

Home Edge Project Community F2F

April 2nd, 2019

 THE **LINUX** FOUNDATION

 **LF** EDGE

Meeting Details

Home Edge Project : April Community Meeting

- › April 2nd, 2019 (@ 8:00 am PST)
- › Meeting Info:
 - › Join Zoom Meeting: <https://zoom.us/j/619158602>
 - › Dial by your location
 - › +1 669 900 6833 US (San Jose)
 - › +1 646 558 8656 US (New York)
 - › +1 855 880 1246 US Toll-free
 - › +1 877 369 0926 US Toll-free
 - › Meeting ID: 619 158 602
 - › Find your local number: <https://zoom.us/u/acAnNIUC3u>
- › Please register yourself into RSVP :
<https://lists.lfedge.org/g/homeedge-tsc/viewevent?eventid=454005>

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Welcome! – Today's Agenda

Time	Topics
08:00am – 10:00am	<ul style="list-style-type: none">• Overview of the Home Edge Project• Use cases driving the design / implementation of the Home Edge Project• Deeper dive on the Project that can connect use cases with functionality
10:00am – 10:15am	Coffee Break
10:15am – 12:00pm	<ul style="list-style-type: none">• Home Edge possible candidates or Blueprints• Possible collaborations with other parts of LF Edge and members• Try to build a Strawman with project milestones/releases/etc.

Overview of the Home Edge Project

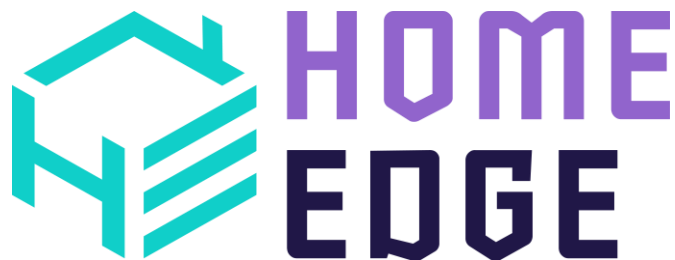
Drivers

Smart Home has a potential to enable new biz apps through edge computing.

- › Smart Home products are now mainstream and need common API, gateway, UI, and lifecycle management.
- › AI technologies enabling learning and lifestyle/safety prediction requires local but connected edge computing.
- › Real time/low latency requirements increasing as safety, natural disasters and home health become mainstream beyond telecom "triple play".
- › Data storage and data privacy increasingly important and require sensitive data closer to home/user.

Introduction

The Home Edge Project is an open source project under the LF Edge umbrella that concentrates on driving and enabling a robust, reliable, and intelligent edge computing framework running on a variety of devices in the home. With seed code contributed by Samsung Electronics, Home Edge will provide users with an interoperable, flexible, and scalable platform with a set of APIs that can also run with libraries and runtimes.



Seed Code Release
Planned by 1H 2019

Project Scope

- › Define use cases, architecture and technical requirements.
- › Develop and maintain the features and APIs targeting Smart Home use cases and requirements in a manner of open source collaboration.
- › Upstream the core features back to the existing/upcoming projects under LF Edge.
- › Connect with Vertical Solutions WG on Smart Home in EdgeX, and Blueprint on Smart Home & Akraino through testbed validation.

Tech. Requirement

The Home Edge Project will offer an edge computing open source platform for various use cases in the home, meeting the technical demands of products and services such as:

- › Distributed machine learning
- › Multi-vendor interoperability
- › Security and data privacy of users
- › QoS guarantee in various dynamic conditions (e.g. devices On or Off)
- › Dynamic device / service discovery at Home Edge

Definition : Technologies of Home Edge Project

Technologies that compute and proceed user data

- › In real-time by using distributed edge devices at home network.
- › BENEFIT : user privacy, low latency, locality.

Performance examples when employing Home Edge Project technologies

	Smart TV	Home Edge
# of cores	4	28
Memory	2 GB	12 GB
Service Examples (Speech recognition)	For device control (Anticipated size of ML model : 20MBytes)	For contents searching (e.g. media, retail) (Anticipated size of ML model : 100MBytes)

* Given number is an example referring from the product specification available from the market (TV, Refrigerator, A/C, Speaker, Mobile).

