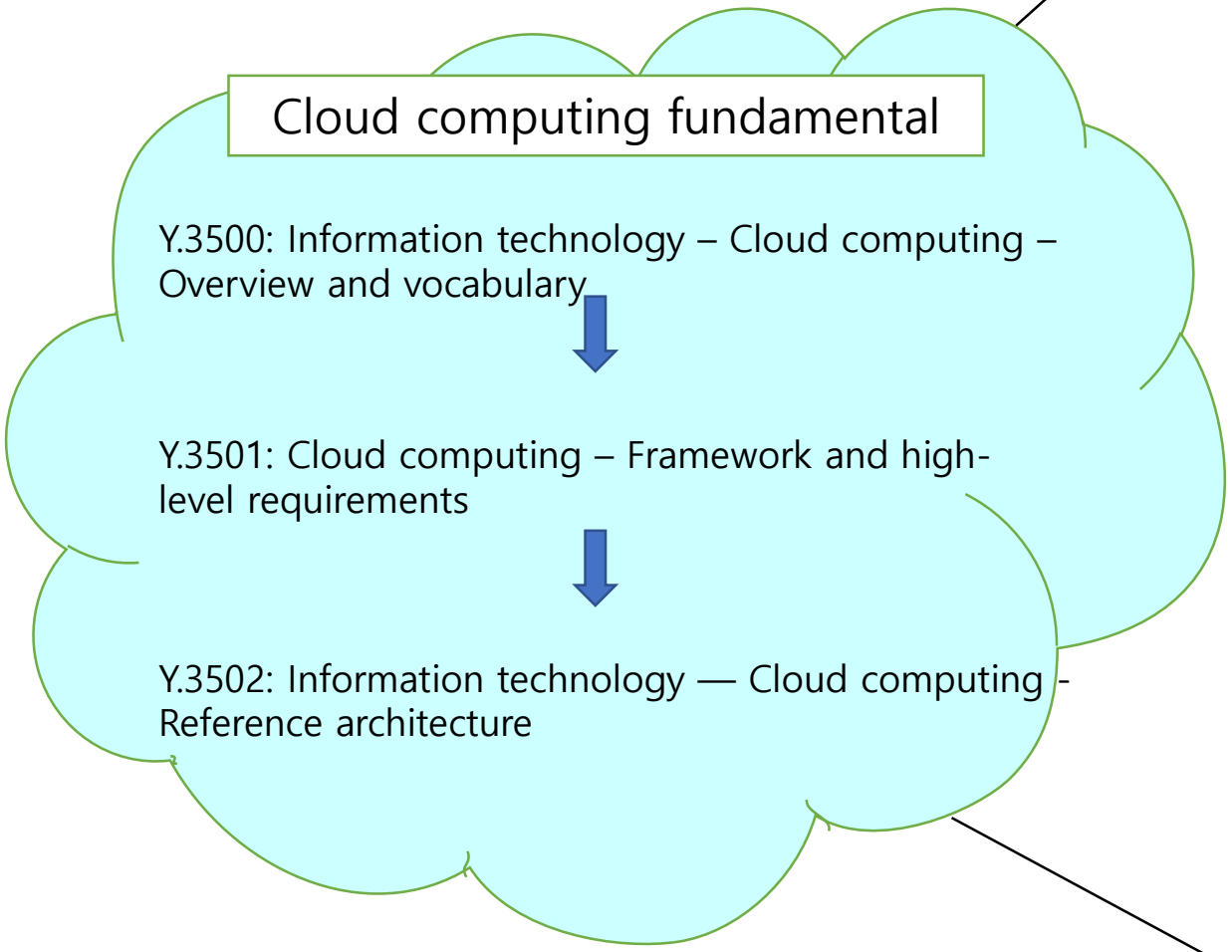
Q18 **Functional architecture for cloud computing and big data**

Q19 **End-to-end cloud computing management, cloud security and big data governance**



* Q7-Big data driven networking (bDDN) and deep packet inspection (DPI)

ITU-T Y.35xx series

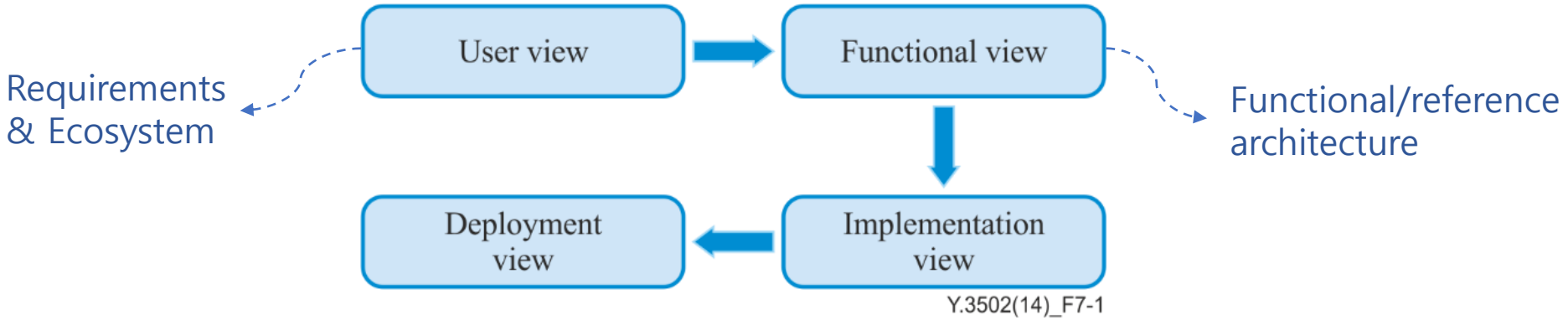


Y.3503: Requirements for desktop as a service
Y.3504: Functional architecture for Desktop as a Service
Y.3505: Cloud computing - Overview and functional requirements for data storage federation
Y.3508: Cloud computing - Overview and high-level requirements of distributed cloud
Y.3509: Cloud computing - Functional architecture for data storage federation
Y.3512: Cloud computing - Functional requirements of **Network as a Service**
Y.3513: Cloud computing - Functional requirements of **Infrastructure as a Service**
Y.3515: Cloud computing – Functional architecture of **Network as a Service**
Y.3516: Cloud computing - Functional architecture of inter-cloud computing
Y.3519: Cloud computing - Functional architecture of **big data as a service**

⋮

Y.3531: Cloud computing- Functional requirements for **machine learning as a service**

Fundamental Concepts for ITU-T Y.35xx series



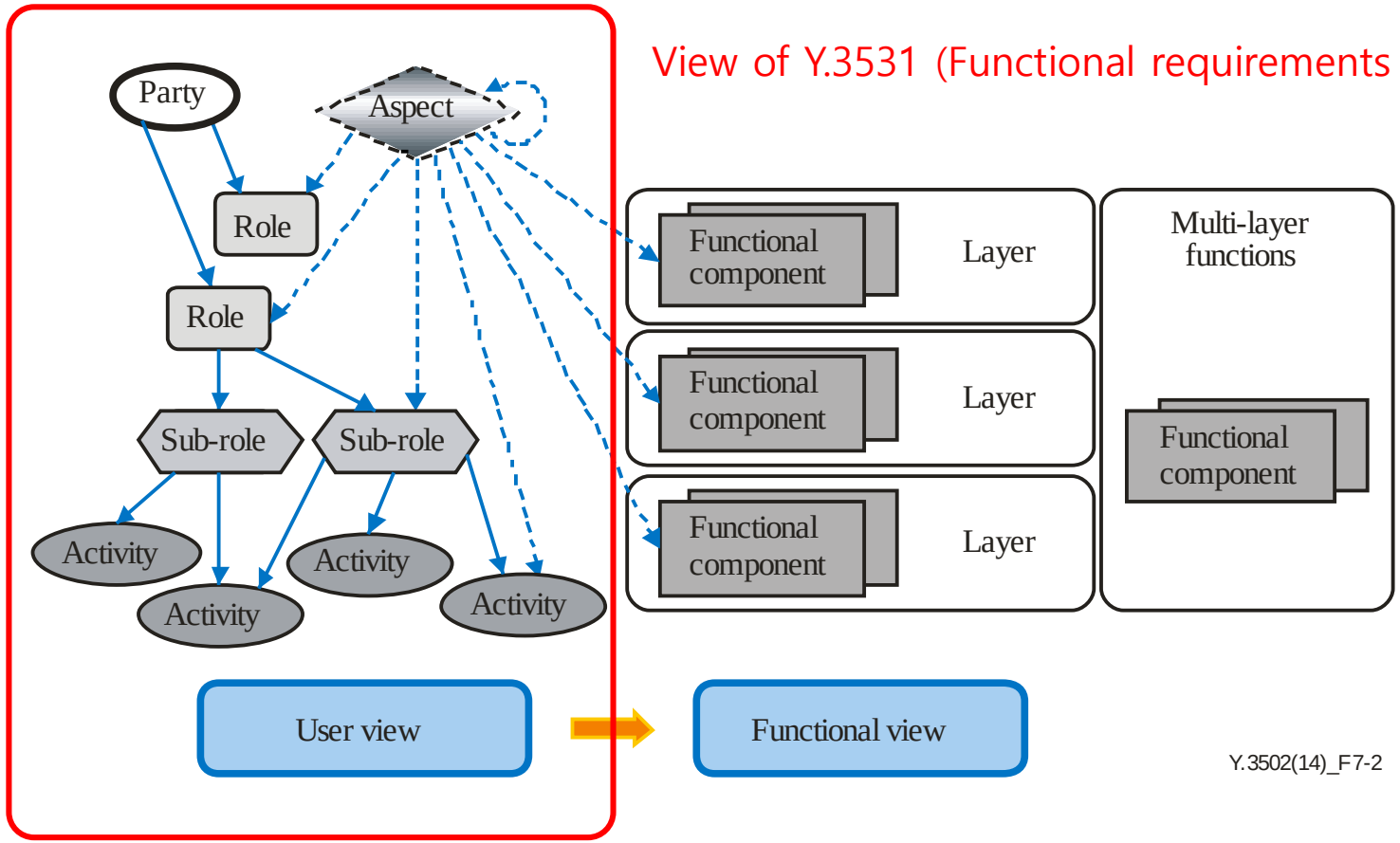
<Transformations between architectural views>

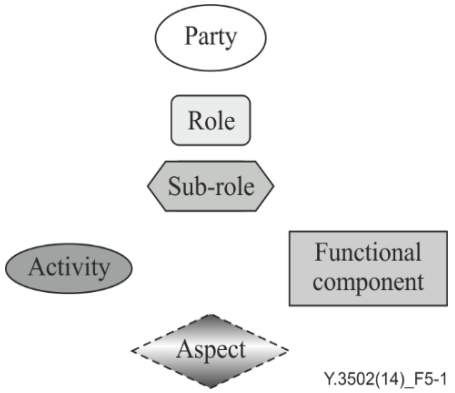
CCRA view	Description of the CCRA view	Scope
User view	The system context, the parties, the roles, the sub-roles and the cloud computing activities	Within scope
Functional view	The functions necessary for the support of cloud computing activities	Within scope
Implementation view	The functions necessary for the implementation of a cloud service within service parts and/or infrastructure parts	Out of scope
Deployment view	How the functions of a cloud service are technically implemented within already existing infrastructure elements or within new elements to be introduced in this infrastructure	Out of scope
NOTE – While details of the user view and functional view are addressed within this Recommendation | International Standard, the implementation and deployment views are related to technology and vendor-specific cloud computing implementations and actual deployments, and are therefore out of the scope of this Recommendation | International Standard.		

