T2TRG: Thing-to-Thing Research Group

IETF 105, July 24, 2019, Montréal

Chairs: Carsten Bormann & Ari Keränen

Note Well

- You may be recorded
- The IPR guidelines of the IETF apply:
  see **http://irtf.org/ipr** for details.

Administrivia (I)

- Pink Sheet
- Note-Takers
- Off-site (Jabber, Hangout?)
  - **xmpp:t2trg@jabber.ietf.org?join**
- Mailing List: **t2trg@irtf.org** — subscribe at: **https://www.ietf.org/mailman/listinfo/t2trg**
- Repo: **https://github.com/t2trg/2019-ietf105**

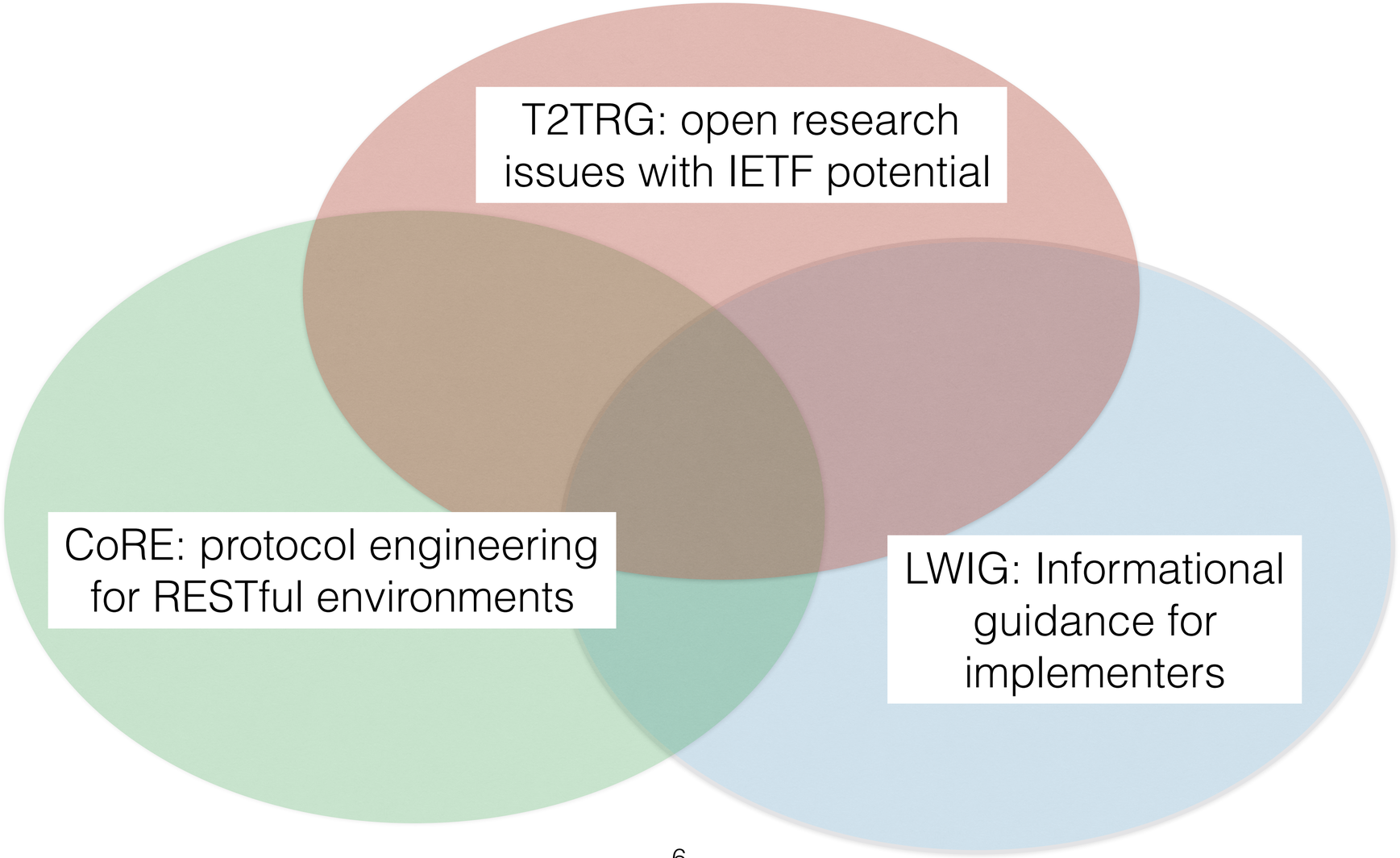
Agenda

Time	Who	Subject	Docs
13:30	Chairs	Intro, RG status, upcoming meetings and activities	RFC8576, draft-irtf-t2trg-rest-iot
13:45	Chairs, various	Report from WISHI, Pre-IETF meeting with OMA, Hackathon, and Morning side meeting	
13:55	Michael Koster	Activities on data model convergence; W3C Community Group on Schema extensions for IoT; schema.org update	
14:15	Michael McCool	W3C Web of Things WG/IG update	
14:30	Ivaylo Petrov	YANG Object Universal Parsing Interface	draft-petrov-t2trg-youpi
14:35	Christian Amsüss	Transports for CoAP: new URI schemes of CoAP protocol negotiation	
14:45	Dirk Kutscher	"Why Edge and IoT will never happen!!1!" (outrageous opinion presentation)	
15:05	Yong-Geun Hong	Problem Statement of IoT integrated with Edge Computing	draft-hong-t2trg-iot-edge-computing
15:20	Yong-Geun Hong	Edge IoT demo	

T2TRG scope & goals

- Open research issues in turning a true "Internet of Things" into reality
  - Internet where low-resource nodes ("things", "constrained nodes") can communicate among themselves and with the wider Internet
- Focus on issues with opportunities for IETF standardization
  - Start at the IP adaptation layer
  - End at the application layer with architectures and APIs for communicating and making data and management functions, including security

IRTF and IETF?