** Assumed that there are 5 edge devices at home enabling the Home Edge Project technologies in this example.

Use Cases Driving the Design / Implementation of the Home Edge Project

Executive Summary

Edge Orchestration

Deploying / searching / and managing services for distributed edge devices

- › Edge Device / Service Discovery, Resource Capability Exchange
- › Topology Decision, Real-time Monitoring

Distributed & Parallel ML

Enabling inference / model learning at home with low latency

- › Data / Service / Model Parallelism

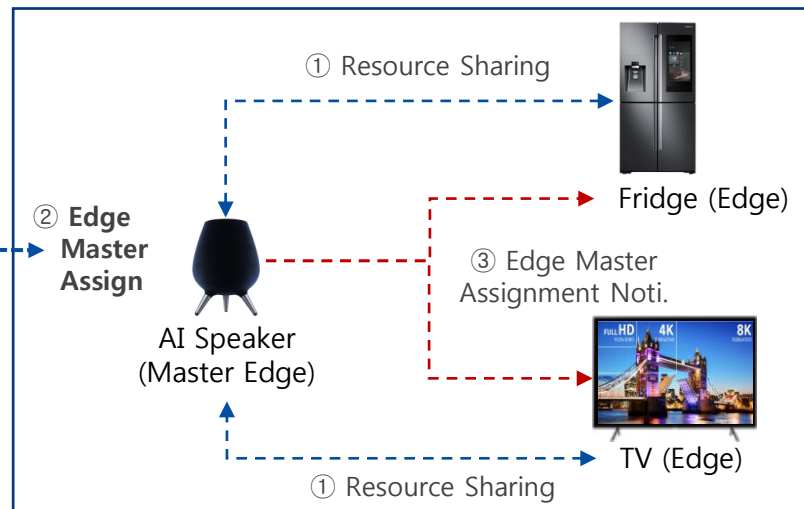
Edge Orchestration (1/2)

Assignment of “Master” edge device among multiple edge devices at home

- › Sharing resource with all edge devices, when a new one is added to the network.
- › Assignment of “Master” edge device after analyzing current resource status and capability about all the edge devices.

	TV	Fridge	AI Speaker
Always ON	O	O	O
CPU	1.7 GHz	1.3 GHz	2.2 GHz
Core Number	4	4	8
Memory	2.0 GB	4.0 GB	1.8 GB
Idle Memory	400 MB	700 MB	1 GB

< Example on Master Edge Device Assignment >

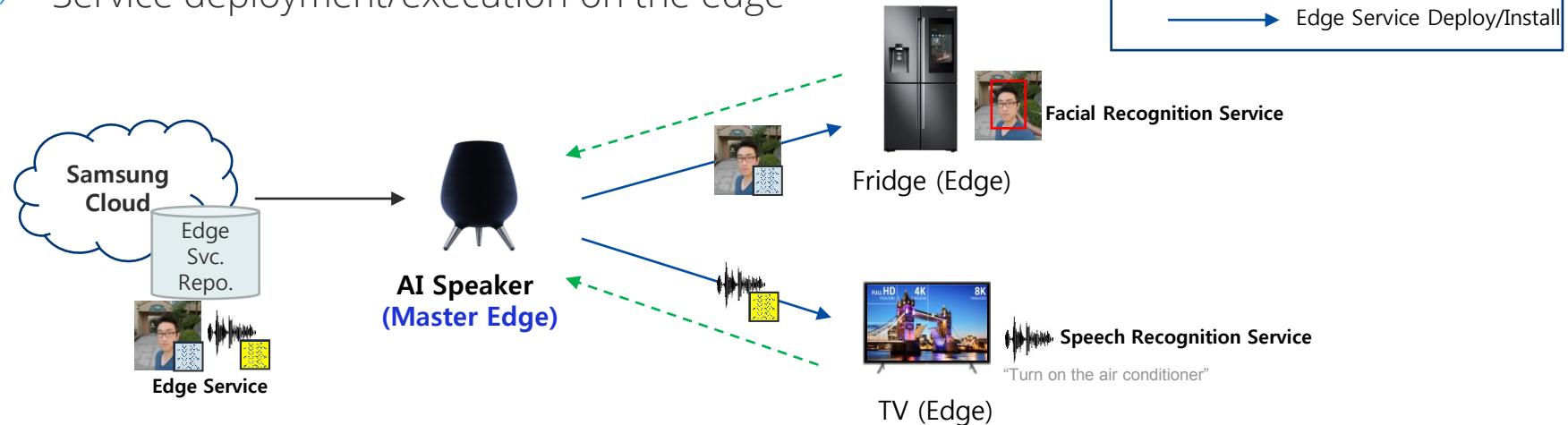


< Master Edge Device Assignment Process >

Edge Orchestration (2/2)