<Cloud computing reference architecture views in Y.3502>

Fundamental Concepts for ITU-T Y.35xx series

View of Y.3531 (Functional requirements for MLaaS)



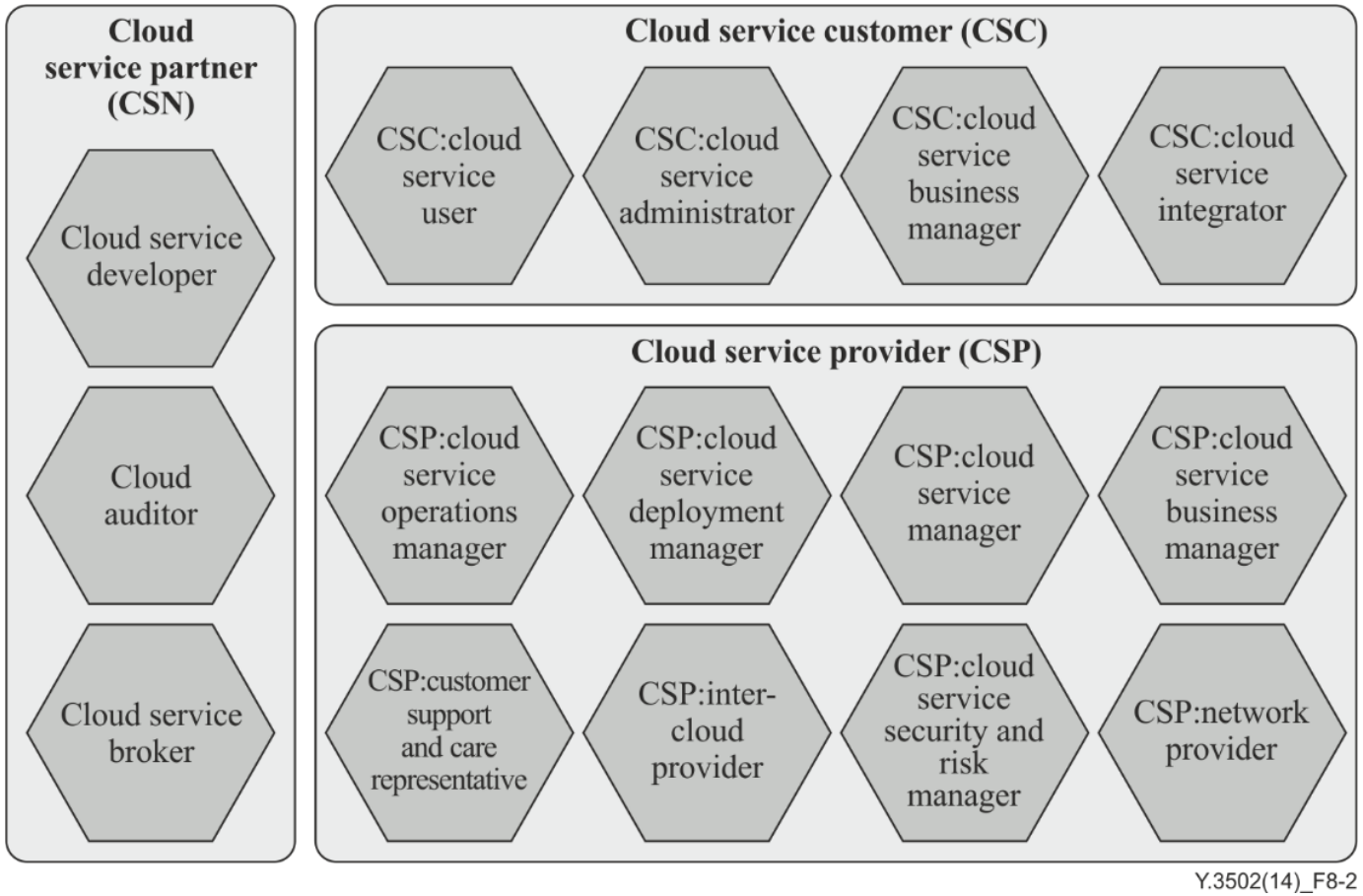


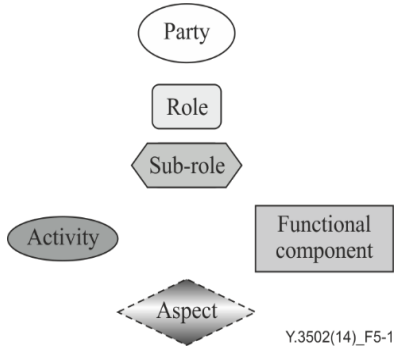
Legend to the diagram

<Transition from user view to functional view>

[Reference] ITU-T Y.3502 Information technology – Cloud computing – Reference architecture, 2014.08.

Fundamental Concepts for ITU-T Y.35xx series

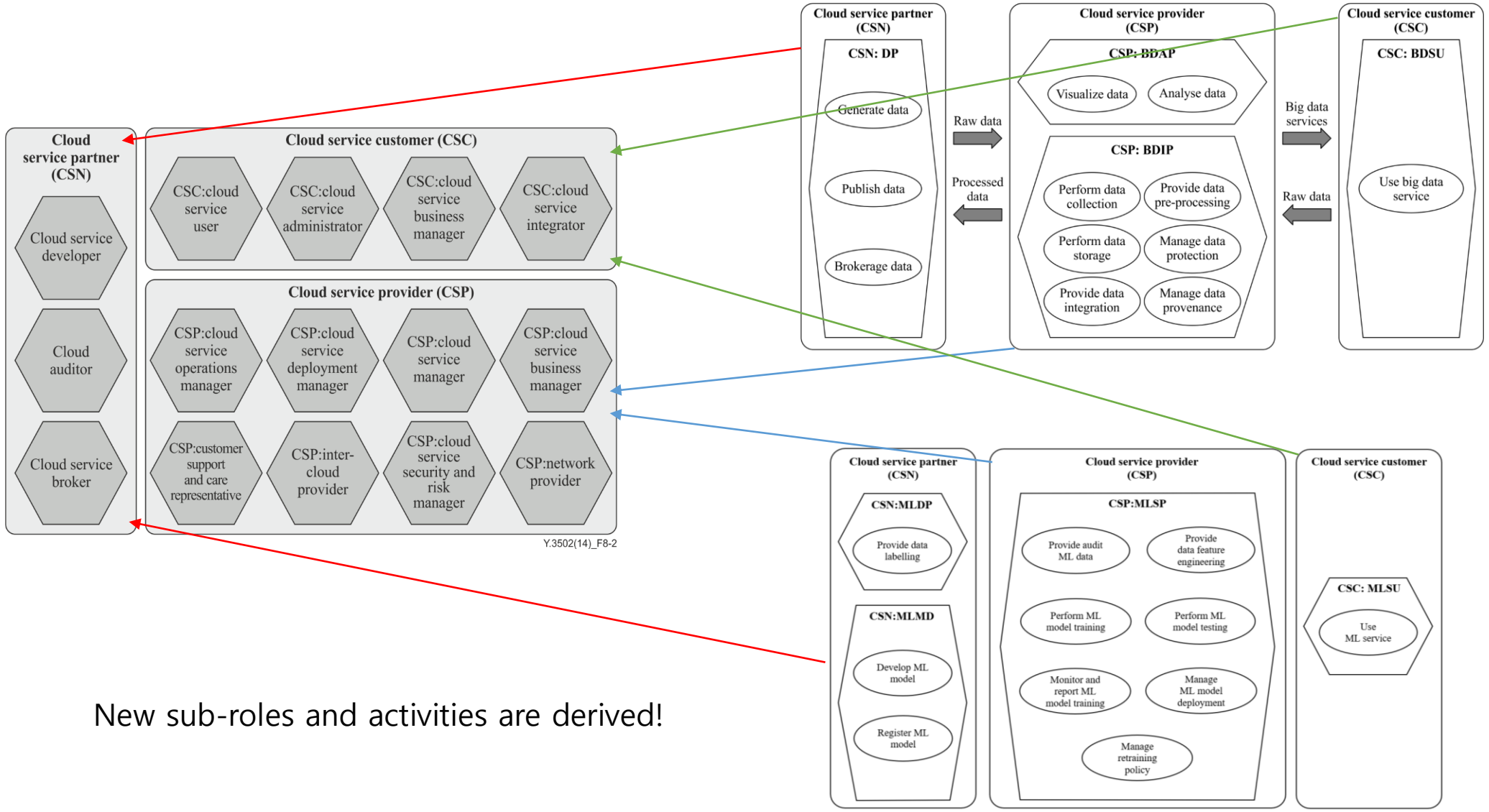




Legend to the diagram

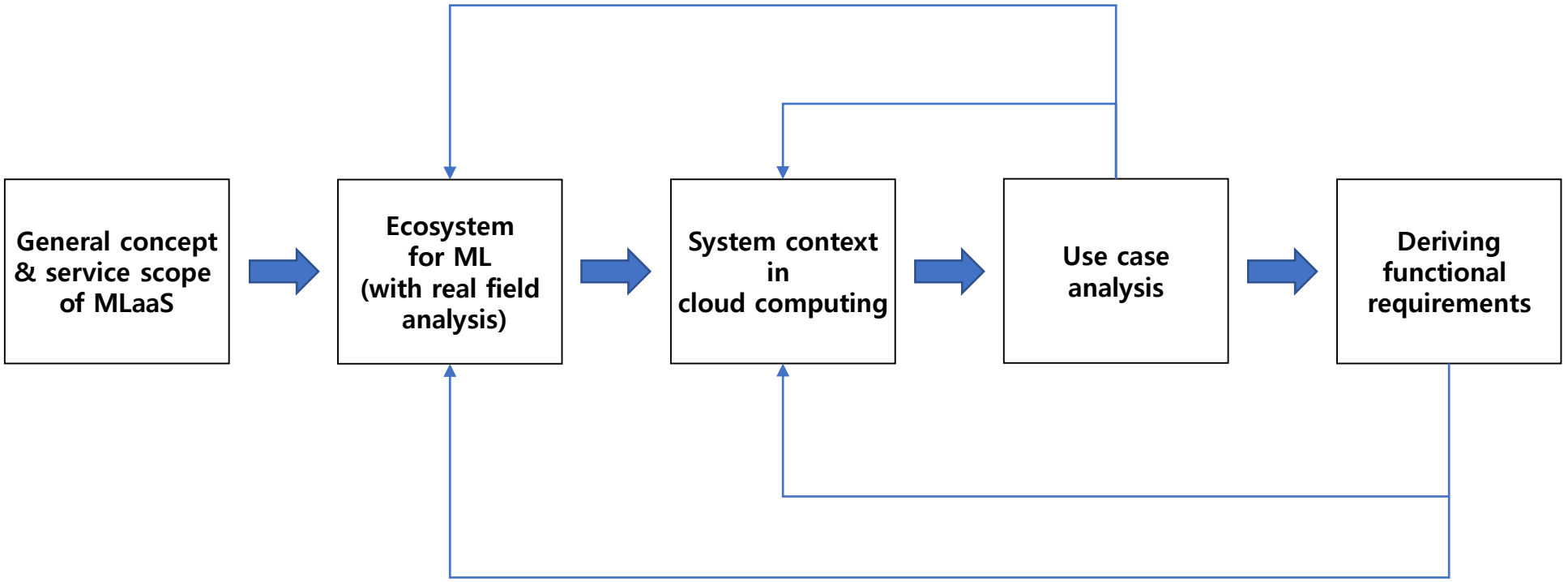
<Existing cloud computing roles and sub-roles in Y.3502>