Recent/related activities

- Work on IoT/Semantic Hypermedia Interoperability (WISHI):
  ~monthly calls and hackathon

- Friday meeting with OMA SpecWorks at IETF 105

- T2TRG work meeting: Wednesday 08:30..09:45.
  Several small items; focus on secured L3 setup for Things,
  “Closed Device Groups” (Erik Nordmark)

- Hypermedia/CoRE Applications: Tuesday 15:00..17:00.
  Mostly discussed new design for the CoRE pub/sub application

Next meetings

- Regular WISHI calls (~ monthly?)
- Virtual meetings with OCF?
- Virtual meetings with OMA SpecWorks (LwM2M & IPSO)?
- Singapore IETF 106 (Nov 16-22)
  - WISHI hackathon Sat/Sun, July 20/21
- Co-locating with academic conferences 2019 & 2020?

Singapore IETF and local collaboration

- Using meetings in specific communities as an opportunity to connect
- IETF106: Singapore
- One obvious point of contact: Singapore “Smart Nation” project
  - They have some requirements on standardization
- Friday T2TRG work meeting?

What is business-as-usual?

To deliver city-level data availability for industry and public by 2022, Smart Nation Platform Solutions must be able to demonstrate ability to:

- Standardise, collect and aggregate IOT data at scale
- Guarantee the data comes from authenticated and authorized sources
- Secure the platform end-to-end
- Create immutable records
- Show relevant and sustainable use cases

RG Doc Status

- “State-of-the-Art and Challenges for the IoT Security” published as RFC8576!

RG Doc Status

- “RESTful Design for IoT” (next slide)
- Upcoming:
  - Edge & IoT (presented later today)
  - Secure Bootstrapping for IoT (next slides)
  - CoRE apps, collections part from CoRE interfaces
  - Layer 3 considerations?
  - WISHI notes (see WISHI wiki)

RESTful Design for IoT

- Bunch of small additions / edits done
  - more IoT specifics (commonly constrained servers & dual roles)
  - better and more references
  - server push clarifications & alignment with CoRE dynlink draft
- ToDo: affordances & CoRAL details
- Discovery in IoT? Aligned with CoRE interfaces & RD

Secure Bootstrapping for IoT

- RFC 8576 identifies secure bootstrapping as one of the key challenges for IoT devices
- Plans on future work
  - Document device bootstrapping terminology and relationships: onboarding, commissioning, configuration, setup, initialization
  - Identify common design assumptions, architectural components and underlying protocols that device configuration methods use
  - Investigate the benefits and challenges of EAP for IoT

Work on IoT Semantic/Hypermedia Interoperability (WISHI)

- Two online meetings since IETF104: research agenda & hackathon planning
- Research Agenda topics
  - Modeling data and interaction
  - REST-based hypermedia
  - Connectivity for IoT
  - In-network and edge computing
  - Security
  - Terminology

WISHI hackathon results

- 6th WISHI IETF Hackathon
- ~9 participants (2 remotely)
- Two focus areas
  - IoT Data Model convergence
  - Hypermedia for IoT (and coffee)

IoT Data Model converge

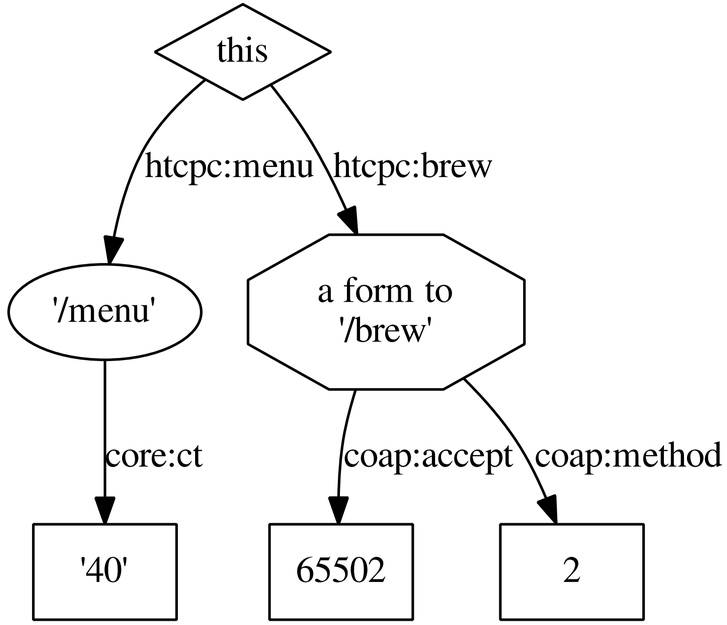
- Using One Data Model (OneDM) Simple Definition Format (SDF) for data and model interchange
  - Improved automatic conversion of IPSO/LwM2M models to SDF
  - Improvement suggestion for SDF data types, schema, constraints
  - Tool generating SDF schema in CDDL
- Proposed JSON format for CoRAL

Binary data extraction

- Problem statement for binary data extraction
- Playground deployment
- "YANG Object Universal Parsing Interface": draft-petrov-t2trg-youpi (presented later)

Brewing coffee with hypermedia

- Reference scenario: Carrier-Grade Coffee Machine
  - Discover and describe coffee machine
  - Discover menu options
  - Make coffee selections
  - Brew
- Two open source implementations using CoRAL and CoAP:
  - RIOT OS (running on SAMR21-xpro board)
  - Python (micrurus)



Friday meeting with OMA

- LwM2M tutorial
- Object registry & LwM2M v1.2 requirements
- OMA-IETF document dependencies
  - RD, Dynlink, CoAP over SMS, SenML registry, ...
- Unconference discussions
  - Data model convergence (LwM2M, OneDM, etc.)
  - Role of hypermedia formats (CoRE link format, CoRAL) in LwM2M
  - Access control modeling
- All materials and notes available in the meeting Github

IoT Data Model Convergence

IETF105

July 24, 2019

IoT Extensions for schema.org

- Extend schema.org to accommodate IoT semantics
- Develop models for sensors and actuators as a first step
  - With connecting semantics to Features of Interest
- Based on a popular emerging meta-model
  - Properties, Actions, Events => Capabilities
- Community contribution process in development
  - Modeled after schema.org