Service deployment/execution/scheduling based on real-time resource status

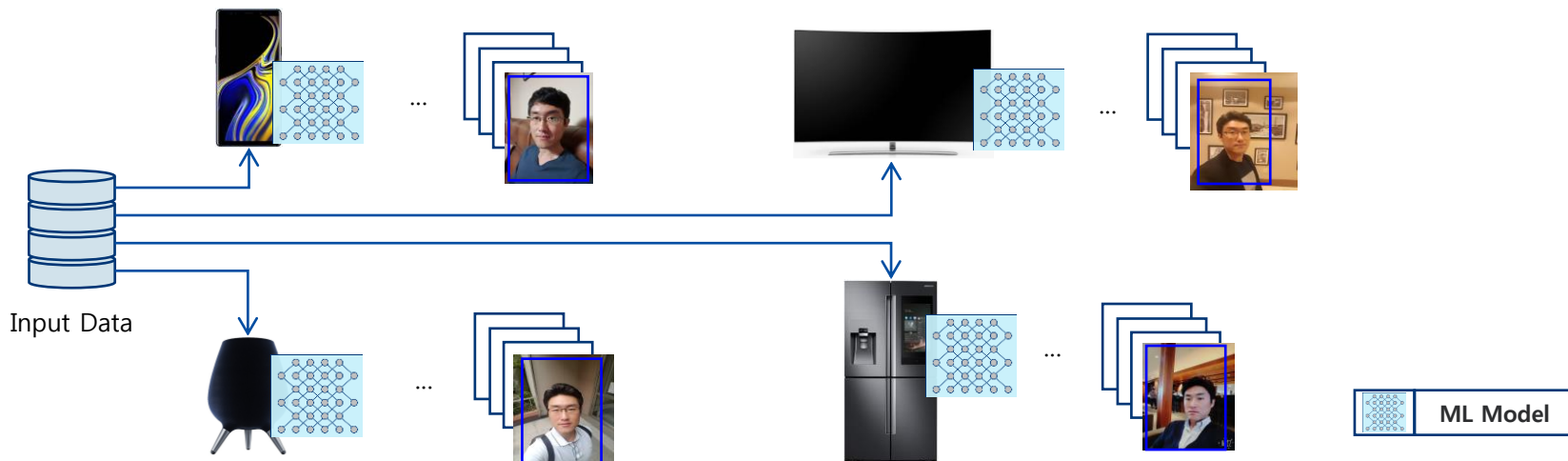
- › Real-time resource monitoring of all edge devices at home
- › Edge service searching and download stored in the cloud
- › Service deployment/execution on the edge



Data Parallelism

Optimization on elapsed time of inference through multi edge devices at home

- › Execution of the same ML service to multi edge devices
- › Distributed transmission of input data into multi edge devices
- › Data distribution transmission scheduling based on edge device resource