Fundamental Concepts for ITU-T Y.35xx series



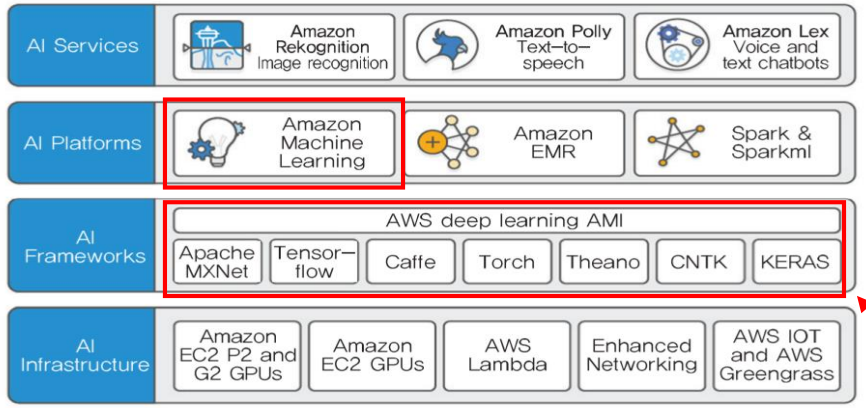
New sub-roles and activities are derived!

Standardization Steps for Functional Requirements

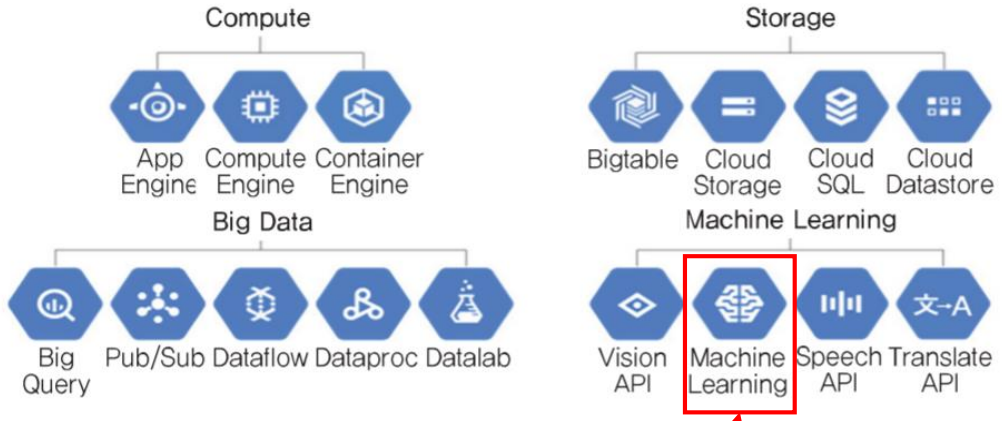


- Iteratively validated the sub-roles and activities for MLaaS
- Derived functional requirements with use cases

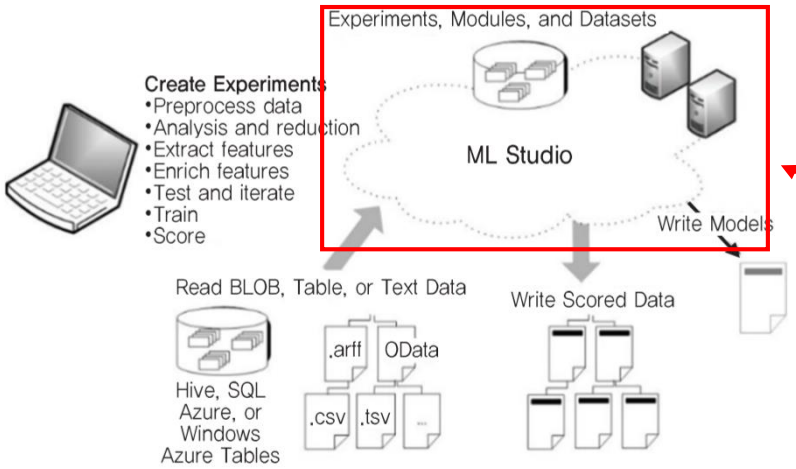
Global services of MLaaS in the field



AWS AI & ML services



Google Cloud Platform

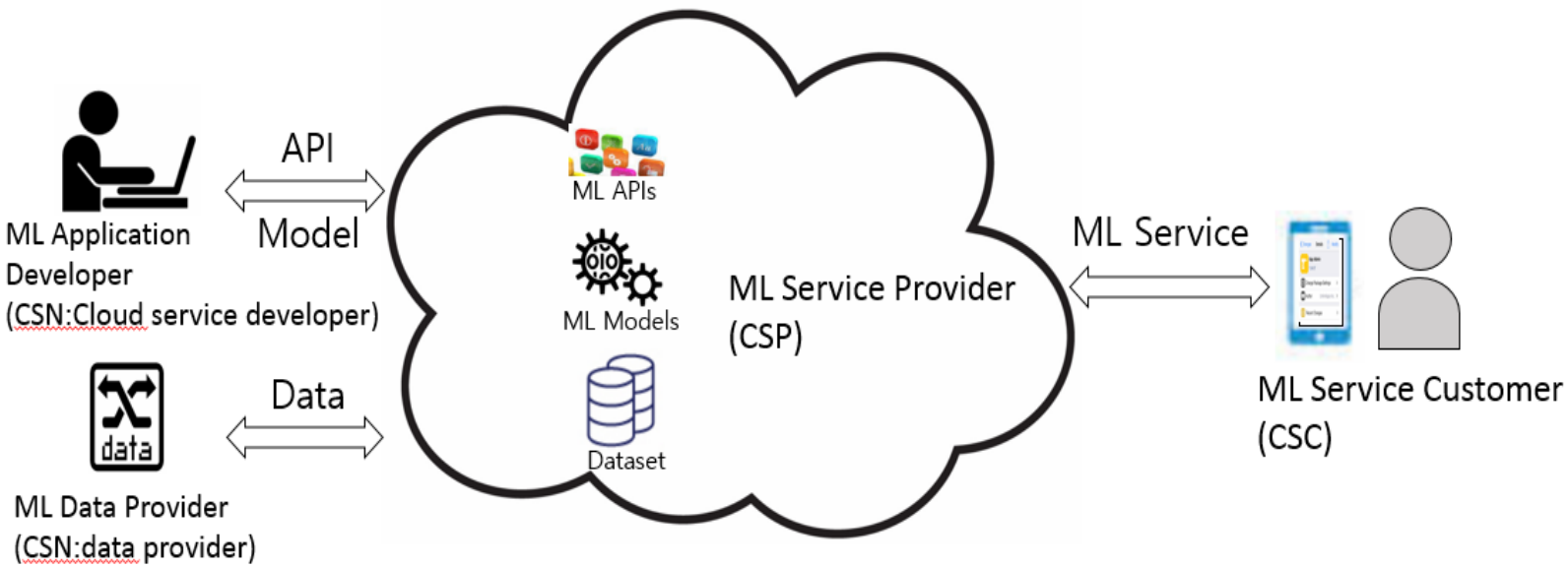


MS Azure ML studio

Scope of Machine Learning as a Service (MLaaS)
= ML framework in cloud computing

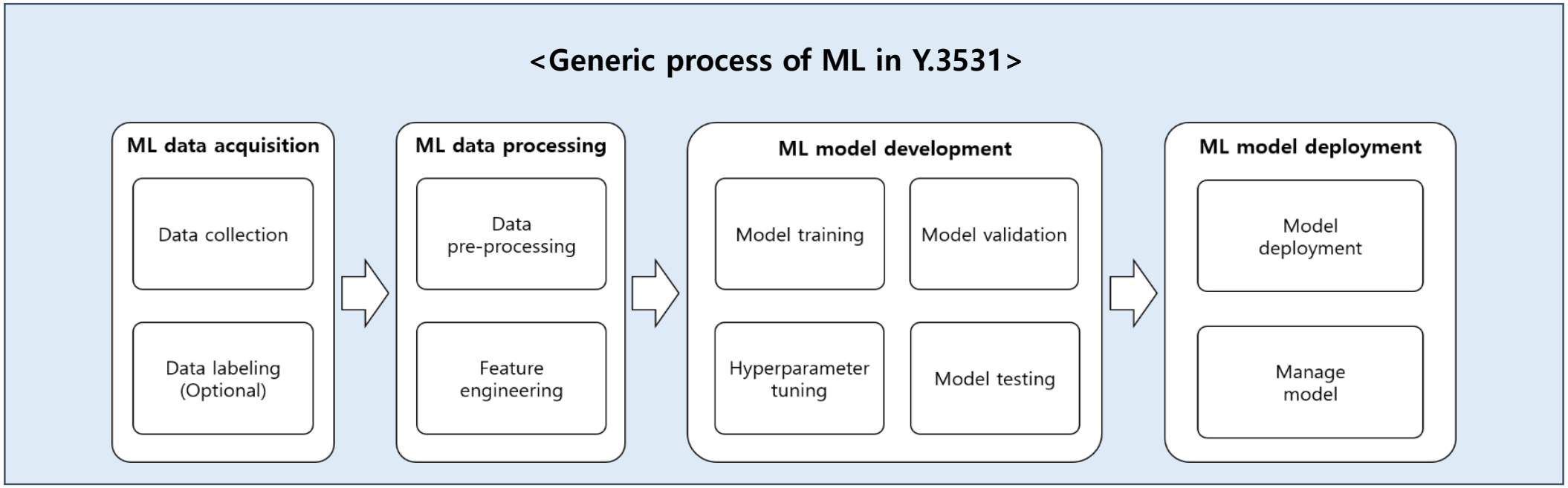
Definition & Scope of MLaaS in ITU-T Y.3531