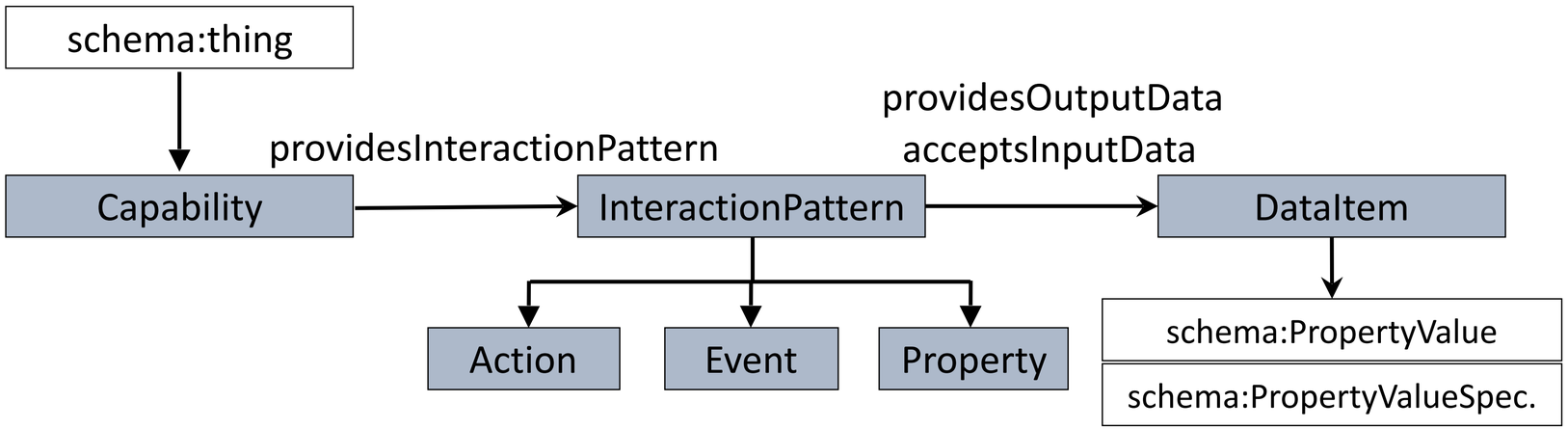
iotschema Meta-model

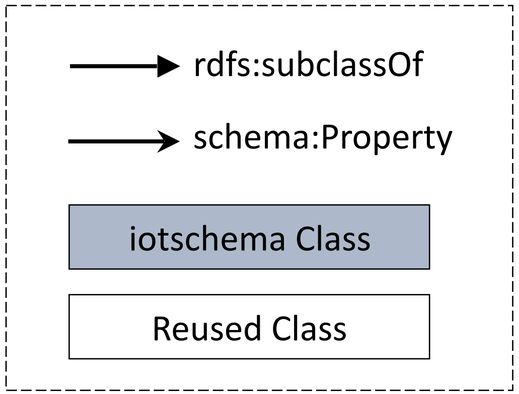
- Semantic model for interaction affordances
- Property
  - Readable and optionally writeable state element
- Action
  - A parameterized incoming state change with rich responses
- Event
  - A parameterized outgoing state change
  - Also can be a message describing a happening
  - Can be delivered asynchronously, proactively

iotschema Meta-model

- Capability
  - A set of Properties, Events, and Action definitions that provide common interaction affordances
  - Related to providing a function of limited scope
  - Defined with semantic meaning
  - For example: on/off control, temperature measurement, thermostatic temperature control,
  - Could be larger aggregations, e.g. air conditioner
- Data Types
  - Associate semantic meaning with data constraints
  - For Example, Temperature data, allowed units, number type