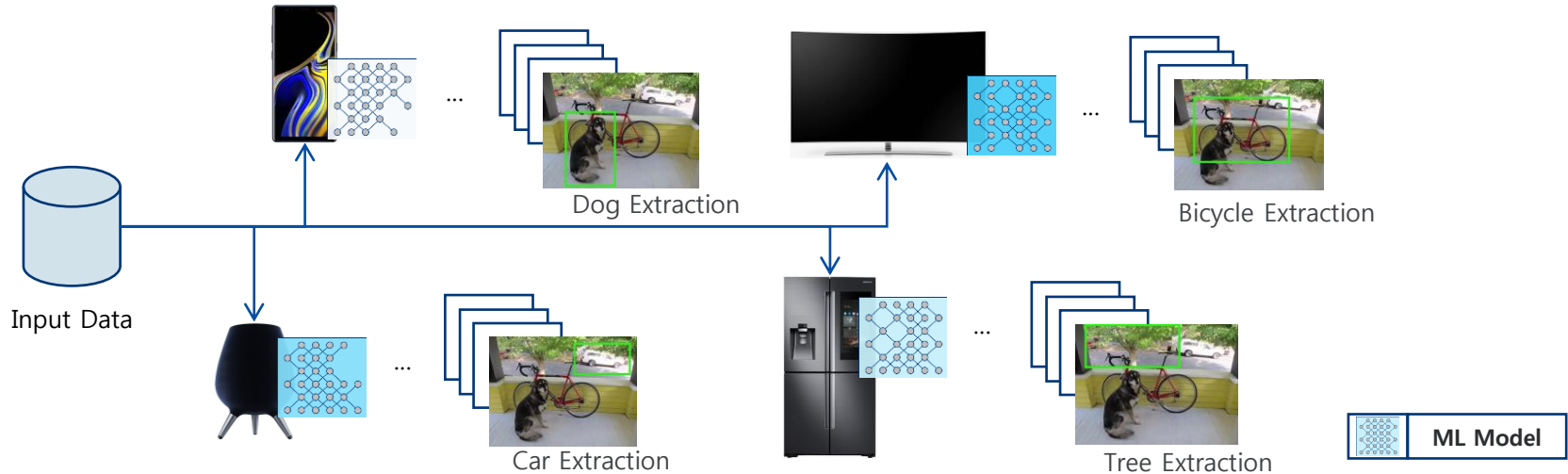


< Data Parallelism (Data Parallelism, using same model) >

Service Parallelism

Parallel service processing through multi edge devices

- › Simultaneous execution of variant ML services into multi edge devices
- › Transmission of all input data into multi edge devices
- › Model deployment scheduling based on edge device resource

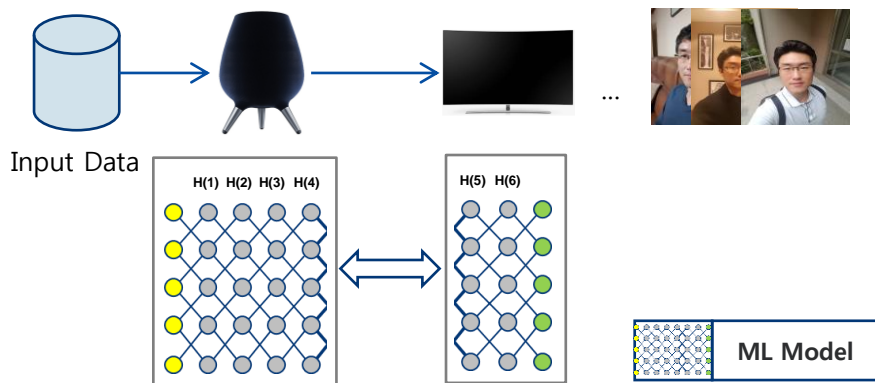


< Service Parallelism (using same data, different model) >

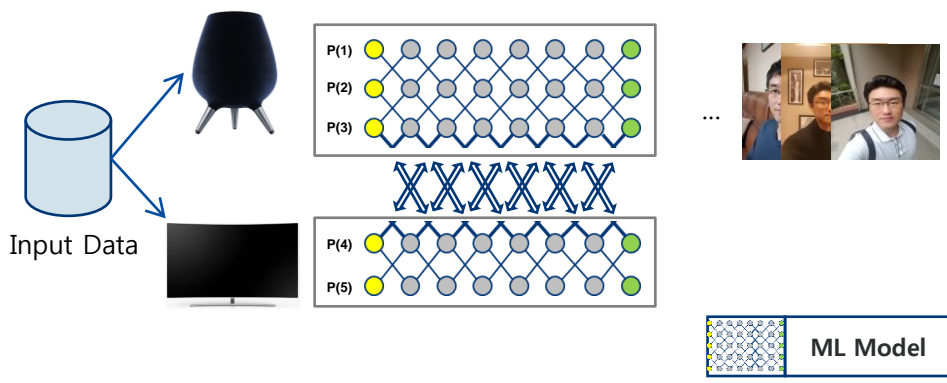
Model Parallelism

ML inference / model learning through multi edge devices

- > Distribution and execution of a single ML model from multi edge devices
- > Model partition w.r.t. the size of ML model, cost of communication, resource