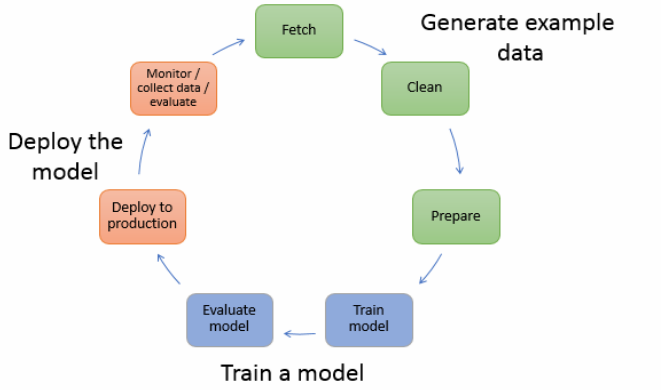
Machine Learning as a Service (MLaaS): A cloud service category in which the capabilities provided to the cloud service customer is the provision and use of machine learning framework



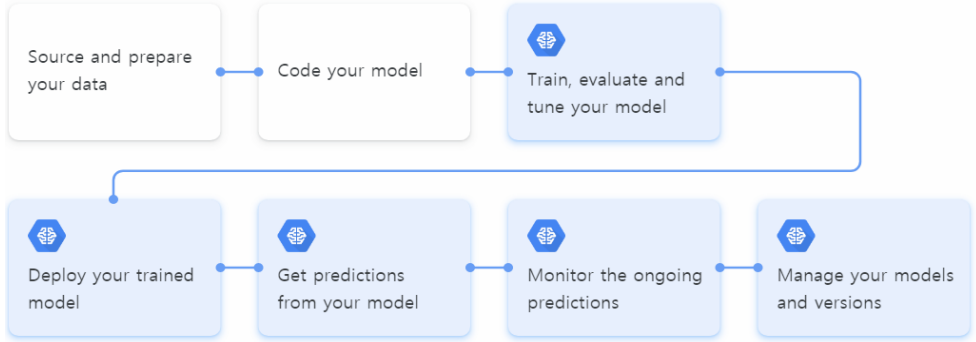
***Infrastructure as a service (IaaS)**	Cloud service category in which the cloud capabilities type provided to the cloud service customer is an infrastructure capabilities type.
***Platform as a service (PaaS)**	Cloud service category in which the cloud capabilities type provided to the cloud service customer is a platform capabilities type.
***Network as a service (NaaS)**	Cloud service category in which the capability provided to the cloud service customer is transport connectivity and related network capabilities.

Generic Process of ML framework



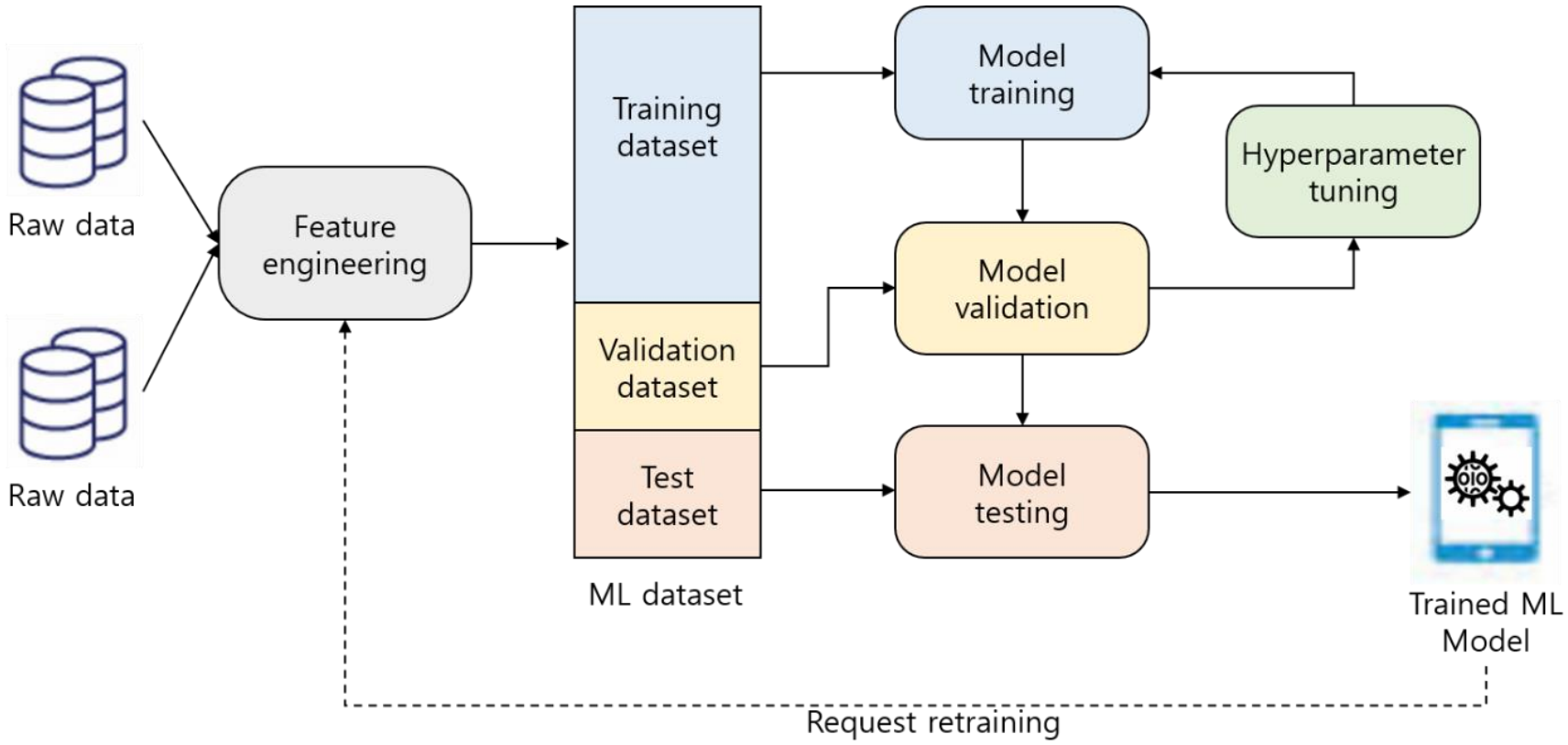


<AWS ML process>



<Google Cloud Platform ML process>

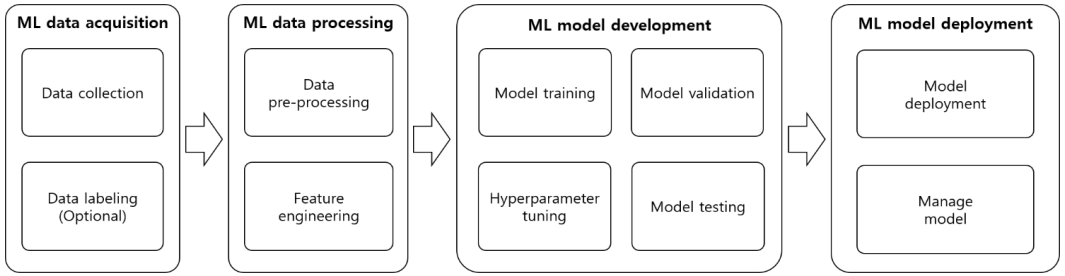
Implementations of Generic Process of ML

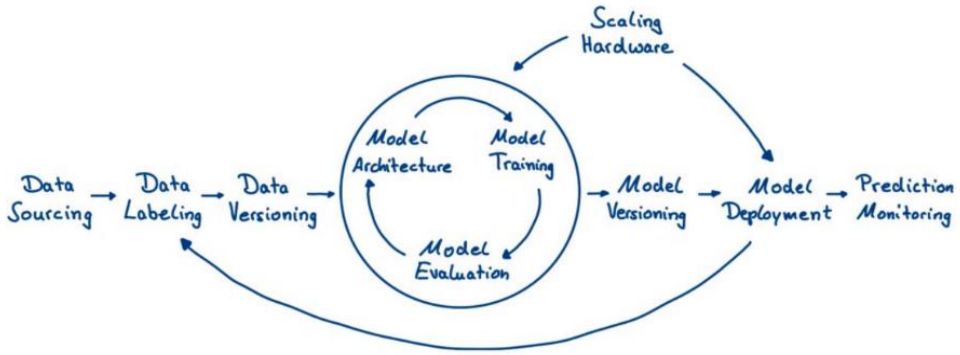


[Reference] ITU-T Y.3531 Cloud computing - Functional requirements for machine learning as a service, 2020.07.

