SESLAB
Software Engineering & Security Lab

AIStar
Enabling AI to IoT

글로벌 ICT 표준 컨퍼런스 2022
Global ICT Standards Conference 2022

AI/ML enabled IoT platform and standards

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Contents

- Introduction to the AIStar project
- Motivation and background
- How to support common AI/ML features via IoT service layer platform?
- Introduction to AI enabled oneM2M system
- Other data centric work items in oneM2M

AIStar Project

과제 특징	정책지정( ), 혁신도약형( ), 경쟁형( ), 표준화연계(O), SW자산뱅크등록대상( ), 공개SW( ), 기술료비징수(O)
총괄 과제명	AI 서비스 및 이기종 지능 연동 IoT 플랫폼 국제 표준 및 오픈소스 개발
연구책임자	송재승 교수 (세종대학교)
총 개발기간	2021.04 ~ 2023.12. (31개월)
총 연구 개발비 / 당해년도 연구 개발비	1,525,596 천원 (정부 : 1,375,000 천원, 민간 : 150,596) / 415,508 천원 (정부: 375,000, 민간 : 40,508)
TRL	RFP 1단계 2단계 3단계 4단계 5단계 6단계 7단계 8단계 9단계 Proposal

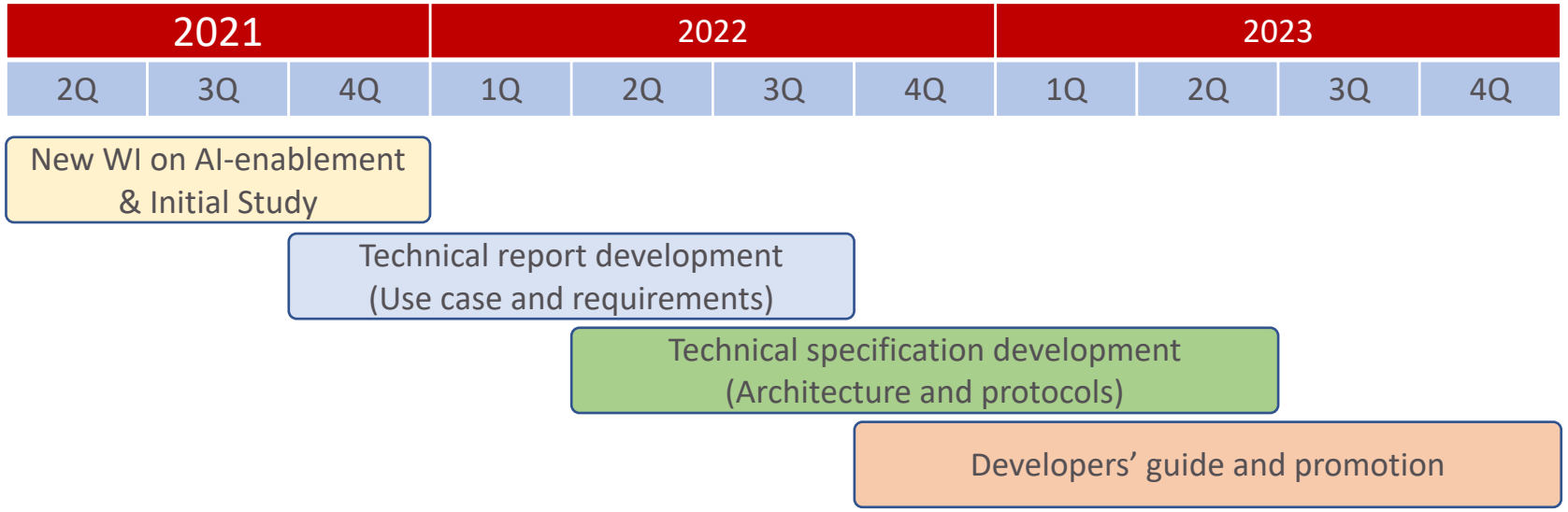
세종대학교 SEJONG UNIVERSITY
송재승 교수
김재호 교수

제주대학교 JEJU NATIONAL UNIVERSITY
김도현 교수

대전대학교 DAEJEON UNIVERSITY
홍용근 교수

Open Source and Standards

- **주요 기능:**
  - oneM2M 기본 구조가 인공지능 서비스를 지원하기 위한 기능 및 리소스 제안
  - 이기종 플랫폼간 인공지능 서비스 지원 기능 제안
- **주요 예정 활동:**
  - 신규 워크 아이템 (New Work Item) 제안 및 승인
  - 기술 보고서 (Technical report) 및 기술 표준 (Technical specification) 개발
  - 개발자 가이드 (Developer's guide) 개발을 통한 개발자 지원



AIStar 표준화 실적

- oneM2M
  - A new work item WI-0015 “System enhancements to support AI capabilities”
    - Rapporteur: Song JaeSeung (Sejong University)
    - Supporting members: KETI, Hyundai Motors, Exacta GSS, Deutsche Telekom, SBS, Nokia, Orange, Convida Wireless, Hansung University
  - A new Technical Report is being developed
    - TR-0068 : AI enablement to oneM2M
    - Current version: 0.6.0
    - Statistics: Total 15 contributions / 6 use cases / 13 potential requirements / 20 input use cases from ETSI
  - Open source OCEAN
    - Develop Metaverse use case
    - Apply AI features
    - Become a committer
  - Open source OM2M
    - Bug fixes
    - Add new features on flexContainerInstances
    - Plan to become a committer

AIStar 표준화 실적

- IETF : IoT 환경에서 통신 및 AI 서비스 제공 관련 표준화

순번	표준화기구 (SG,WG까지)	구분		성과명(표준명)	문서번호	(예정)시기* (연.월)
		제정/개정	승인/개발/제안			
1	IETF 6lo WG	제정	개발	IPv6 over Constrained Node Networks (6lo) Applicability & Use cases	draft-ietf-6lo-use-cases-13	2022.07
2	IETF 6lo WG	제정	개발	Transmission of IPv6 Packets over PLC Networks	draft-ietf-6lo-plc-11	2022.05
3	IETF 6lo WG	제정	개발	Transmission of IPv6 Packets over PLC Networks	draft-ietf-6lo-plc-10	2022.02
4	IETF 6lo WG	제정	개발	IPv6 over Constrained Node Networks (6lo) Applicability & Use cases	draft-ietf-6lo-use-cases-12	2022.01
5	IETF 6lo WG	제정	개발	Transmission of IPv6 Packets over PLC Networks	draft-ietf-6lo-plc-09	2022.01
6	IETF NMRG	제정	개발	Considerations of deploying AI services in a distributed approach	draft-hong-nmrg-ai-deploy-01	2022.07
7	IETF NMRG	제정	개발	Considerations of deploying AI services in a distributed approach	draft-hong-nmrg-ai-deploy-00	2022.03
8	IETF T2TRG	제정	개발	IoT Edge Challenges and Functions	draft-irtf-t2trg-iot-edge-07	2022.06
9	IETF T2TRG	제정	개발	IoT Edge Challenges and Functions	draft-irtf-t2trg-iot-edge-06	2022.05
10	IETF T2TRG	제정	개발	IoT Edge Challenges and Functions	draft-irtf-t2trg-iot-edge-05	2022.05
11	IETF T2TRG	제정	개발	IoT Edge Challenges and Functions	draft-irtf-t2trg-iot-edge-04	2022.01