iot.schema.org Categories/Classes



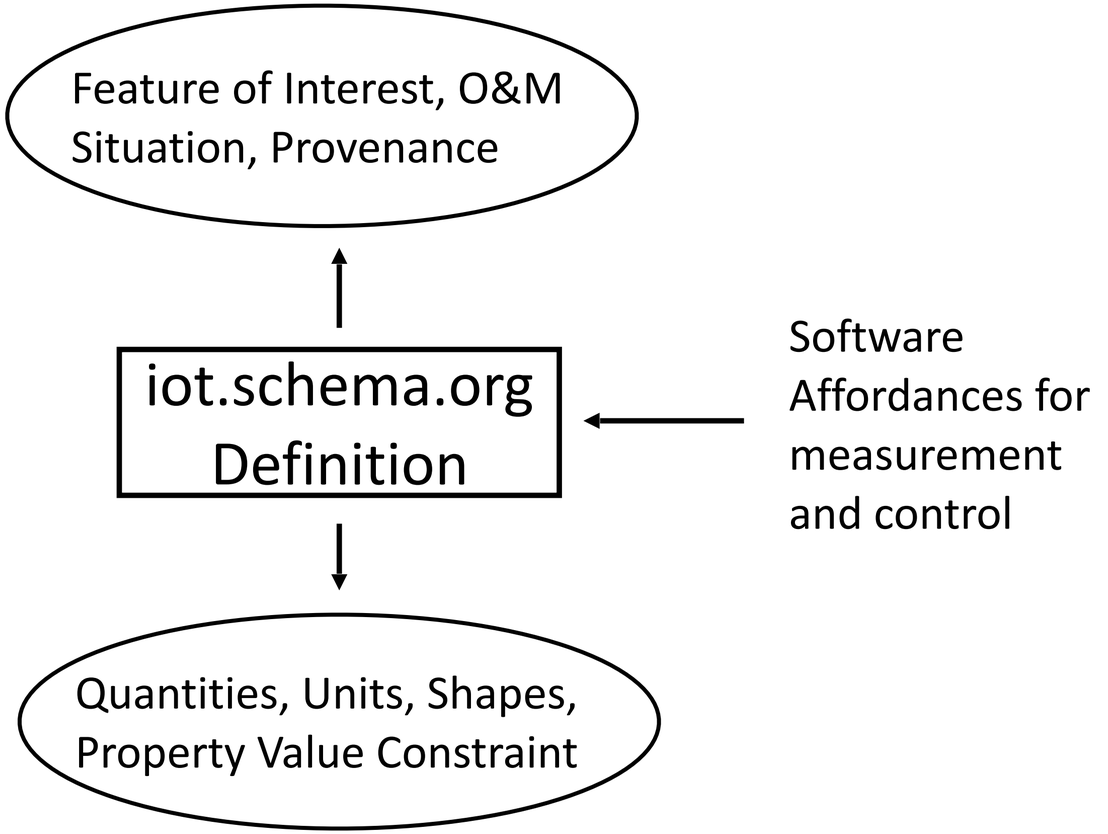


iot.schema.org Conceptual Integration with other ontologies

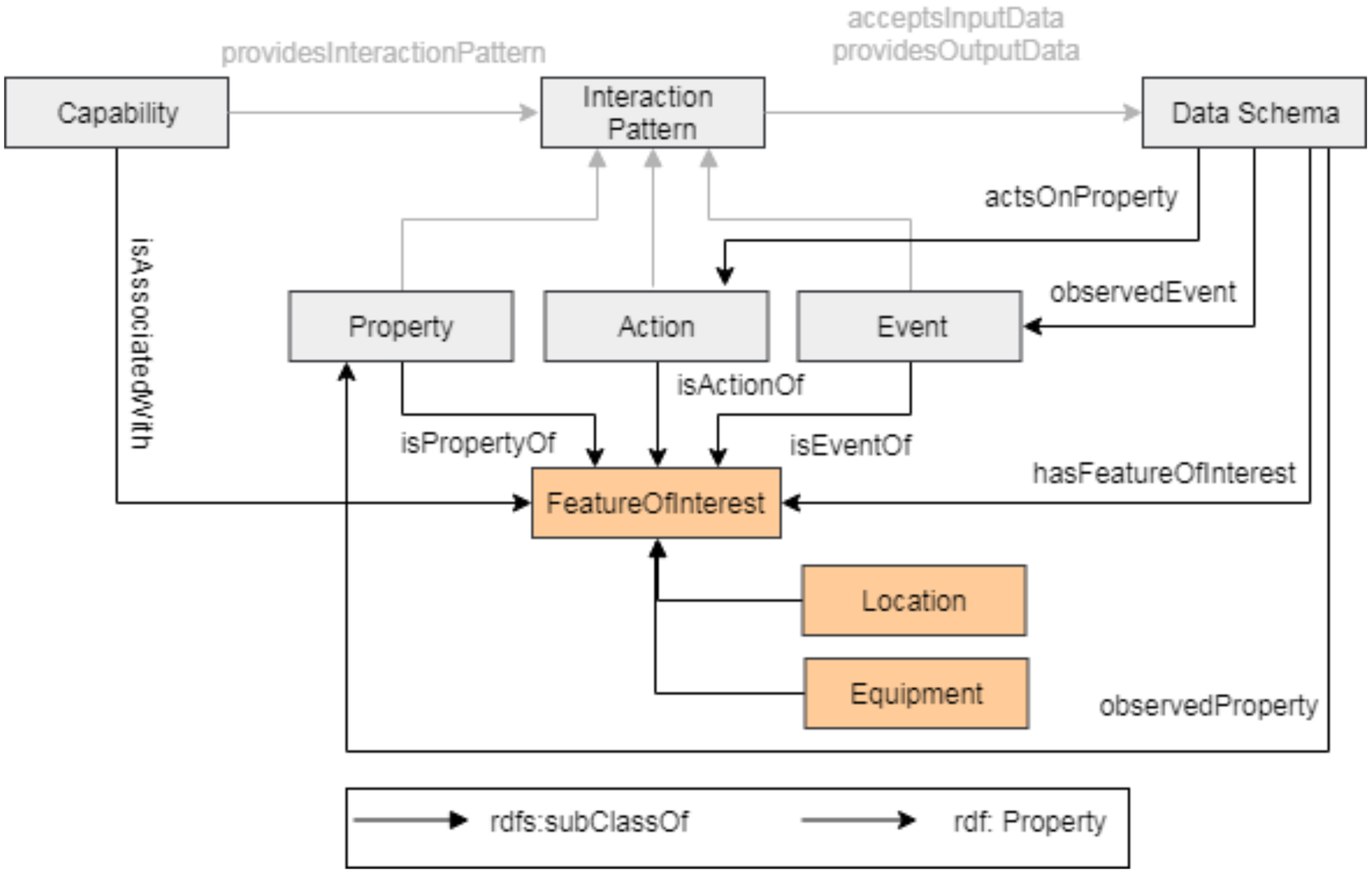
- Feature of Interest concepts and property types to describe location, equipment, or other classifiers
- For example, BrickSchema definitions from Haystack, GENIVI for Automotive FoI
- Quantity and Units constraints can use QUDT concepts and appropriate identifiers
- SSN, SOSA, SAREF concepts can extend a definition
- Definitions and instances may be annotated using RDF

Integration with other Ontologies

Enables Well-Characterized interactions with Physical Entities



Feature of Interest Properties



Status

- Prototype definitions in JSON-LD are online in an experimental namespace
- Used in W3C WoT work for semantic interoperability
- High level interoperability demonstrations using Node-RED
- Forms based submission option in development
- W3C Community Group started for contributions
- Monthly teleconferences

One Data Model

- Emerging activity to drive data model convergence across various SDOs, vendors, and other organizations
- Developing a common definition language that can describe diverse device descriptions
- Not an API description, depends on Protocol Binding to map to network resources
- Using a similar/same meta-model as iotschema
- The language can be used to create iotschema definitions

```
{
  "info": {
    "title": "Example file for ODM" ,
    "version": "20190424",
    "copyright": "Copyright 2019 Example Corp.",
    "license": "http://example.com/license"
  },
  "namespace": {
    "st": "http://example.com/st/#"
  },
  "defaultnamespace": "st",
  "odmObject": {
    "Switch": {
      "odmProperty": {
        "value": {
          "type": "string",
          "enum": ["on", "off"]
        }
      },
      "odmAction": {
        "on": {},
        "off": {}
      }
    }
  }
}
```