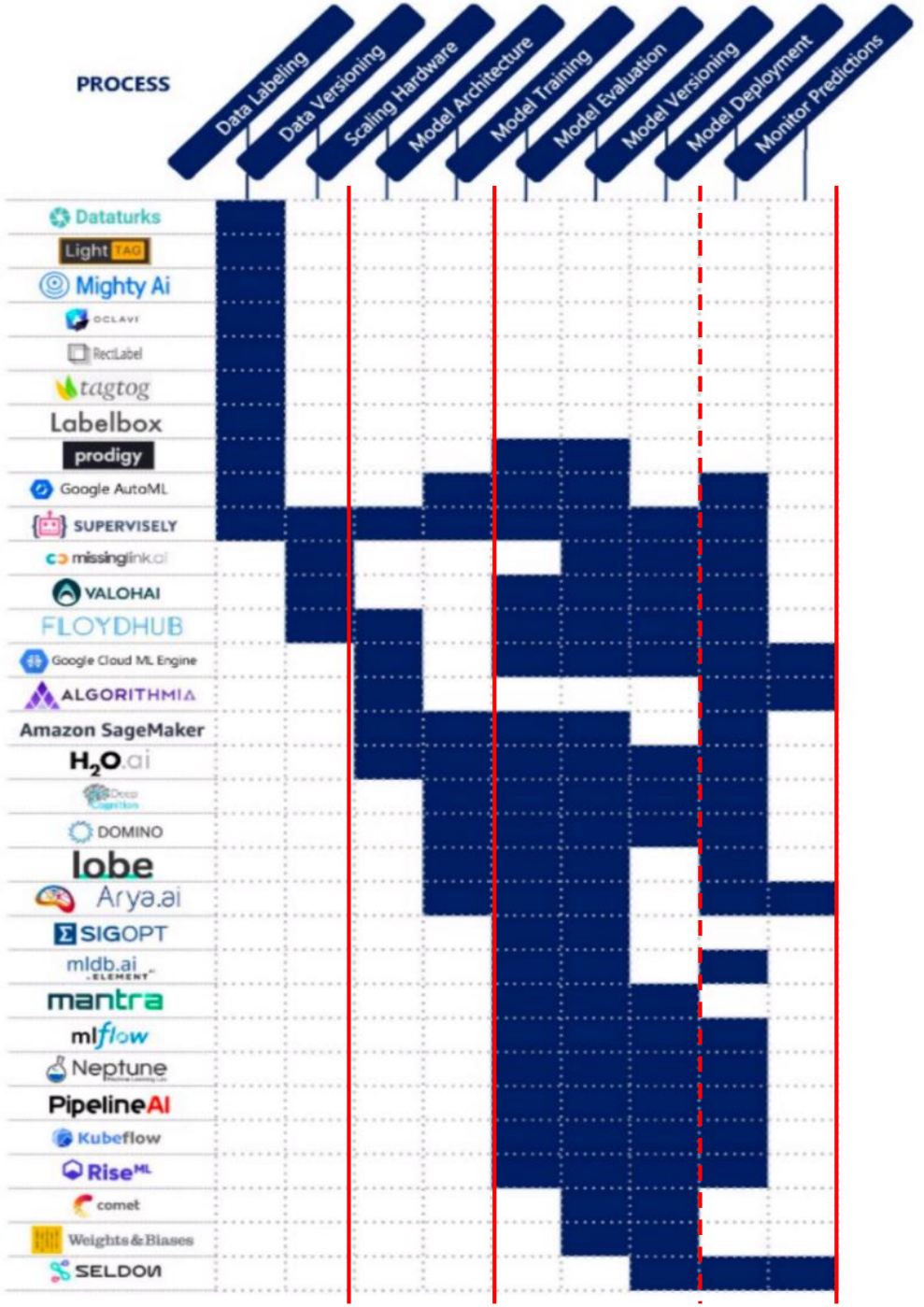
Companies in Real Field

Real field analyzing : Step for deriving ecosystem and sub-roles



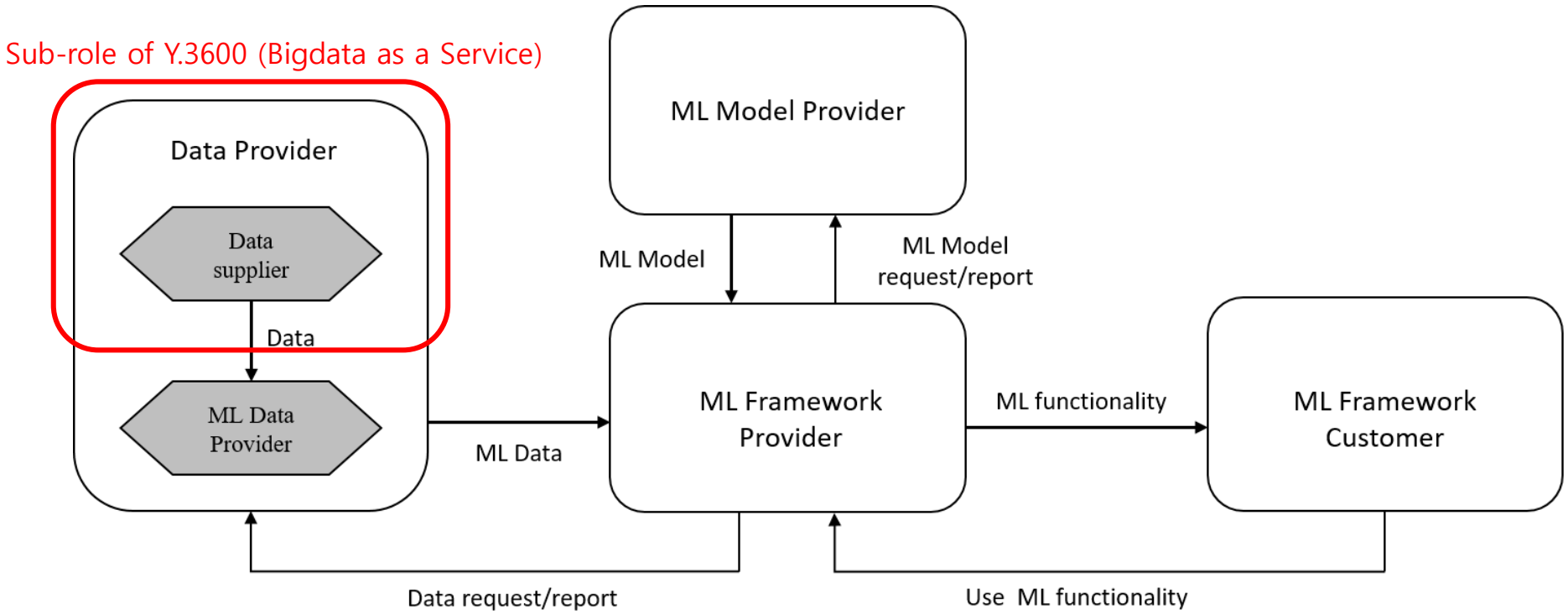


<An example of ML life cycles>



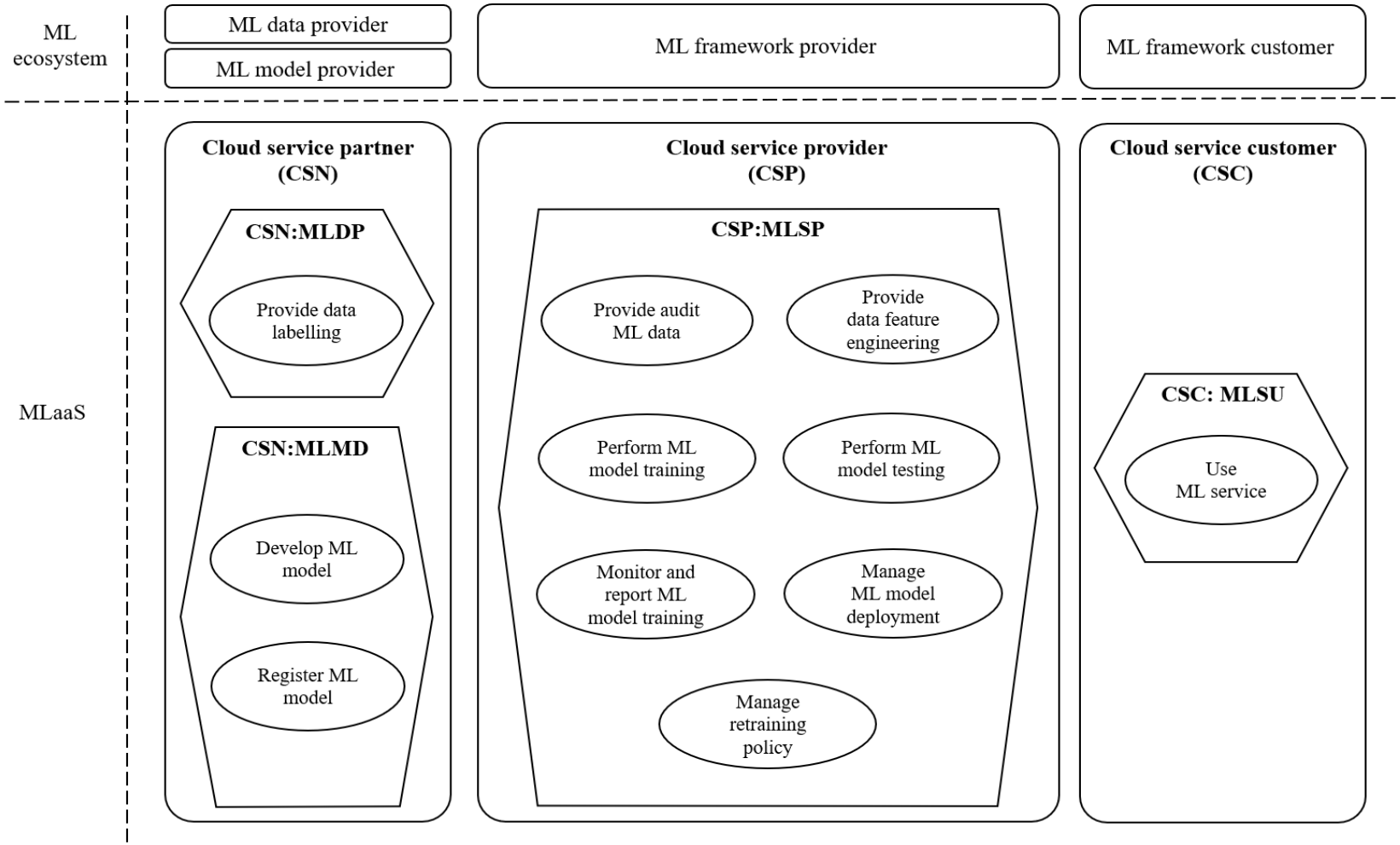
[Reference] The Deep Learning Toolset - An Overview, Medium, URL: https://medium.com/luminovo/the-deep-learning-toolset-an-overview-b71756016c06

Ecosystem for ML in Y.3531



[Reference] ITU-T Y.3531 Cloud computing - Functional requirements for machine learning as a service, 2020.07.

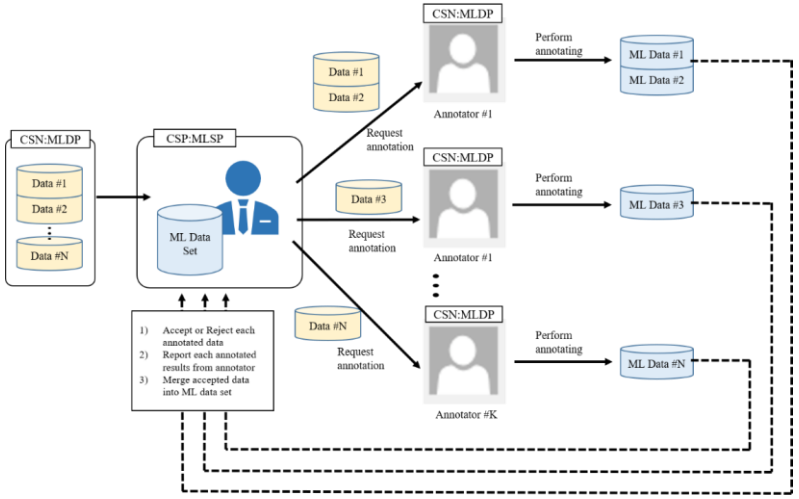
MLaaS System Context (cloud computing aspect)



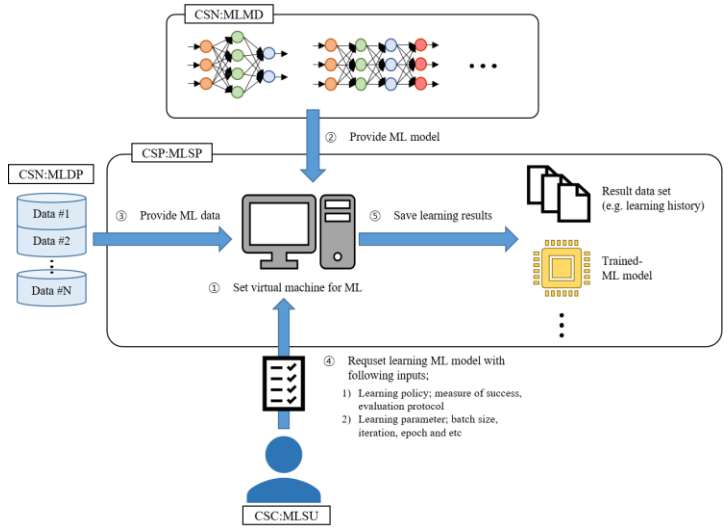
MLDP: Machine learning data provider
MLMD: Machine learning model developer
MLSP: Machine learning service provider
MLSU: Machine learning service user