- ITU-T : AIoT를 위한 서비스 및 Common Rule Enablement 기술 관련 표준화

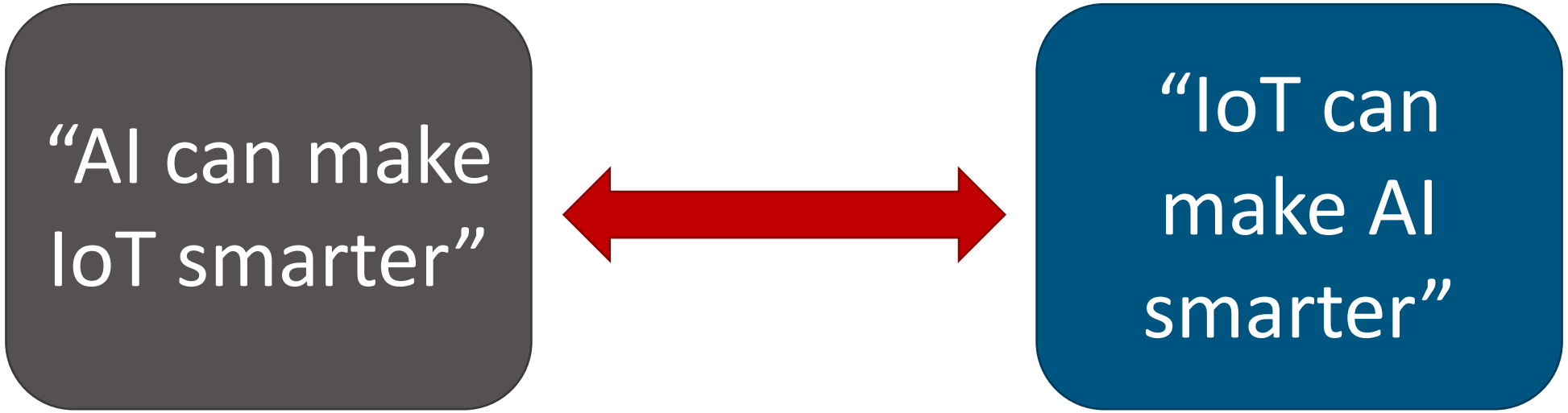
순번	표준화기구 (SG,WG까지)	구분		성과명(표준명)	문서번호	(예정)시기* (연.월)
		제정/개정	승인/개발/제안			
1	ITU-T SG 20	제정	제안	Proposal of new work items of Framework of intelligent IoT services for data processing and analytics (Y.IoT-DPA)	T22-SG20-C-0037	2022.07
2	ITU-T SG 20	제정	제안	Proposal of new work items of Framework of Common rule enablement for intelligent IoT services in heterogeneous IoT platform environments (Y.IoT-CRE)	T22-SG20-C-0038	2022.07
3	ITU-T SG 20	제정	개발	A.1 justification for proposed new draft Recommendation ITU-T Y.SF-AIoT "Overview of service framework for artificial IoT"	T22-SG20-220718-TD-GEN-0261	2022.07
4	ITU-T SG 20	제정	개발	Output text of proposed draft new Recommendation ITU-T Y.SF-AIoT "Overview of service framework for artificial IoT"	T22-SG20-220718-TD-GEN-0262	2022.07
5	ITU-T SG 20	제정	개발	A.1 justification for proposed draft new Recommendation ITU-T Y.IoT-CREF "Framework of Common rule enablement for intelligent IoT services in heterogeneous IoT platform environments"	T22-SG20-220718-TD-GEN-0263	2022.07
6	ITU-T SG 20	제정	개발	Output text of proposed draft new Recommendation ITU-T Y.IoT-CREF "Framework of Common rule enablement for intelligent IoT services in heterogeneous IoT platform environments"	T22-SG20-220718-TD-GEN-0264	2022.07
7	ITU-T SG 20	제정	개발	Proposal of new work items of Framework of transparent rule enablement for Heterogeneous IoT Platforms (Y.TRE-IoT)	Q4-20-Apr22-C-008-NWI-TRE-IoT	2022.04
8	ITU-T SG 20	제정	개발	Proposal of new work items of Framework of AI service production for intelligent IoT services (Y.AISP-IoT)	Q4-20-Apr22-C-009-NWI-AISP-IoT	2022.04

AIStar 표준화 실적

- IETF에서 IoT Edge computing 관련 표준 개발 주도
  - 표준 문서 : IoT Edge Challenges and Functions (draft-irtf-t2trg-iot-edge)
  - 전통적인 클라우드 컴퓨팅 중심의 IoT 서비스를 edge computing 중심으로 제공하기 위한 핵심 기능과 함께 Edge 환경에서 AI 서비스를 제공하기 위한 네트워크 구조 기술
- IETF에서 분산 협력으로 AI 서비스를 구축하기 위한 표준화 논의 주도
  - 표준 문서 : Considerations of deploying AI services in a distributed approach (draft-hong-nmrg-ai-deploy)
  - IoT 환경에서 AI 서비스를 도입하는데 필요한 네트워크 구조 및 주요 기능을 분석하고 AI 모델의 정확도 뿐만 아니라 추론 지연시간, 통신 방식, 모델의 종류, 서빙 프레임워크 등을 기술
- ITU-T SG20에서 AIoT 관련 2건의 신규 권고안 승인
  - 표준문서 : ITU-T Y.SF-prediction (Service framework of prediction for intelligent IoT), ITU-T Y.IoT-CRE-fr (Framework of Common rule enablement for intelligent IoT services in heterogeneous IoT platform environments)

AI and IoT

AI enabled IoT?



Motivation and Background

- Many Artificial Intelligence (AI) and Machine Learning (ML) applications use data collected in IoT platforms to train their model.
- Depending on the quality and quantity of collected dataset for model training, the performance of AI models are different.
- IoT platform (including oneM2M) is a place holder to collect and manage various data (image, text, sensory, etc.)
- In order to build a good model, it is very important to have good data management.
- As AI technologies are now being used in many network systems (such as telco core network, smart factory platform, including IoT platforms), it is good to consider providing necessary AI enablement features to IoT platforms.
- If AI applications use IoT platforms that support proper AI data management, the applications can provide various intelligent services more easily.