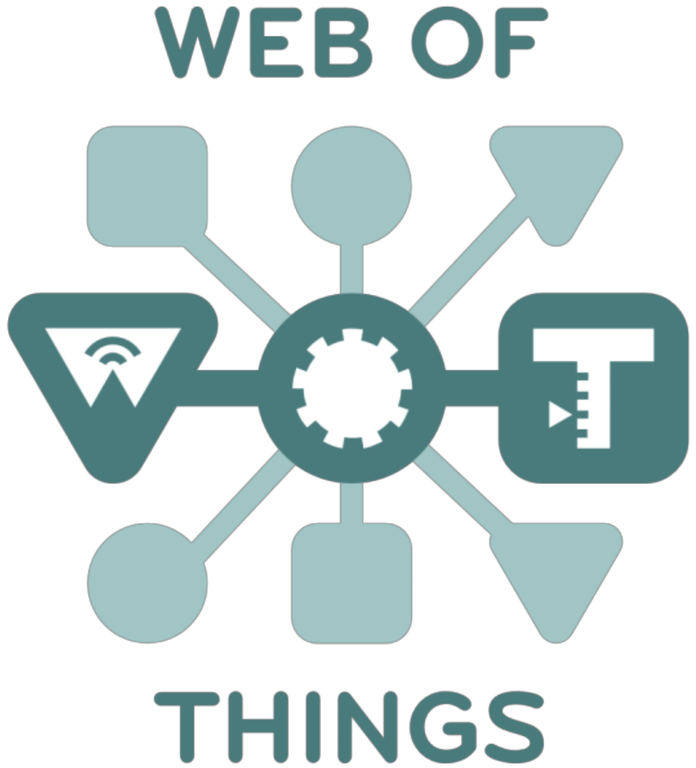
One Data Model Example (JSON)

```
info {
  title "Example file for ODM Simple JSON Definition Format"
  version "20190424"
  copyright "Copyright 2019 Example Corp.
             All rights reserved."
  license http://example.com/license
}
namespace {
  st http://example.com/st/#
}
defaultNamespace st
odmObject {
  Switch {
    odmProperty {
      value {
        type string
        enum [on off]
      }
    }
    odmAction {
      on {}
      off {}
    }
  }
}
```

One Data Model Example

ODM Status

- About 6 months into the activity
- Operating under a set of liaison agreements
- Weekly teleconferences
- Language definition is progressing
- The language is being tested against models from various SDOs and organizations
- Participation from several members of T2TRG



W3C WoT Update

IETF 105 T2TRG

Montreal Canada July 2019

W3C Web of Things

Goal: Support IoT Interoperability via Open Standards

- **W3C WoT Interest Group (IG)**
  https://www.w3.org/2016/07/wot-ig-charter.html
  - Started spring 2015
  - ~200 participants
  - Informal work and outreach
  - “PlugFest” validation with running code
  - Exploration of new building blocks
  - “OpenDays” with external speakers
  - Liaisons and collaborations with other organizations and SDOs
  - ***Second Workshop on Web of Things held 3-5 June 2019 in Munich***

- **W3C WoT Working Group (WG)**
  https://www.w3.org/2016/12/wot-wg-2016.html
  - Started end of 2016 (effectively Feb 2017)
  - ~100 participants
  - Normative work on specific deliverables
  - W3C Patent Policy for royalty-free standards
  - Only W3C Members and Invited Experts
  - ***Architecture and Thing Description were published as Candidate Recommendations on 16 May 2019***
  - ***Notes published on Protocol Bindings, Security, and Scripting API***

W3C Web of Things – Building Block Approach

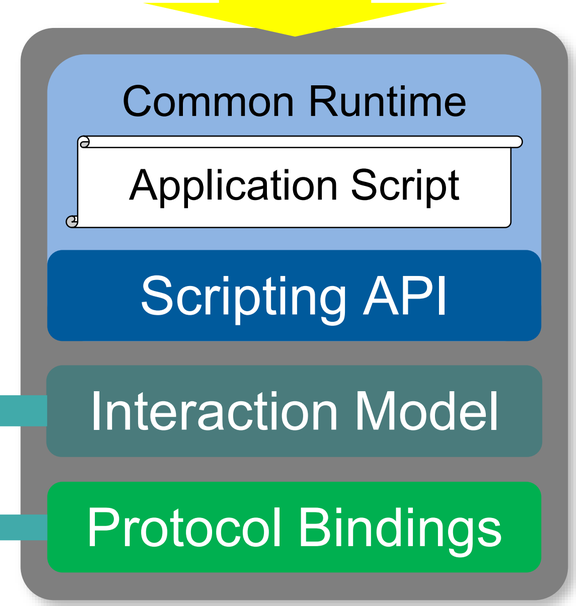
WoT Architecture

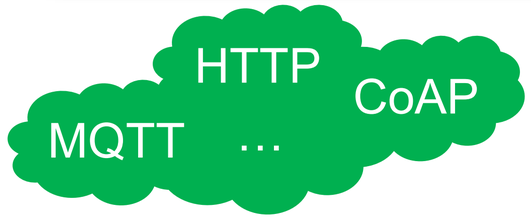
Overarching umbrella with architectural constraints and guidance on how to use and combine building blocks.

WoT Thing Description (TD)

JSON-LD representation format to describe Thing *instances* with **metadata**. Uses **formal interaction model** and **domain-specific vocabularies** to uniformly describe how to use Things, which enables semantic interoperability.

Security Guidelines





WoT Scripting API

Standardized **JavaScript** object API for an IoT runtime system **similar to the Web browser**. Provides an interface between applications and Things to simplify IoT application development and enable **portable apps** across vendors, devices, edge, and cloud.

WoT Binding Templates

Capture how the **formal Interaction Model** is mapped to concrete protocol operations (e.g., CoAP) and platform features (e.g., OCF). These templates are re-used by concrete TDs.

W3C Web of Things – Building Block Approach

REC Track

WoT Architecture

Overarching umbrella with architecture constraints and guidance on how to use and combine building blocks.