Legend: Role, Sub-role, Activity

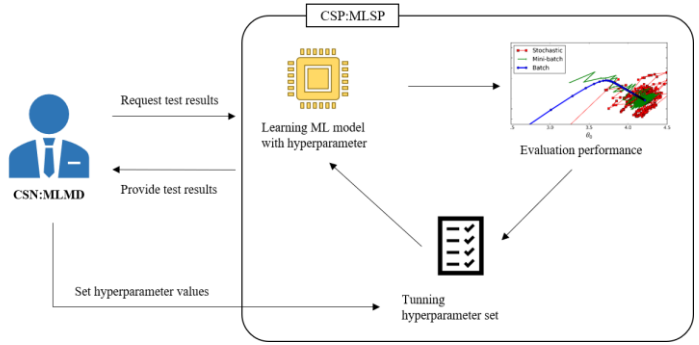
Functional Use cases



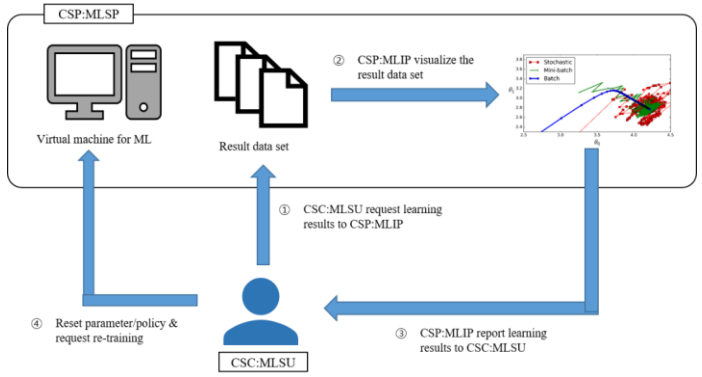
<ML Data Annotation/Labelling Management>