Steps of Machine Learning (ML)

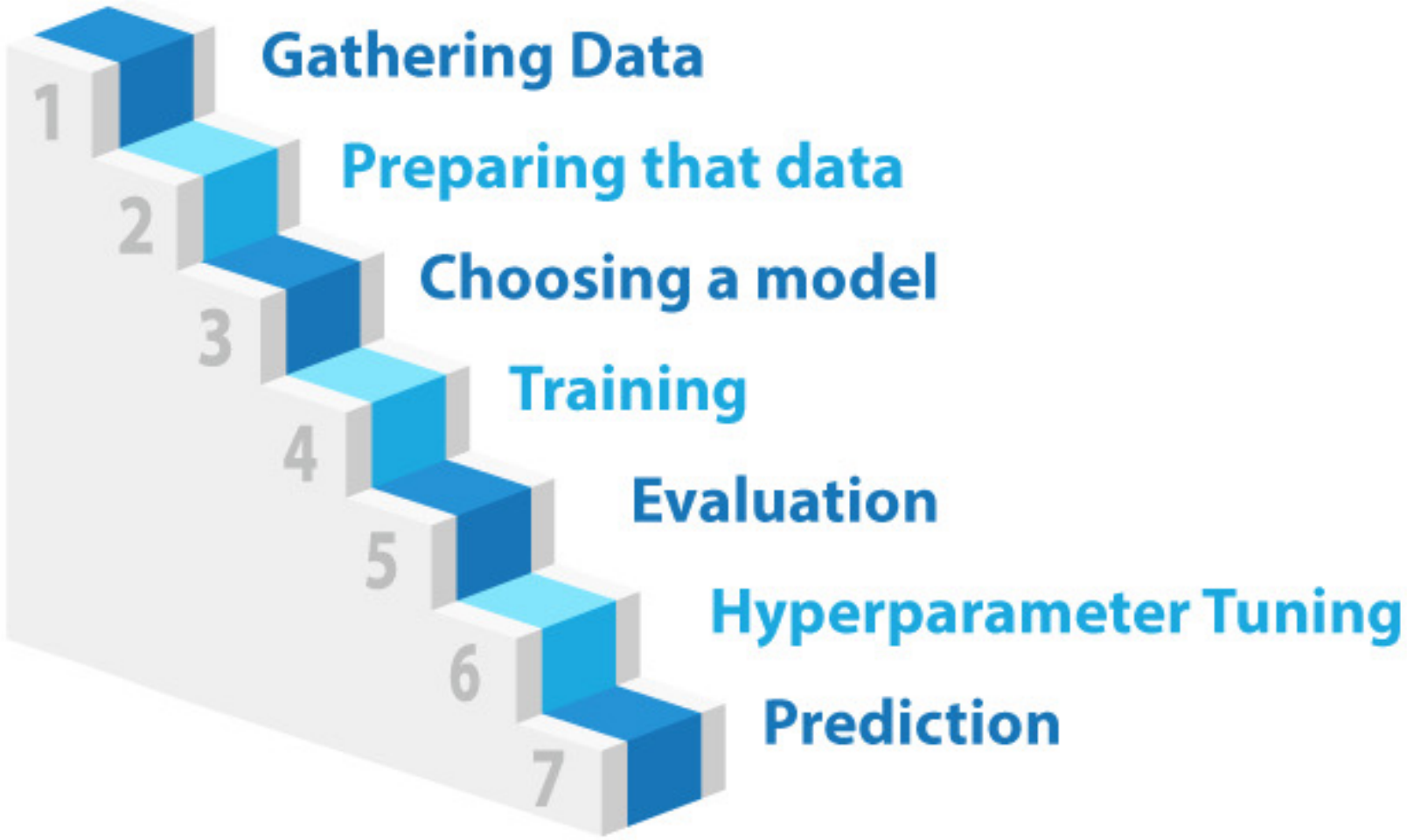


Image from https://www.mygreatlearning.com/blog/what-is-machine-learning/

Steps of Machine Learning (ML)