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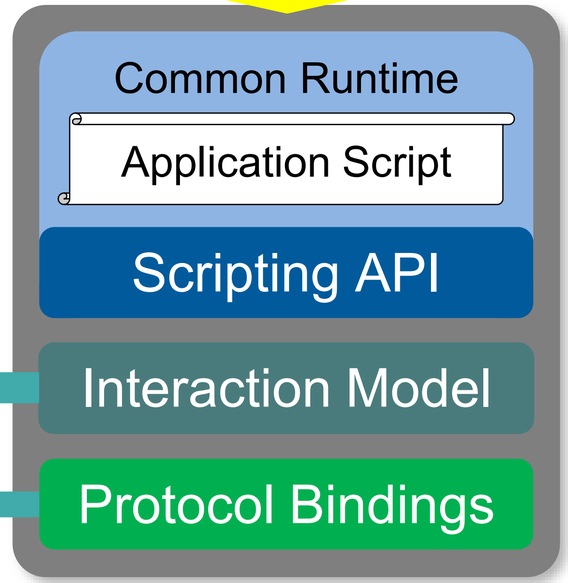
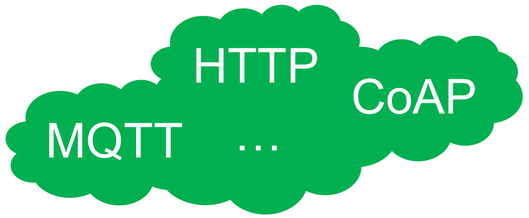




WoT Scripting API

WG Note

Standardized **JavaScript** object API for an IoT runtime system **similar to the Web browser** interface between applications to simplify IoT application development and enable **portable apps** across vendors, devices, edge, and cloud.

WoT Binding Templates

Capture how the **formal Interaction Model** is mapped to concrete protocol operations (e.g., CoAP) and platform features (e.g., OCF). These templates are re-used by concrete TDs.

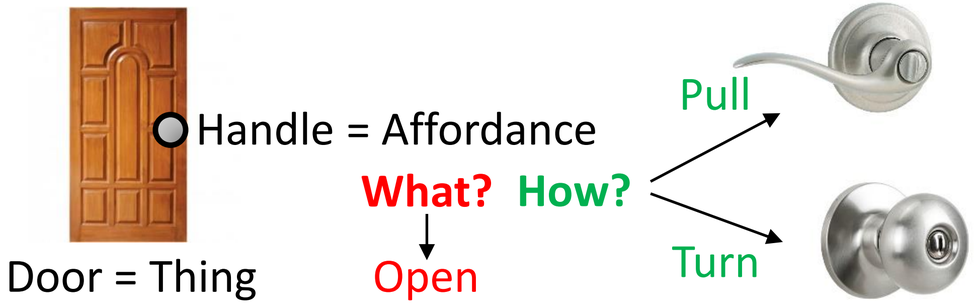
Published Candidate Recommendations

- **WoT Architecture**
  - Constraints that define the difference between IoT and W3C WoT
  - Definition of Interaction Affordances
  - Definition of Web forms
  - Use cases and requirements
  - Terminology
  - Interplay of W3C WoT building blocks
  - Examples

- **WoT Thing Description (TD)**
  - Information model & representation format for Thing metadata, generic data model, and hypermedia-based interface desriptions
  - Namespace and vocabulary definitions
  - Parsing and serialization rules
  - Extension points
  - Examples

Published Candidate Recommendations

- **WoT Architecture**
  - Constraints
    - Things must have TD (W3C WoT)
    - Must use hypermedia controls (general WoT)
      - URIs
      - Standard set of methods
      - Media Types
  - Interaction Affordances
    - Metadata of a Thing that shows and describes the possible choices (what) to Consumers, thereby suggesting how Consumers may interact with the Thing



- **WoT Thing Description (TD)**

```
{
  "@context": [
    "https://www.w3.org/2019/wot/td/v1",
    { "iot": "http://iotschema.org/" }
  ],
  "id": "urn:dev:org:32473:1234567890",
  "name": "MyLEDThing",
  "description": "RGB LED torchiere",
  "@type": ["Thing", "iot:Light"],
  "securityDefinitions": ["default": {
    "scheme": "bearer„
  }],
  "security": ["default"],
  "properties": {
    "brightness": {
      "@type": ["iot:Brightness"],
      "type": "integer",
      "minimum": 0,
      "maximum": 100,
      "forms": [ ... ]
    }
  },
  "actions": {
    "fadeIn": {
      ...
```

Published WG Notes

- **WoT Security and Privacy Guidelines**
  - Details beyond the security considerations in each specification for a holistic security and privacy configuration of Things
  - Security testing plan
- **WoT Binding Templates**
  - Documetation for how to describe existing IoT ecosystems (e.g., OCF or generic Web) with WoT Thing Description
- **WoT Scripting API**
  - Proposal for a standard API to consume and produce WoT Thing Descriptions
  - Provides interface between applications and network-facing API of IoT devices (cf. Web browser APIs)
  - Documents learnings from the design process

Status and Recent Developments

- Decision to adopt JSON-LD 1.1 proposed features to allow:
  - Default values
  - Object notation (name: value) instead of arrays
  - More similarity to common JSON practices
- Security metadata
  - Focus on HTTPS (Basic Auth, Digest, Tokens, OAuth2)
- Protocol Bindings
  - Focus on HTTP and structured payloads compatible with JSON
  - Support for Events also using subprotocols (e.g., long polling in HTTP)
- Extension Points
  - CoAP(S), MQTT(S), and further security schemes (e.g., ACE)
  - Semantic annotations with custom vocabularies (JSON-LD @context and @type)

W3C WoT Summary

- Counter fragmentation in the IoT
  - Web of Things to Internet of Things is similar to the Web to Internet relation
  - Narrow waist: common interaction model and metadata description
  - Take patterns from the World Wide Web and adapt and apply them to the IoT

    - JSON Schema and Linked Data
    - URIs and Media Types
    - JavaScript runtime

- By describing and complementing
  - Not competing with existing IoT standards, as not prescribing a full-stack solution
  - Instead, *describes* existing solutions so they can work with each other (interoperate)
  - W3C WoT defines common building blocks to enable semantic interoperability
    - WoT Thing Description (TD)
    - WoT Binding Templates
    - WoT Scripting API