<Model Training with User Configuration>

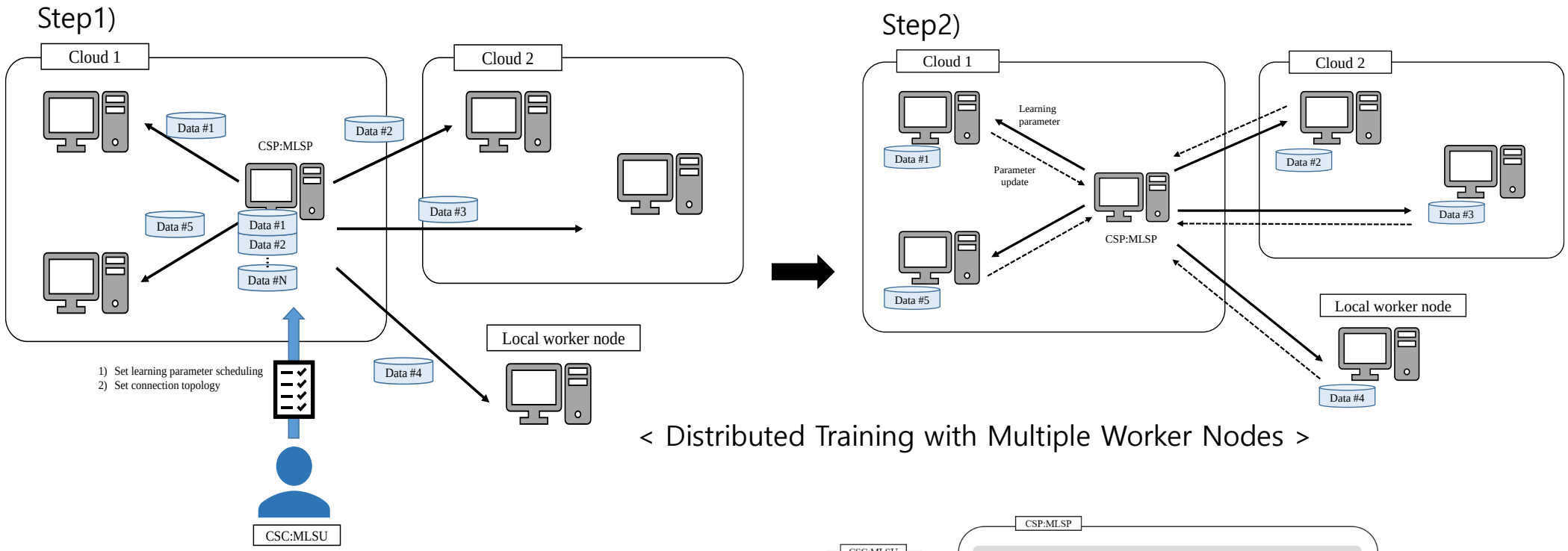


<Model Testing and Optimizing the Hyperparameter>

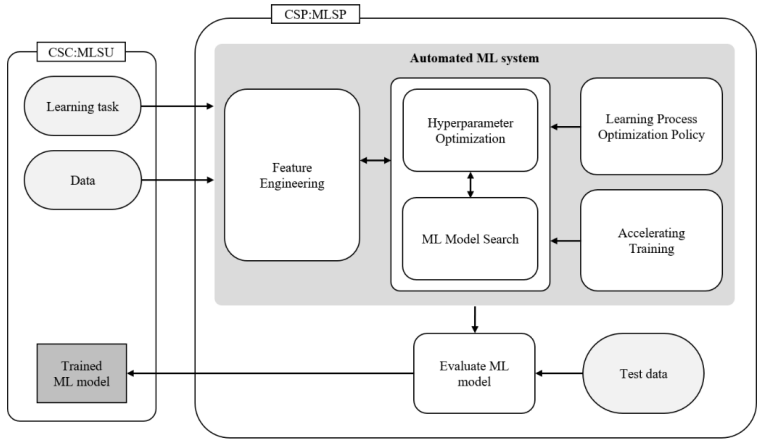


<Reporting Learning Result and Re-training>

Functional Use cases

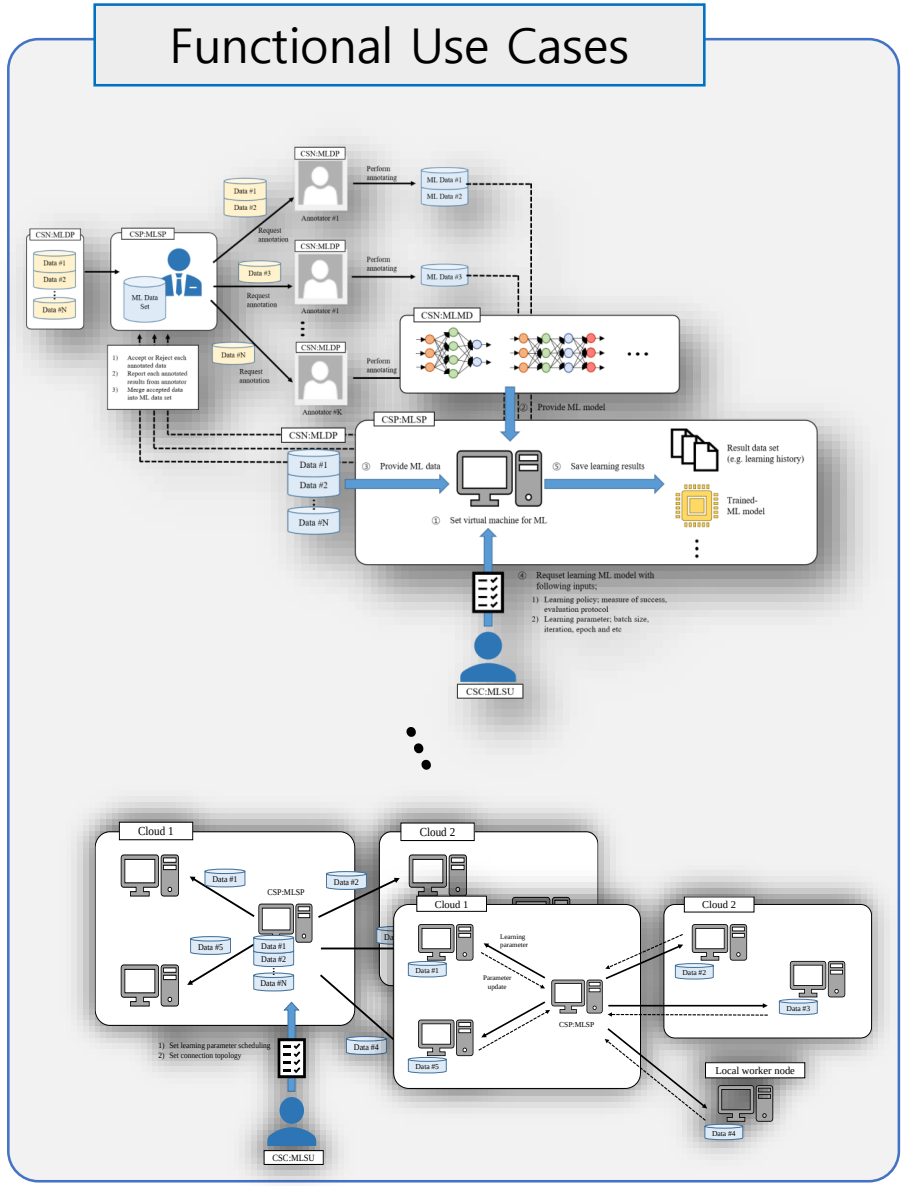


< Distributed Training with Multiple Worker Nodes >



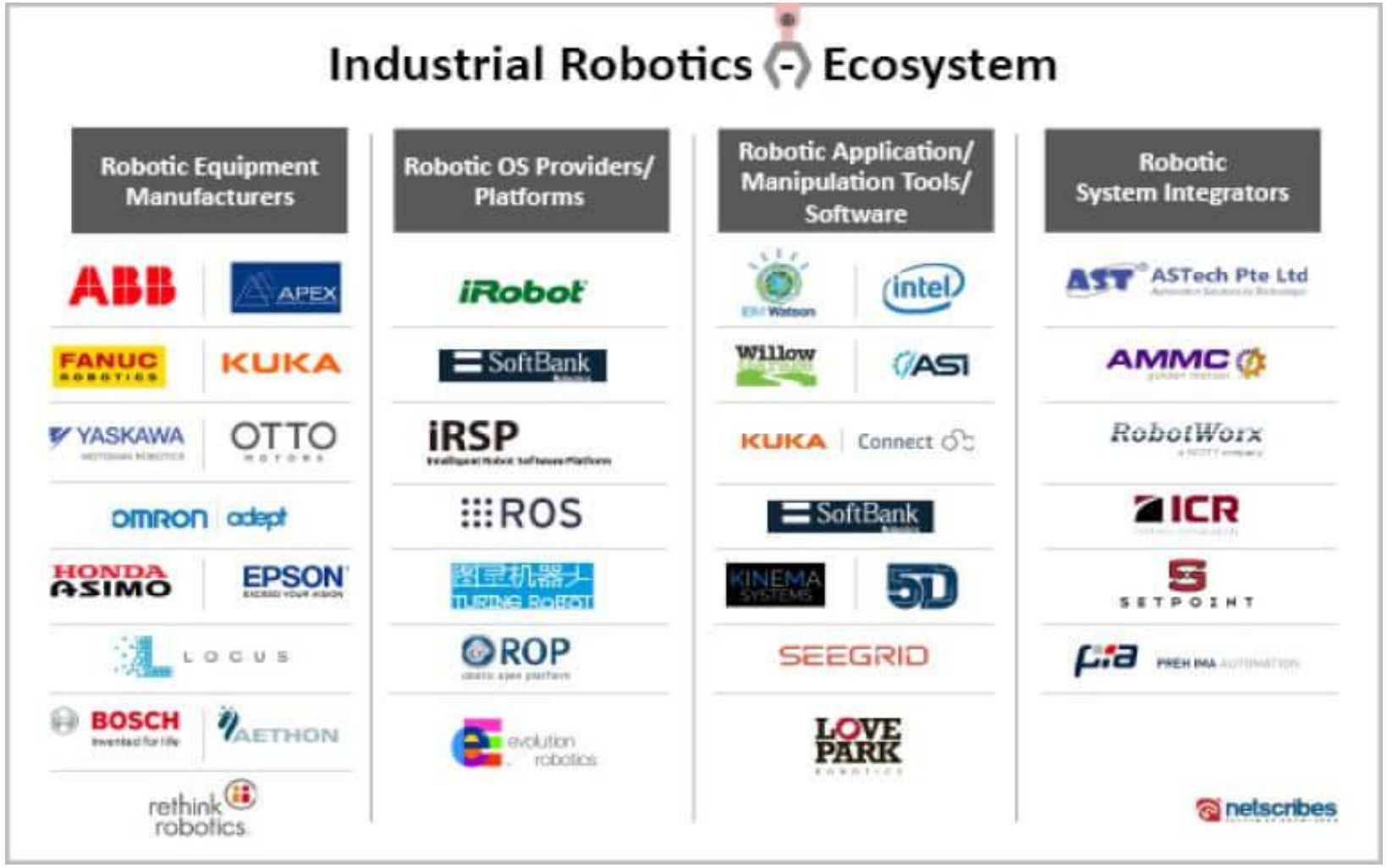
< Auto ML in Cloud Computing >

Functional Requirements from use cases

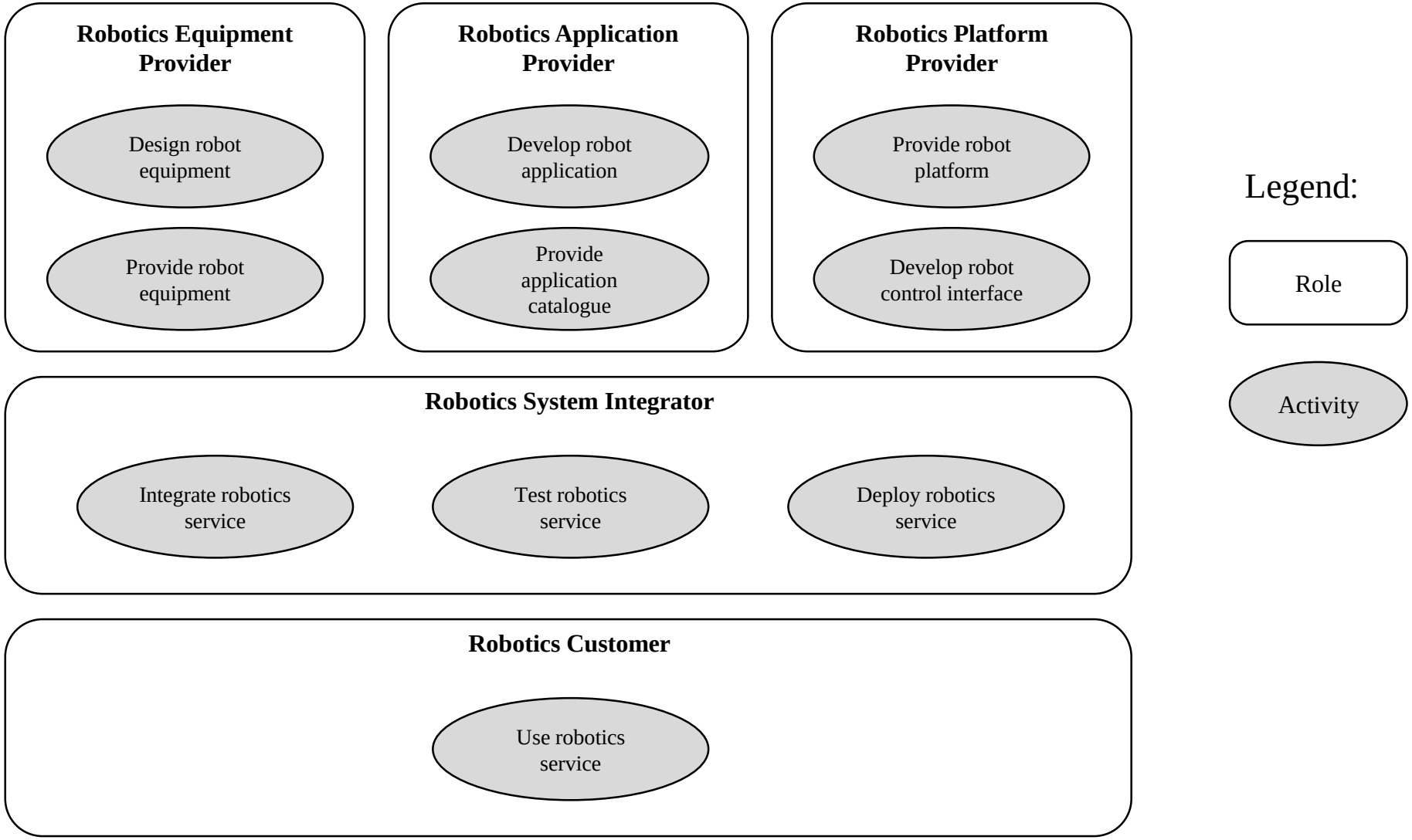


- ✓ ML data collection requirements
- ✓ ML data storage requirements
- ✓ ML data labelling requirements
- ✓ ML data pre-processing requirements
- ✓ ML data analysis requirements
- ✓ ML data feature engineering requirements
- ✓ ML model training requirements
- ✓ ML model monitoring requirements
- ✓ Trained ML model deploying requirements
- ✓ Trained ML model retraining requirements

Companies in Real Field for Robotics



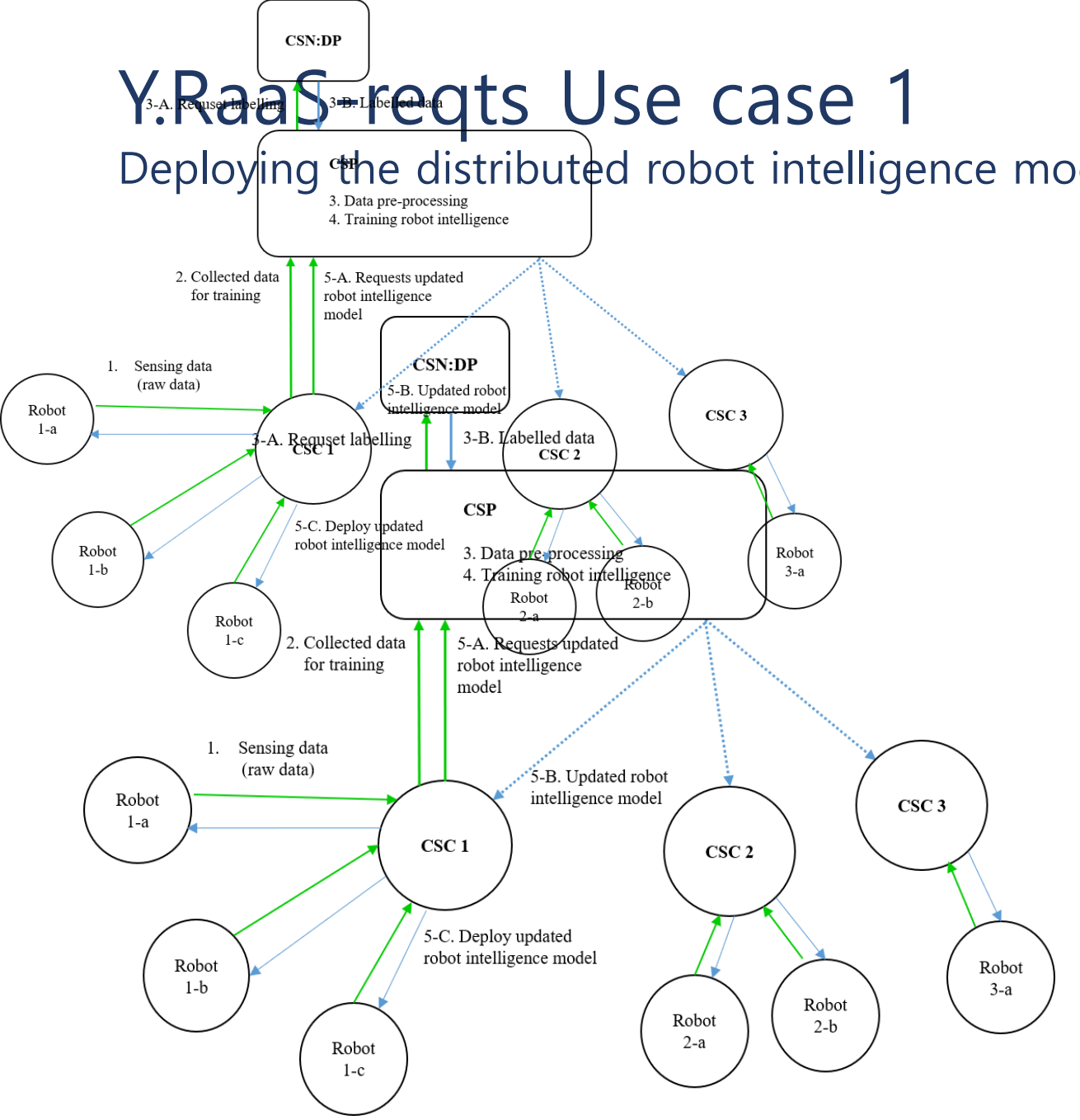
Ecosystem for Y.RaaS-reqts



[Reference] ITU-T Y.RaaS-reqts Cloud computing - Functional requirements for robotics as a service, 2021.