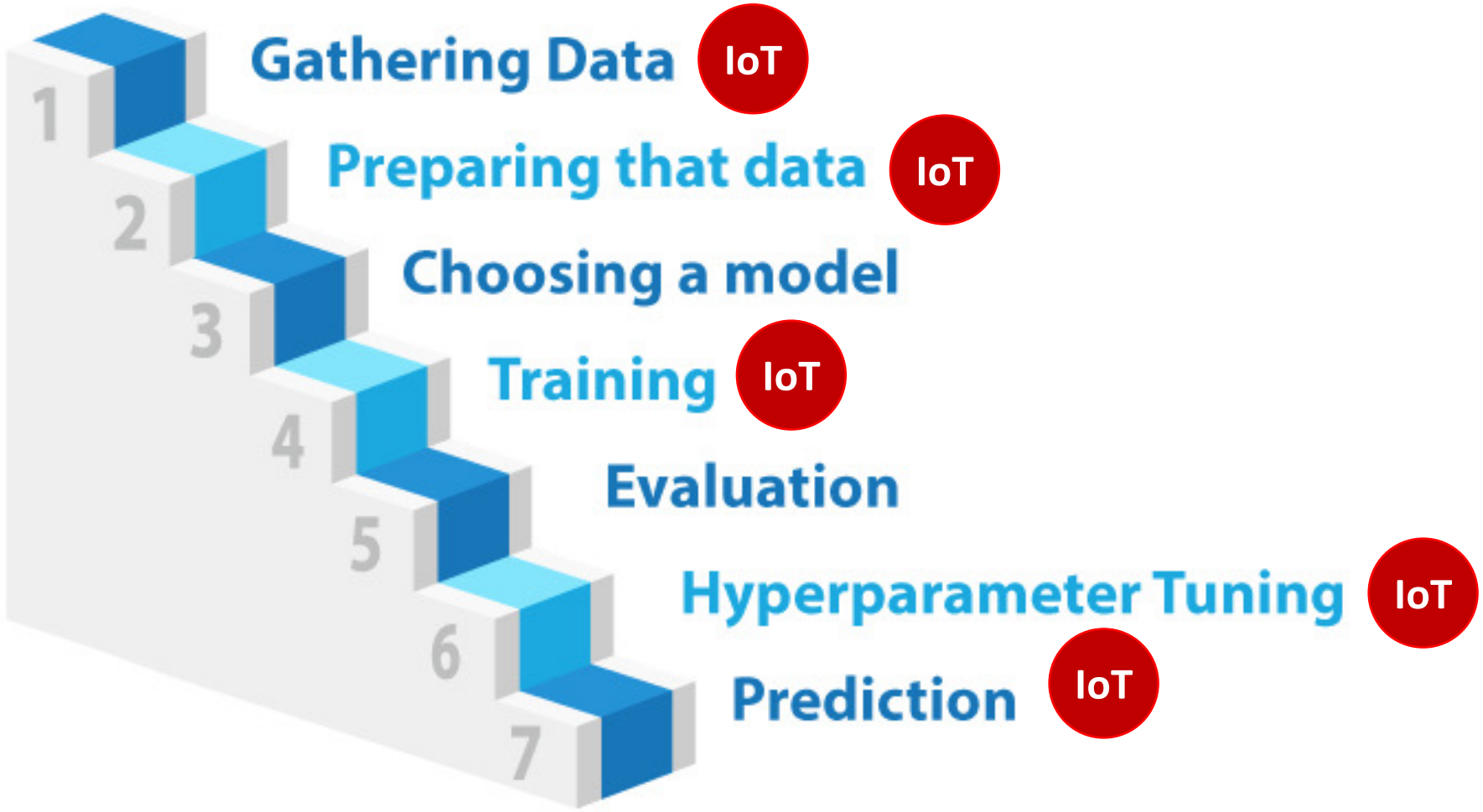


Image from https://www.mygreatlearning.com/blog/what-is-machine-learning/

Nothing NEW

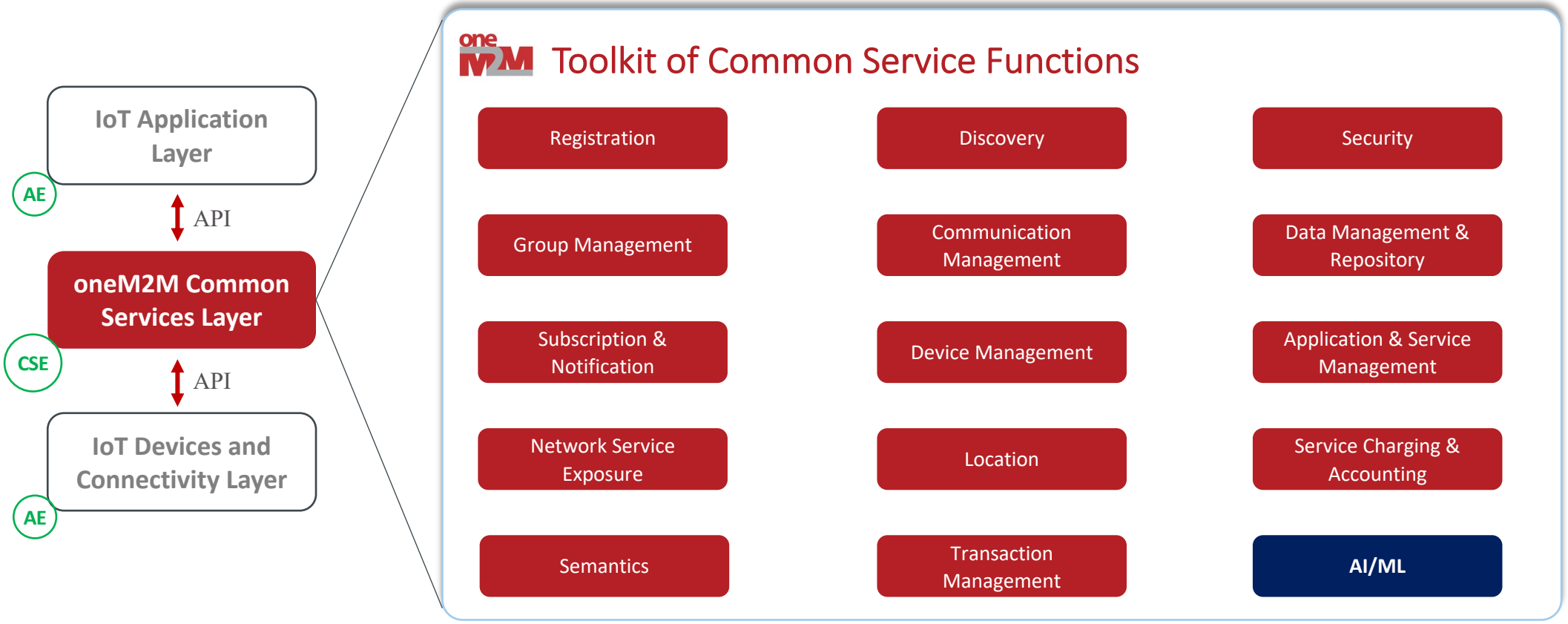
- ETSI:
  - SmartM2M STF 584
    - Objectives: The objective of STF 584 is to provide an initially validated architecture that describes how IoT systems can make use of Artificial Intelligence (AI) and Machine Learning (ML) for the management and interpretation of IoT devices data over a large variety of deployment models (e.g., edge or cloud-based) while remaining interoperable, secure and manageable.
  - ETSI TR 103 674 (v1.1.1) – Artificial Intelligence and the oneM2M architecture
  - ETSI TR 103 675 (v1.1.1) – AI for IoT: A Proof of Concept

- South Korea:
  - A new government project, called ‘AIStar’, has been granted to enable AI features to oneM2M platform
  - An open-source project based on oneM2M
  - Huge interest in AI/ML
  - AI + Edge + IoT

What oneM2M can do?

- oneM2M can consider to support data management for AI/ML
- For example,
  - A resource for AI/ML algorithms?
  - Classification and management of ML dataset stored in oneM2M?
  - A new CSF for various AI/ML models?
  - Management of parameters for AI/ML models?
  - Management of trained AI/ML models?
- A new WID for the enablement of AI/ML features to oneM2M?