< 4:2 Layer Partition >



< 3:2 Feature Partition Model >

Deeper Dive on the Project that can Connect Use Cases with Functionality

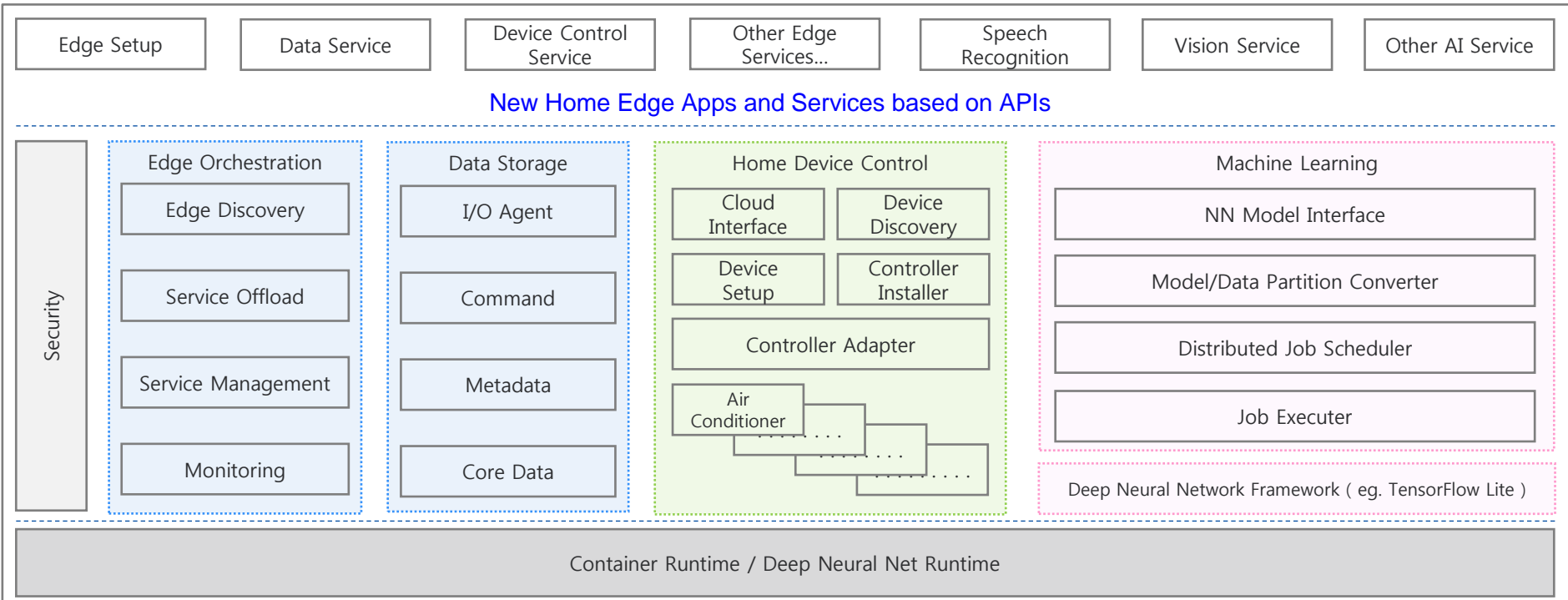
Required Functionalities (1/2) : Edge Orchestration

Key Features	Description
Edge Device / Service Discovery	Discovery on edge devices and their services (e.g. voice recognition, device control, etc.)
Resource Capability Exchange	Exchange the available (computing) resource information (e.g. CPU, GPU, NPU, Storage, type of connected devices, etc.)
Topology Decision	Decision on Master / Slave device roles, devices that are able to interoperate with cloud
Real-time Monitoring	Offers network connection status (e.g. power on / off), services based on (computing) resource at home

Required Functionalities (2/2) : Distributed & Parallel ML

Key Features	Description
Data Parallelism	Distribution and Parallel ML through data partition into multiple edge devices at home
Service Parallelism	Distribution and Parallel ML through multiple services into multiple edge devices at home
Model Parallelism	Distribution and Parallel ML through knowledge model partition into multiple edge devices at home

High-Level Platform Architecture from Functionalities

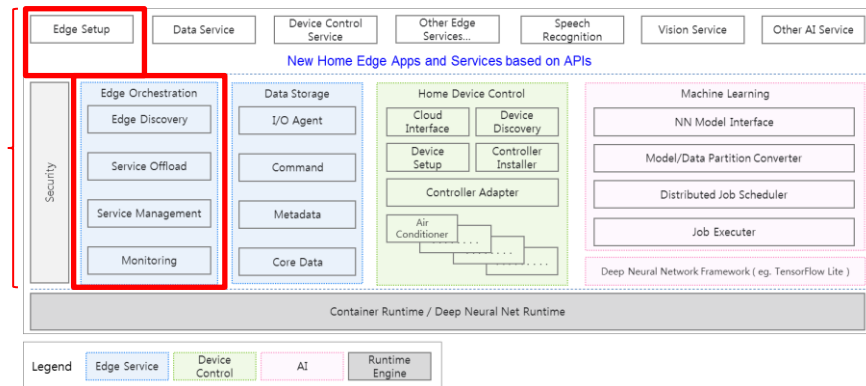


* Samsung seed code is based on EdgeX Foundry that is able to provide real-time, locality, and user privacy for various use cases, initially focused on Orchestration and storage.