W3C WoT Resources

- W3C WoT Wiki
  - https://www.w3.org/WoT/IG/wiki
    (IG/WG organizational information)
- W3C WoT Interest Group
  - https://www.w3.org/2016/07/wot-ig-charter.html
    (charter)
  - https://lists.w3.org/Archives/Public/public-wot-ig/
    (mailing list)
  - https://github.com/w3c/wot
    (technical proposals)
- W3C WoT Working Group
  - https://www.w3.org/2016/12/wot-wg-2016.html
    (charter)
  - https://www.w3.org/WoT/WG/
    (dashboard)

- W3C WoT Candidate Recommendations
  - https://www.w3.org/TR/wot-architecture/
  - https://www.w3.org/TR/wot-thing-description/
- W3C WoT Working Drafts / Group Notes
  - https://www.w3.org/TR/wot-binding-templates/
  - https://www.w3.org/TR/wot-scripting-api/
  - https://www.w3.org/TR/wot-security/
- W3C WoT Editors' Drafts and Issue Tracker
  - https://github.com/w3c/wot-architecture/
  - https://github.com/w3c/wot-thing-description/
  - https://github.com/w3c/wot-binding-templates/
  - https://github.com/w3c/wot-scripting-api/
  - https://github.com/w3c/wot-security/
- Reference Implementation: node-wot
  - https://github.com/eclipse/thingweb.node-wot

Contacts

https://www.w3.org/WoT/WG/

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“Transport Design Team”

Transports for CoAP

new URI schemes of CoAP. protocol negotiation

Bill Silverajan, Klaus Hartke, Ines Robles, *Christian Amsüss*

2019-07-24

“Mini-charter”

G1 Define CoAP over SMS (work in CoRE)

G2 Single scheme for all transports (avoiding URI aliasing)

G3 Announcing the active transports (allow transport switchovers)

“Mini-charter”

G1 Define CoAP over SMS (work in CoRE)

- So we’re ready for other non-IP ones (NB-IoT, slipmux, . . .)
- Starting from old `coap-over-sms` and OMA LwM2M input

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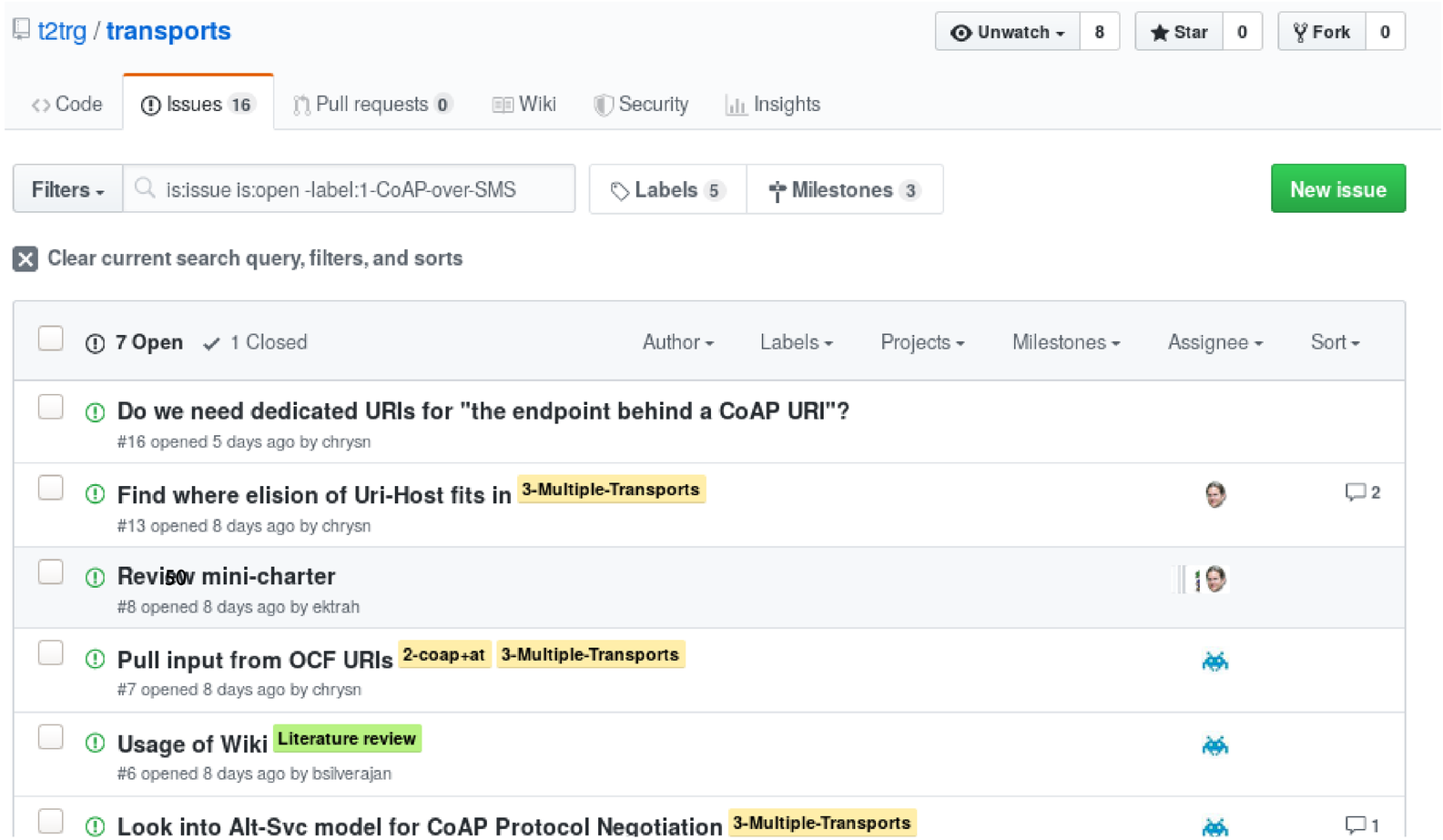
G3 Announcing the active transports (allow transport switchovers)