AI/ML as a common service

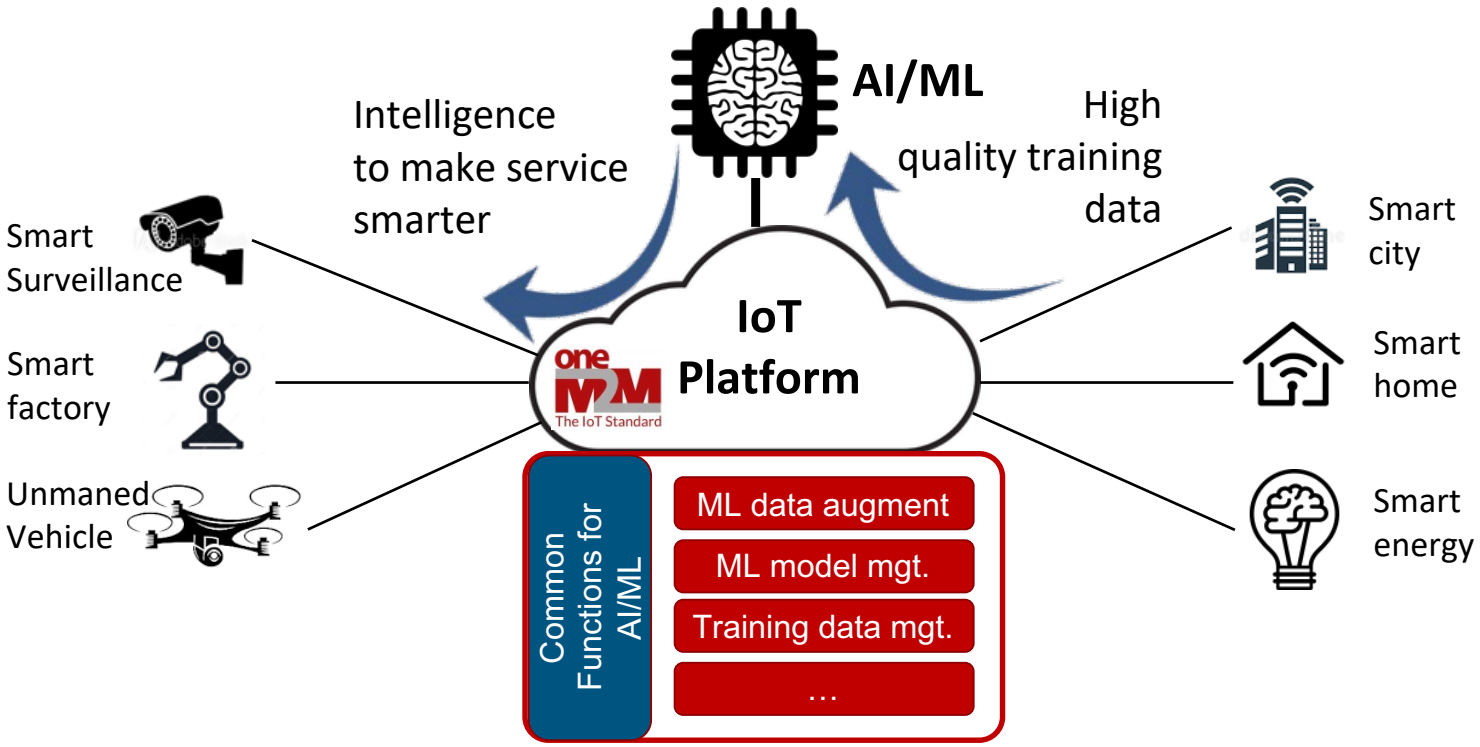


AE In oneM2M terminology, an AE represents an Application Entity

CSE In oneM2M terminology, an CSE represents a Common Services Entity

High-level concept

- oneM2M system should be enhanced with
  - A new common service function (CSF) to support AI capabilities
  - A set of new resources
  - Various AI/ML use cases



Use case #1. Data Augmentation

- The size of the dataset to be used for training is a big problem
- A technique to obtain a larger dataset from original dataset is required ➔ **Data Augmentation**

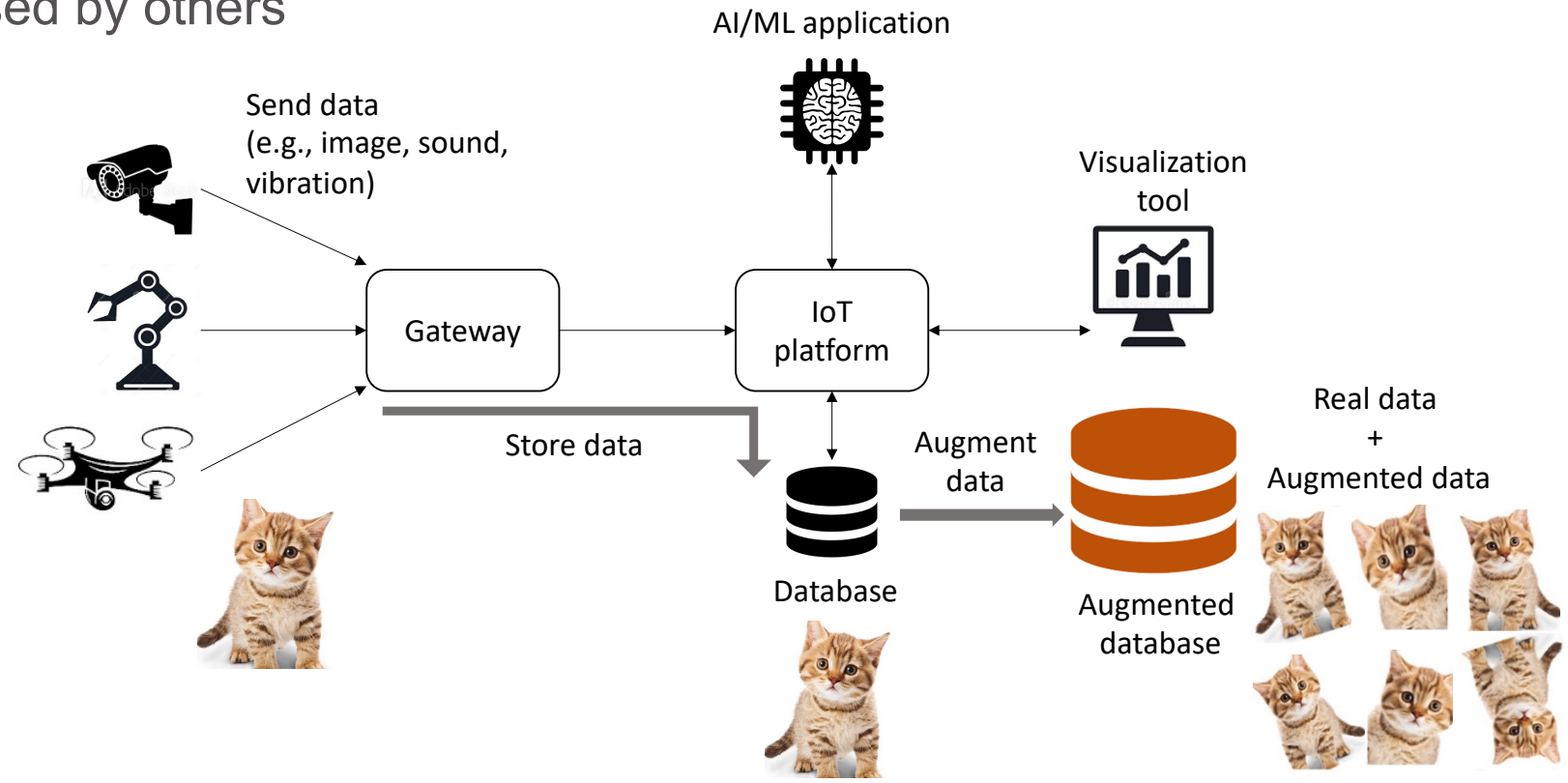
> *"Data augmentation techniques artificially generate different versions of a real dataset by adding slightly modified copies of already existing data or newly created artificial data from existing data to increase its size."*

- Well know data augmentation techniques for image data:
  - Flipping → The image is flipped horizontally and vertically
  - Rotation → The image is rotated by a degree between 0 and 360 degree
  - Cropping → A section of the image is selected, cropped and then resized

What if an IoT platform provides a function to to generate different versions of a dataset?