Module Description (1/5)

Edge Orchestration Module

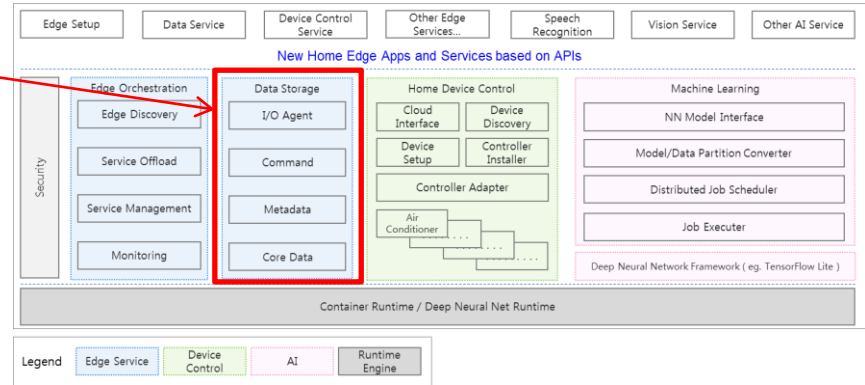
- › Edge Discovery : Find the Home Edge devices in a user's home network.
- › Service Offloading : Re-deploys services to the other Home Edge device for load balancing of device and/or service.
- › Easy Setup : Configures the network info. and user's profile on the Home Edge device.
- › Service Management : Manages lifecycle and replicas of services.
- › Monitoring : Checks and notifies the status of the Home Edge devices and their connected home devices and services in a user's home network.



Module Description (2/5)

Data Storage Module

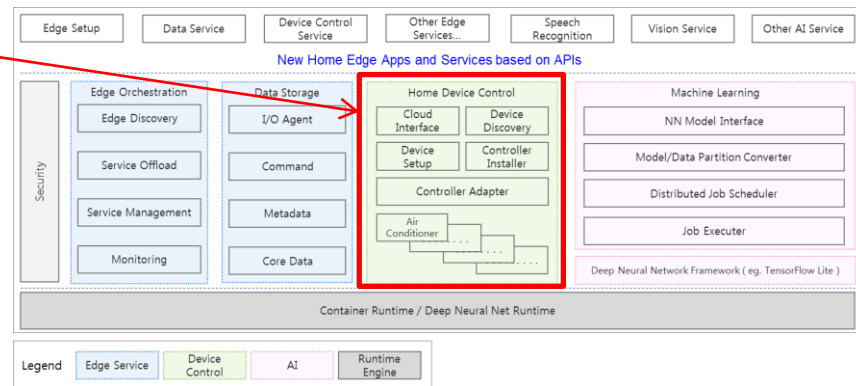
- › Core Data : Provides a persistent storage on the Home Edge device for those collected data from its connected home devices (CE device, sensor, thing) and services.
- › Metadata : Has knowledge about the ID / profile / data of the connected home devices (CE, sensor, thing) and services.
- › I/O Agent : Provides an API for accessing the data storage.
- › Command : Provides a method for getting specific data from the data storage of the Home Edge device by rule-based approach.



Module Description (3/5)

Home Device Control Module

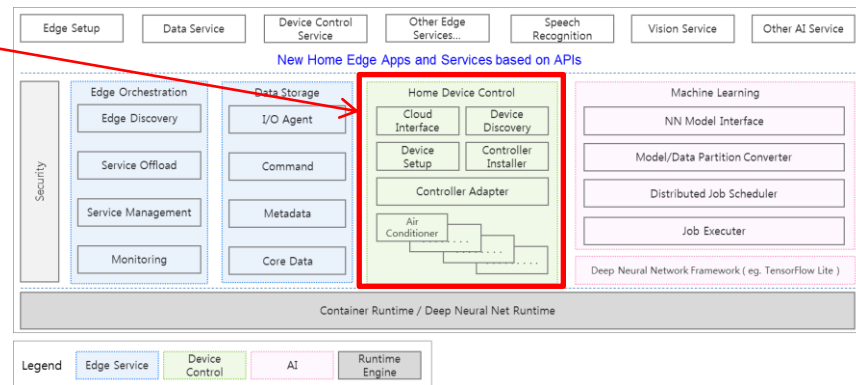
- › Cloud Interface : Provides the interface between cloud services and each home devices in a user's home network.
- › Device Discovery : Finds the connected home devices from the Home Edge device, when the connected home device is found for the first time, their client service will be installed by Controller Installer.
- › Device Setup : Sets the required network information of the connected home device for making it join a user's home network.