Y.RaaS reqts Use case 1

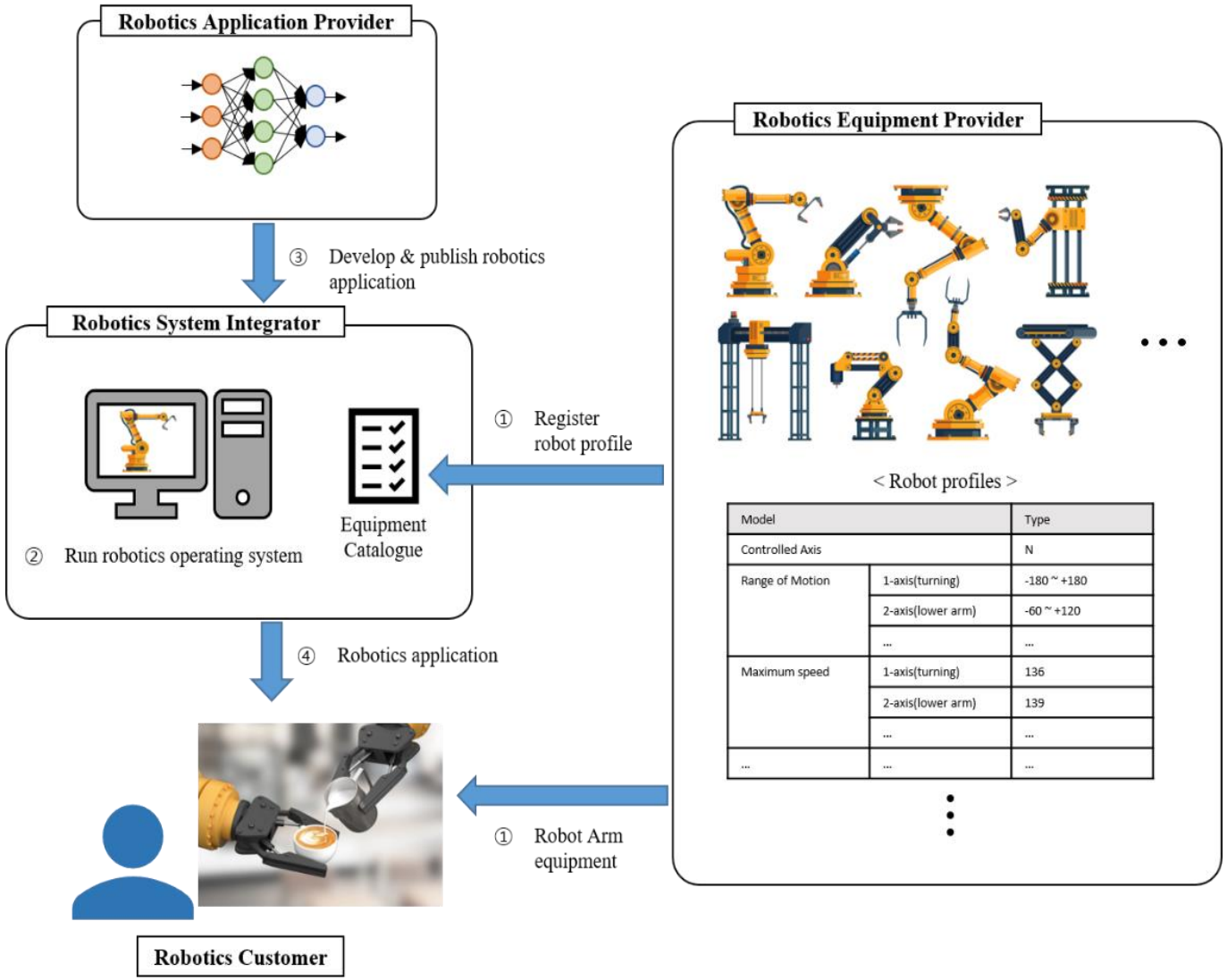
Deploying the distributed robot intelligence model using RaaS & cloud service.



- **High level activity with robotics development procedure**
  - **Designing 3D model of robot(for task)**
    - ✓ Modelling the task for the robot
  - **Listing hardware for robot(sensor, actuation motor…)**
  - **Providing control interface for hardware**
    - ✓ Including input/output data format for controlling robot hardware
  - **Handling data from hardware**
    - ✓ Including generating, storing data
    - ✓ Generating data includes the meta data format of robot(Torque, Force, Location, and etc)
  - **Developing robot API for the task**
    - ✓ Including general robot control API, automation API with AI, and etc
  - **Verifying the robot API (Virtual prototype)**
    - ✓ Testing the robot API in the virtual field
    - ✓ Modifying the model
  - **Testing(simulating) the robot**
    - ✓ Operating the robot in the test environments (Sense -> Plan -> Actuate)
    - ✓ Monitoring the task and store data
    - ✓ Feedback the test results
  - **Deploying robot in real-fields**
    - ✓ Managing the robot
    - ✓ Monitoring the robot

Y.RaaS-reqts Use case 2

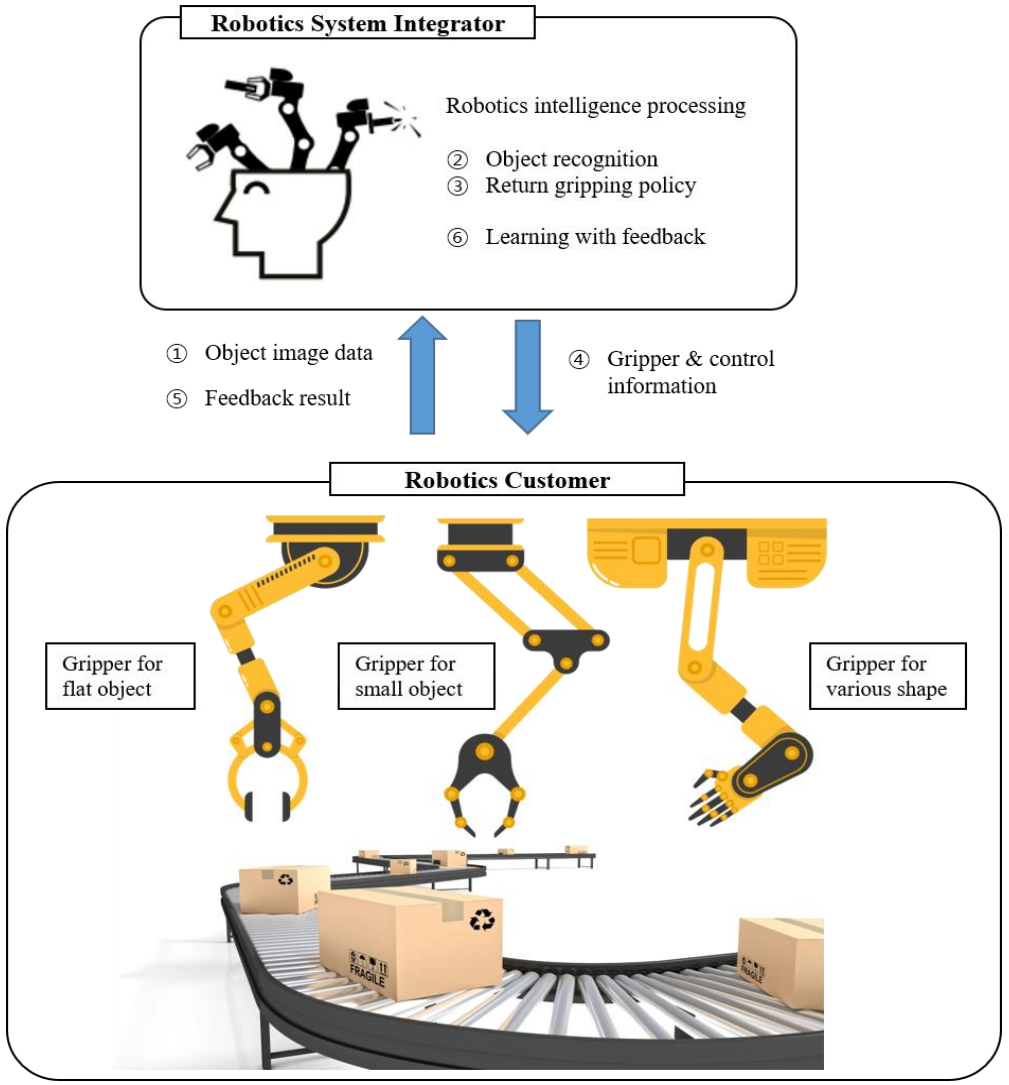
Registration of robot profiles & development of robot applications using the profiles.



- It is required for the CSP:RSI to support the multiple robot profiles for robotics including robotics arm, terrain mobility, drone, humanoid, and etc.
- It is required for the CSP:RSI to provide registry of the robot profiles catalogue to CSN:REP.
  NOTE - The robot profiles include the specifications of robot equipment and its restrictions.
- It is recommended that CSP:RSI provide the applicable task for the equipment.
  NOTE – The robot task for the certain equipment can be collected from CSN: REP, and CSN:RAP.
- It is required for the CSP:RSI to provide visualization tools for simulation of robotics applications.
  NOTE – The GUI (Graphical User Interface) tools for visualization can be designed by CSN:RAP.
- It is required that the CSP:RSI record the logfile for the environments of robotics application.
  NOTE – The logfile for the environments of robotics application includes the information of ROS, task, equipment, and etc.

Y.RaaS-reqts Use case 3

Registration of robot profiles & development of robot applications using the profiles.



- It is required for the CSP:RSI to provide real-time network connections upon request.
- It is required for the CSP:RSI to provide the robot interaction languages.
  NOTE – The robot interaction languages are the programmable code for robot control.
- It is required for the CSP:RSI to support translation for multiple robot interaction languages.
- It is required for the CSP:RSI to provide message format for robot control.
  NOTE – The robot equipment control unit execute the movement of robot with control messages. The robot equipment control units can be different between different CSN:REP.
- It is required for the CSP:RSI to provide capsulation of robot control massage.
- It is required for the CSP:RSI to record robot control massage with policy results.
- It is required for the CSP:RSI to alert the abnormalities of robot executions.

Future work in 2021

Candidate use case scenario for RaaS

- ✓ deploying the distributed robot intelligence model;
- ✓ management of robotics hardware/device profile for cloud services;
- ✓ discovery and publishing RaaS service to customer;
- ✓ alerting the abnormality of robot equipment;
- ✓ operating autonomous and distributed system of robots;
- ✓ enhancement of robotics intelligence using cloud services;
- ✓ contracting SLA related RaaS;
- ✓ etc.