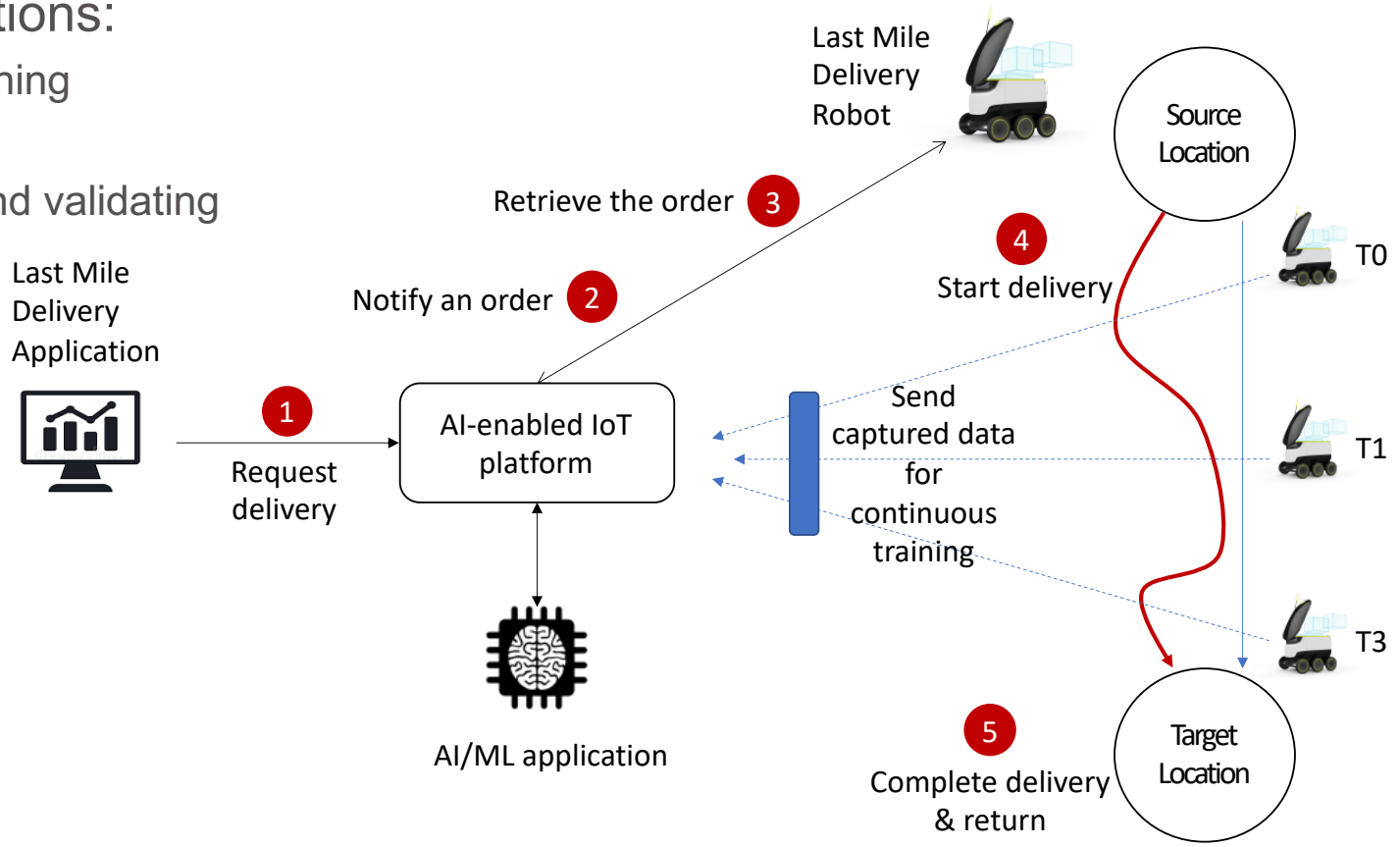
Use case #1. Data Augmentation

- Introduce a new resource to oneM2M for data augmentation
- AI/ML developers simply request data augmentation to oneM2M platform
- Larger training dataset is given to AI/ML developers for training and build a model
- Augmented dataset can be reused by others

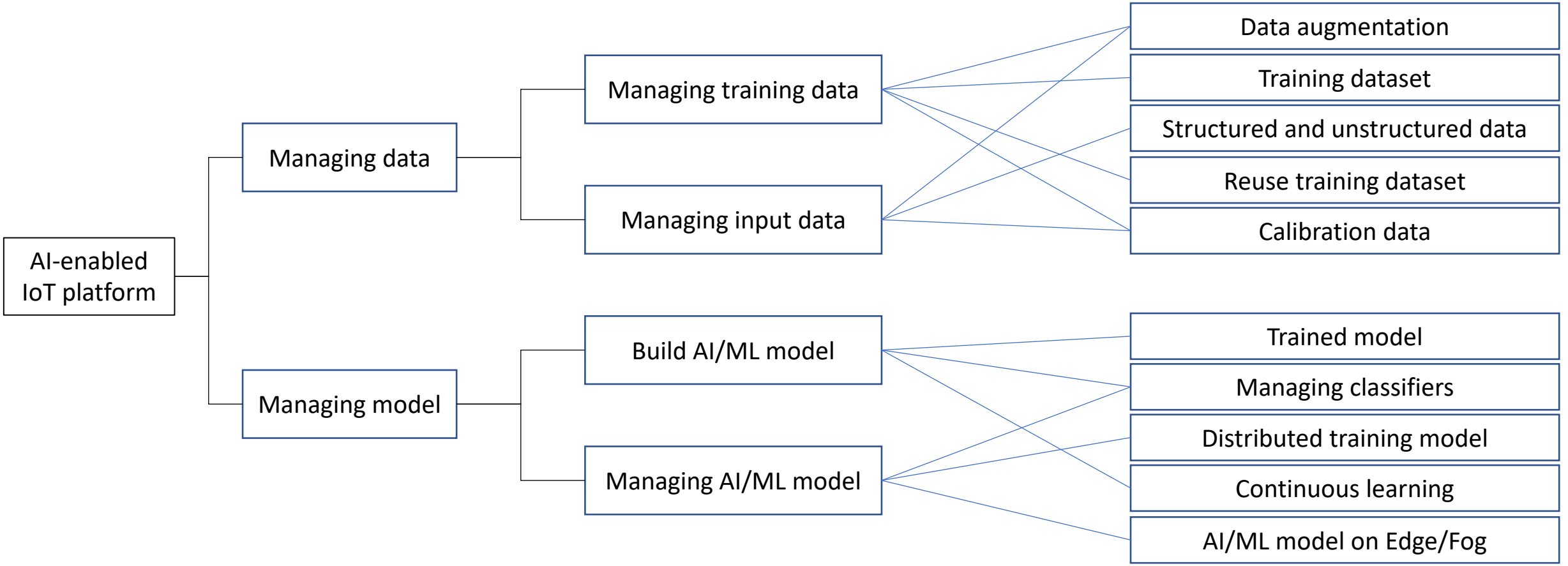


Use case #2 – Last Mile Delivery

- Last Mile is a term used in supply chain management and transportation planning to describe the last leg of a journey comprising the movement of people and goods from a transportation hub to a final destination.
- IoT platform can provide the following functions:
  - » Manage structured and unstructured data for training
  - » Update trained model using new inputs everyday
  - » Classify AI/ML data into two parts, i.e., training and validating