Module Description (3/5)

Home Device Control Module (Cont'd)

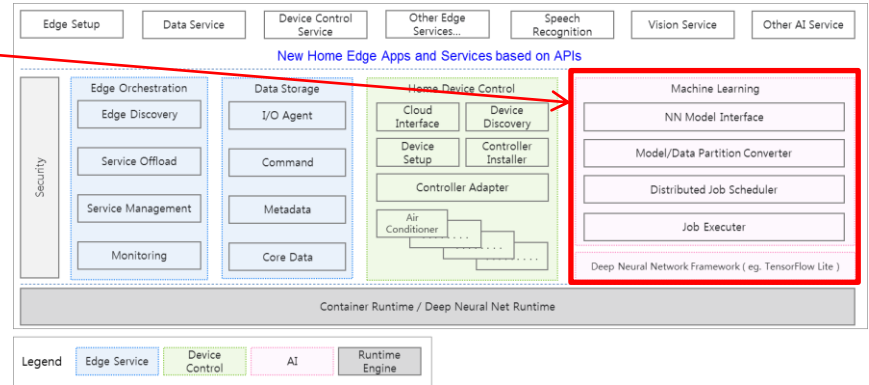
- > Controller Installer :
Installs a client service of the discovered connected home device.
- > Controller Adapter :
Provides unified APIs for the control of the connected home devices.
- > Home Device Client : Controls the connected home devices (e.g. user's refrigerator, washing machine, light bulb, door-lock, HVAC, and temperature sensor).



Module Description (4/5)

Machine Learning Module

- › Neural Network Model Interface : Provides APIs for inference and recognition using (distributed) neural network processing.
- › Model Partition Converter : Divides model for distributed neural network processing.
- › Distributed Job Scheduler : Schedules and allocates distributed job.
- › Job Executer : Executes distributed job on the Home Edge device using Deep Neural Network Framework.



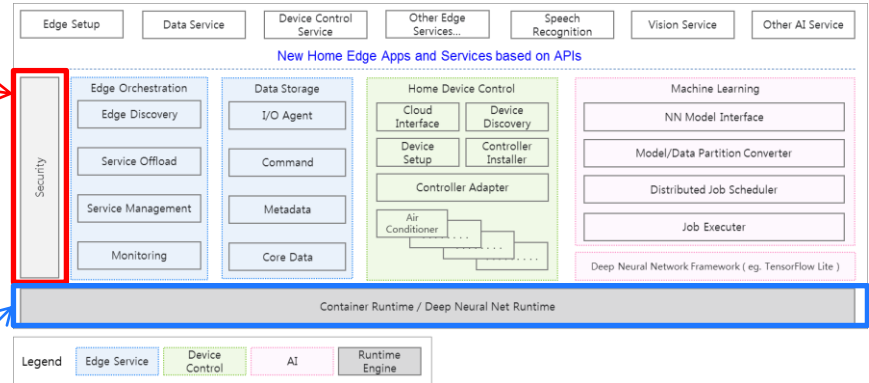
Module Description (5/5)

Security Module

- › Security Module provides security features that the Home Edge devices and service should have to provide, such as secure on-boarding, Certificate, AAA, encryption/decryption of the message protocols, and so on.