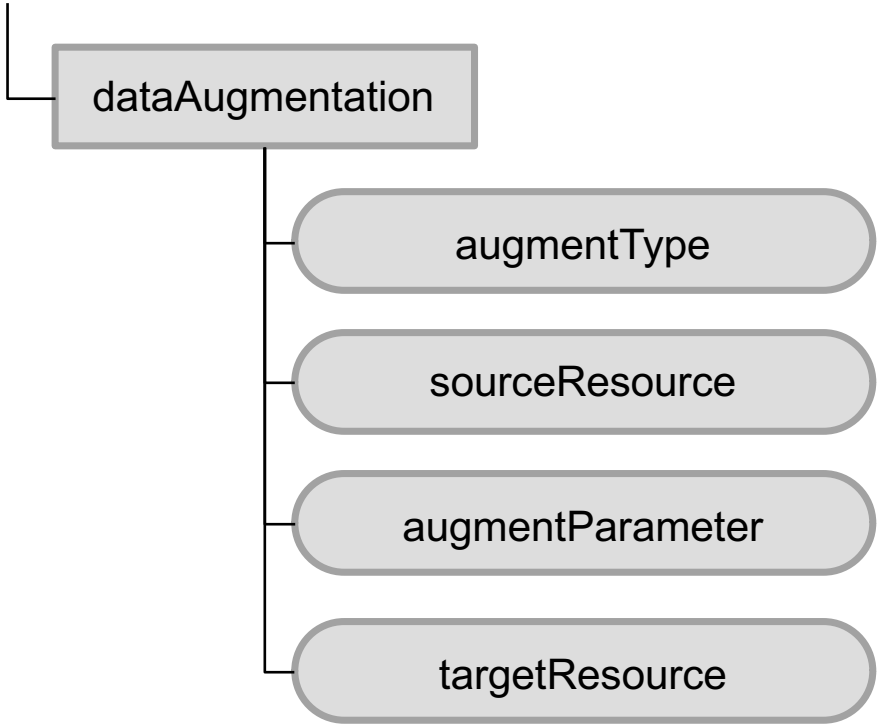
Potential Requirements to Support AI/ML



Potential solutions (Data Augmentation)

An example structure of

[*dataAugmentation*] resource



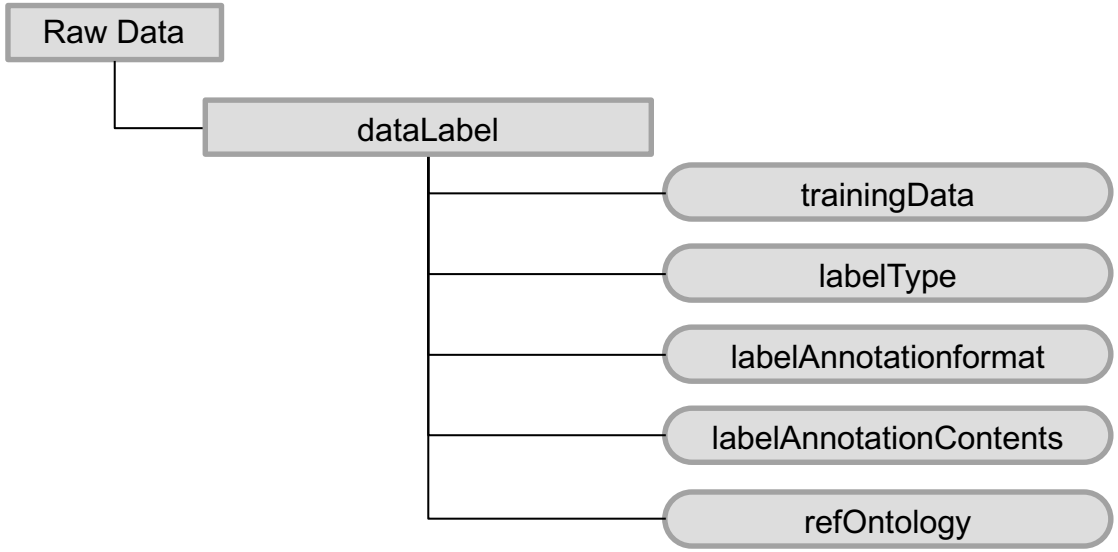
Description of attributes for

[*dataAugmentation*] resource

Attribute Name	Description
autmentType	type of data augmentation (e.g., resize, crop, rotate)
sourceResource	a resource (or list) that contains the raw image
augmentParameter	required parameters for the selected augmentation type
targetResource	a resource or a set of resources to store generated images

Potential solutions (Data Labelling)

An example structure of [*dataLabel*] resource



Description of attributes for [*dataLabel*] resource

Attribute Name	Description
trainingData	confirms that this data is for training
labelType	describes labelling type, e.g. square, polygon, line
labelAnnotationFormat	there exist many labelling format such as COCO and YOLO
labelAnnotationContents	contains actual annotation contents following the given format (e.g., XML or JSON)
refOntology	reference ontology used in data label annotation

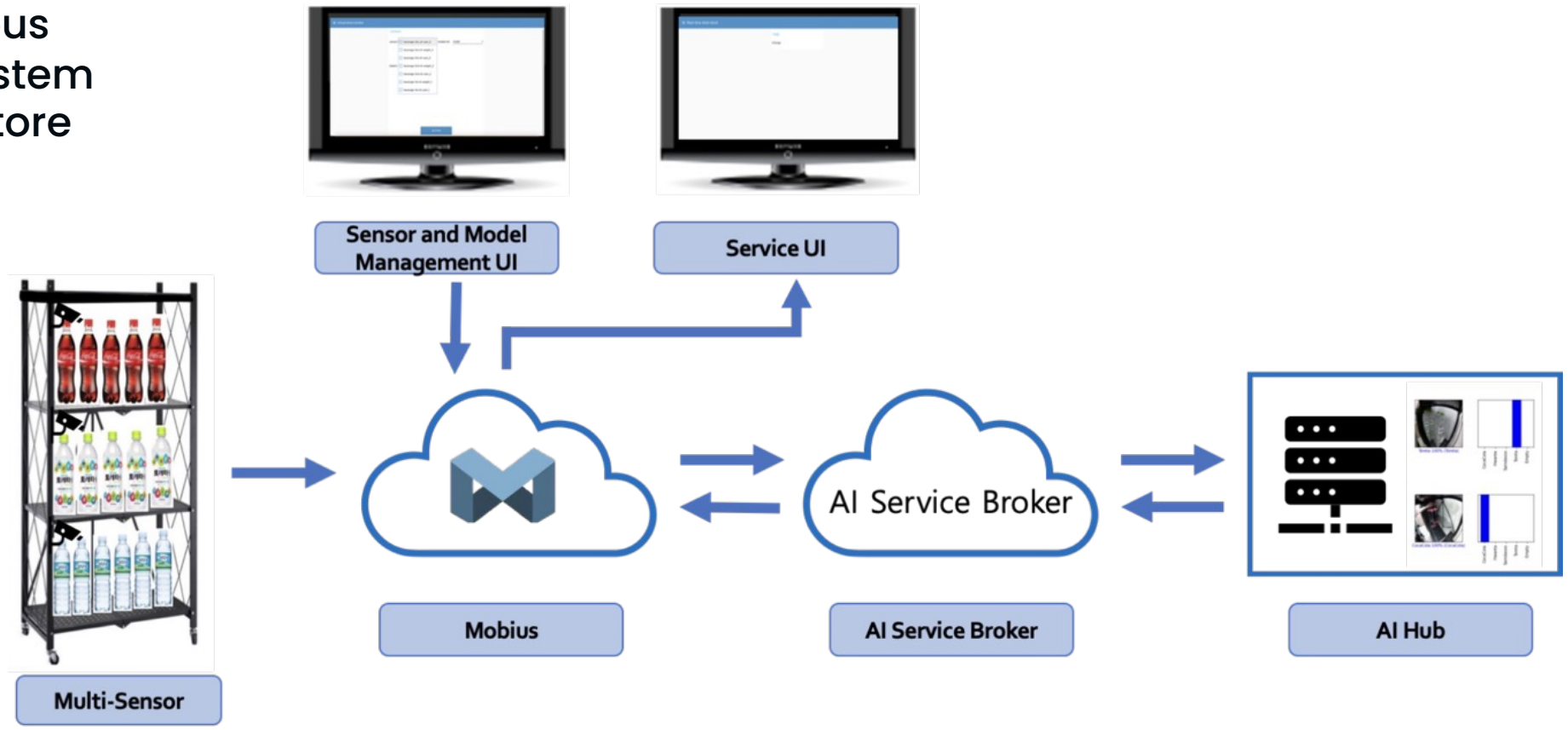
Demo at ETSI IoT Week 2022

AI-Enabled IoT based on the oneM2M Sta

(Sejong University & KETI)

ETSI IoT Week 2022

Autonomous
Counting System
for Smart Store



ETSI IoT Week 2022 – Talks on AI and IoT

11:15 SESSION 14 : ARTIFICIAL INTELLIGENCE LEVERAGING IoT

Session Chair: Michelle Wetterwald, Netellany/ FB Consulting

Artificial Intelligence and IoT are closely linked. The data processed by AI are very often produced by sensors, while the automated outcome of AI decisions is executed by IoT actuators. Standards, more specifically on shared data, have a major role to play in this interaction, which will be outlined in this session.

11.15 Overview of AI Activities in ETSI

Lindsay Frost, NEC

11.35 Artificial Intelligence, IoT Device Management : the Indispensable Collaboration

Samuel Berlemont, Orange

11.55 Bringing the Power of Standards IoT Platform to AI

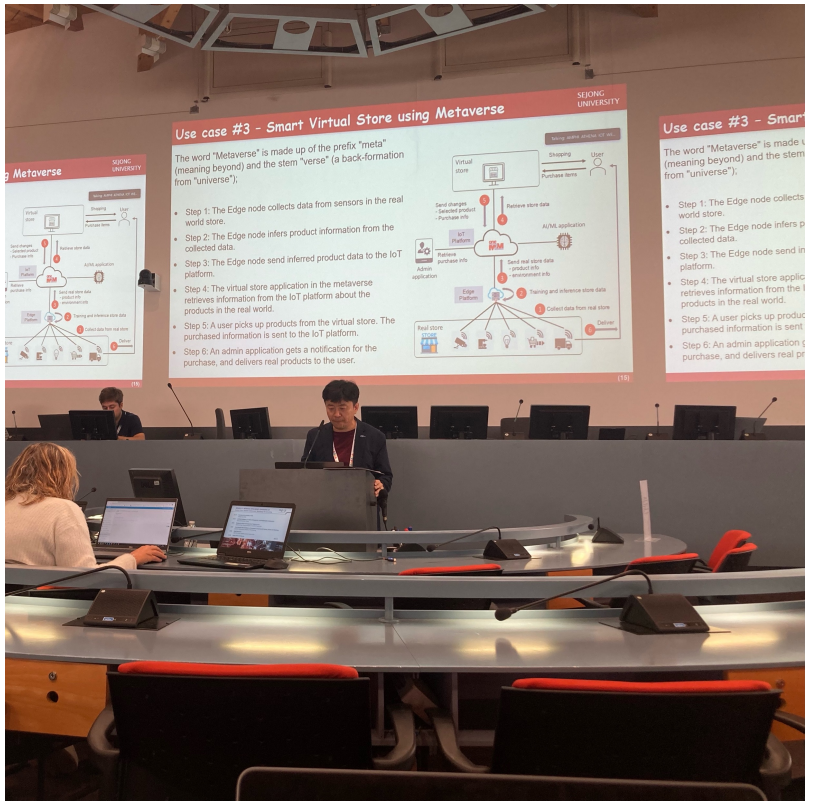
JaeSeung Song, Sejong University, oneM2M TP Vice Chair

12.15 Cross-Domain Data Usability in IoT Ecosystem Comprising IoT Devices, Humans and Machines

Michelle Wetterwald, Netellany / FB Consulting

12.35 Panel Discussion

with the session speakers, led by Session Chair



NEW
Rel-5 Feature

Data License Management

Allow oneM2M to manage data license so support

- **Linked Open Smart City Data**
- **License-based discovery**

WORK ITEM	
Work Item Title:	System enhancements to support Data License Management
Document Number	WI-00XX
Supporting Members or Partner type 2	Hyundai Motors, KETI, Deutsche Telecom, Telecom Italia, Convida Wireless, BT, Orange
Date:	2020-05-20
Abstract:	Proposes a work item to study oneM2M system enhancement to support data license management.

NEW
Rel-5 Feature

Data Protection Regulations

Make oneM2M platform to be **compliant** with Data Protection Regulations such as GDPR and PIPA

WORK ITEM	
Work Item Title:	System enhancements to support Data Protection Regulations
Document Number	WI-00XX
Supporting Members or Partner type 2	Hyundai Motor, KETI, BT, SyncTechno Inc., Hansung University, EGM
Date:	2019-09-27
Abstract:	Proposes a work item to study oneM2M system enhancement to support data protection regulations such as General Data Protection Regulation from EU.

NEW
Rel-5 Feature

AI-enabled oneM2M System

Make oneM2M platform to support data management for AI and provide AI/ML capabilities

WORK ITEM	
▪ Work Item Title:	System enhancements to support AI capabilities
▪ Document Number	WI-00XX
▪ Supporting Members or Partner type 2	KETI, Hyundai Motors, Exacta GSS, Deutsch Telecom, SBS, Nokia, Hansung University, Orange, Convida Wireless
▪ Date:	2021-05-27
▪ Abstract:	This work item aims to enable oneM2M to utilize Artificial Intelligence models and data management for AI services.
▪ Template Version:23 February 2015 (Do not modify)	

NEW
Rel-5 Feature

MetaIoT

Make oneM2M platform to support Metaverse services

WORK ITEM	
Work Item Title:*	Enablement of IoT in the metaverse (MetaIoT)
Document Number*	WI-xxxx
Supporting Members or Partner type 2*	Hansung University, Nokia, KETI, Sejong University
Date:*	2022-09-28
Abstract:*	Propose a Work Item for enabling Metaverse services on IoT
'Template Version: January 2020 (do not modify)	

Thank You

<Prof. Song JaeSeung>

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