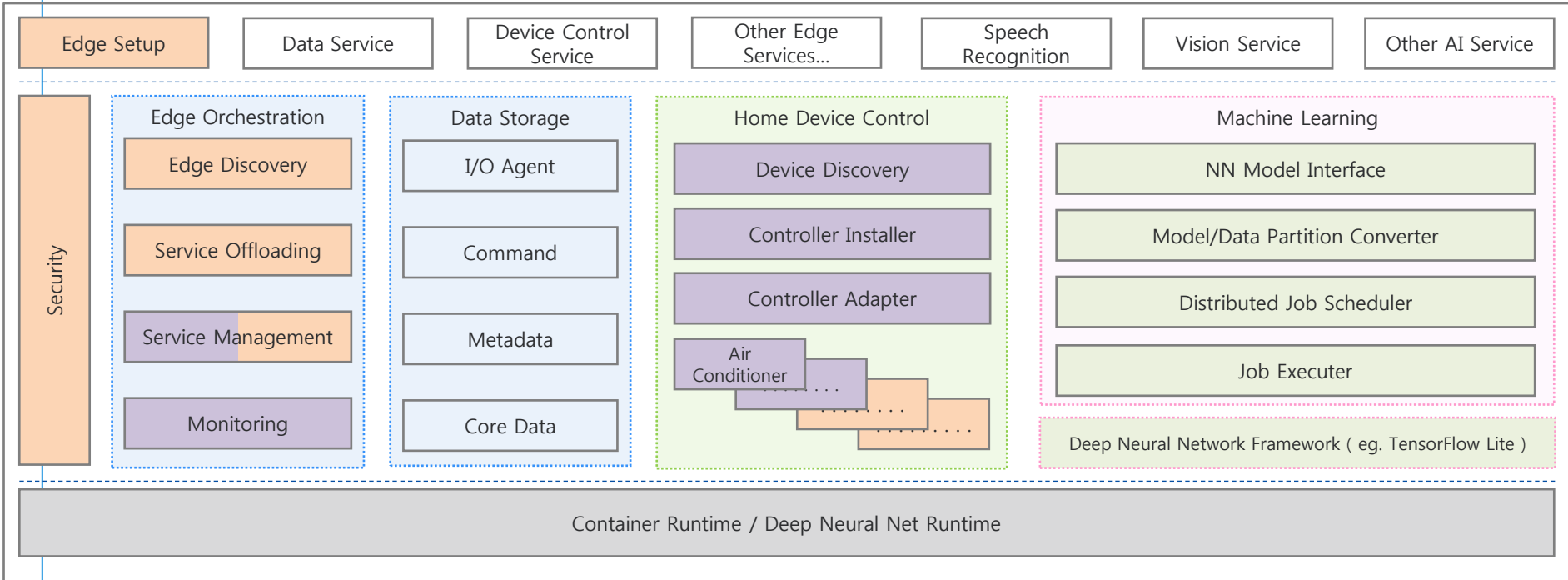
Deep Neural Network Framework

- › Deep Neural Network Framework provides dataflow programming framework for machine learning such as TensorFlow Lite.



Home Edge Possible Candidates or Blueprints

Current Roadmap of the Project (in 2019)



Alpha '19.05 : Can control Home device on the Edge services

V1.0 '19.10 : Can harmonize Multiple Edge on the Home

TOBE

※ Service Management

- Life-cycle management will be released on Alpha.
- Replica management will be released on V1.0.

Potential Code Contributions as “*Super Alpha*”

Home Device Control : Cloud interface, etc.

Data storage : Management of all metadata, I/O agent with cloud services, etc.

Security & data privacy : Data policy management, Identity management, etc.

Machine Learning : Data and model preparation, model deployment, etc.

and...

Within Home Edge and Cross Domain Collaboration

Conventional Smart Home Use Cases with CE devices

In conjunction with Telco business : Smart Home services offering by Telco

Retail solutions at Home

and else...

Possible Collaborations with Other Parts of LF Edge and Members

Collaboration with Other Projects and Members

Top priority : Open to any proposal from members

- › Any forms of contribution : code implementation, documentation, bug fixes, ...

Collaboration Candidates

- › Since our platform architecture philosophy, will strongly collaborate with EdgeX Foundry (through Vertical Solutions Working Group) in terms of :
 - › Requirement and gap analysis feedback
 - › Deployment case study
 - › Backward upstream contribution and syncup
- › Akraino Edge Stack : if in conjunction with MEC use cases
 - › Propose a new Blueprint with potential stakeholders

Need a Liaison?

Smart Home alliances and SDOs (and open source projects)

- › Open Connectivity Foundation
- › OSGi Alliance
- › IoTivity
- › ...

Try to Build a Strawman with
Project Milestones/Releases/etc.

Tiger Team @ Technical Steering Committee

TSC Chair

Community Manager : Documentation, Outreach, Coordination

Release Manager

WG Chairs with respect to the “Module” from the Platform Architecture

Else?