- Starting[49] from `protocol-negotiation`

Participation appreciated

https://github.com/t2trg/transports



draft-petrov-t2trg-youpi

Ivaylo Petrov <ivaylo@ackl.io>

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Problem statement

- Discussed during the WISHI hackathon
- LPWAN and other very constrained networks use proprietary binary formats (including Modbus)
- Other systems can not easy interoperate with those
- Needs a format to express their binary payloads and be able to reformat it as CBOR/JSON/JSON-LD/XML/something else

What it is

```
...
    typedef battery-level {
        type decimal64 {
            fraction-digits 2;
            range "3 .. 4.2";
        }
        description "CHANGEME";
        units "<units uri>";
        youpi:units-subject "<item id>";
    }
   ...
    leaf battery {
        type battery-level;
        youpi:position "8..11 | 7";
        youpi:multiplier "0.05";
        youpi:offset "54";
    }
```

```
...
choice data {
  case _temp {
    container button-data {
      leaf temp {
        type uint8;
        youpi:position "relative 24..29";
        youpi:multiplier "2";
        youpi:offset "54";
        youpi:multiplier "3";
      }
    }
  }
  ...
  youpi:condition "mode";
}
```

Steps forward

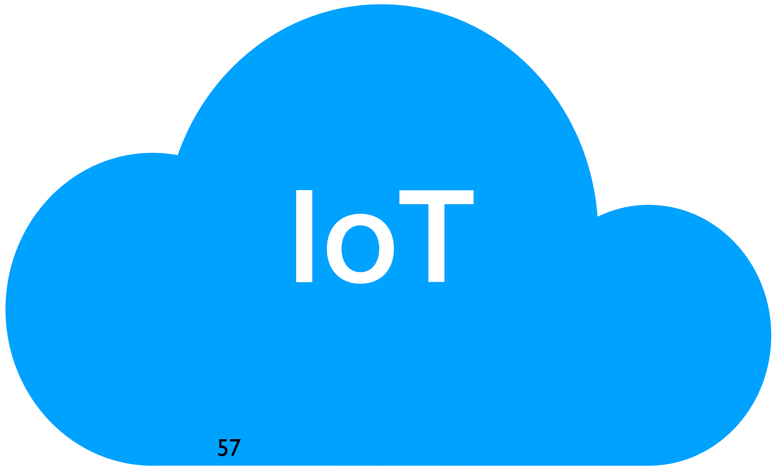
- Check interest
- Try to write models for different specific use cases in order to make sure every important case is supported
- Take it from there

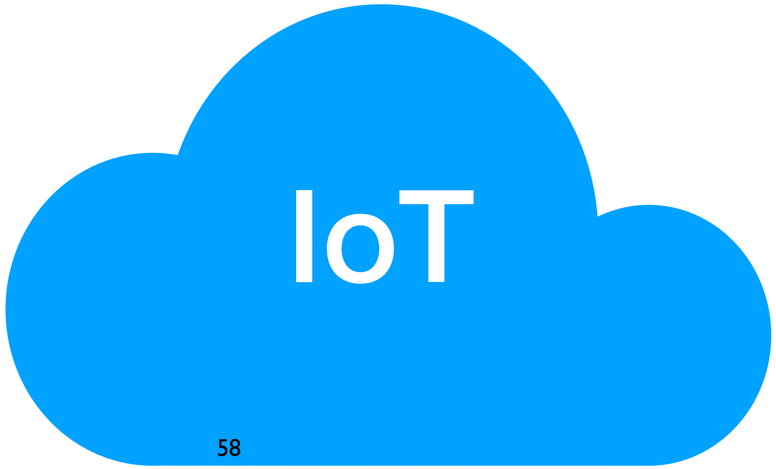
Questions and answers

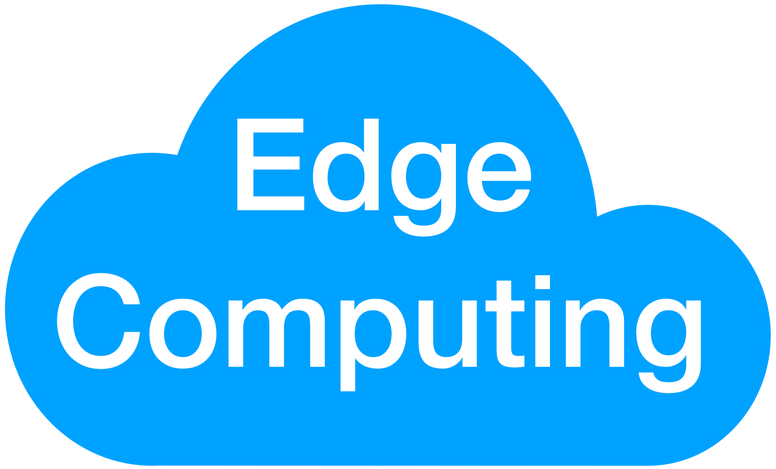
Thank you!

Why Edge Computing for IoT Will Never Happen

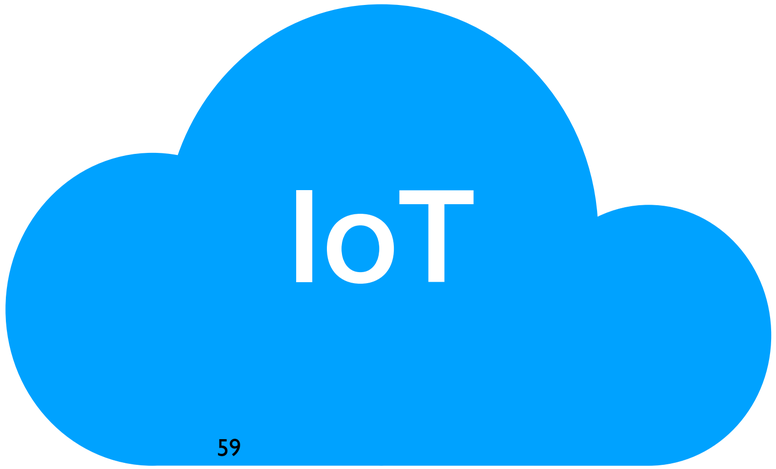
Dirk Kutscher
University of Applied Sciences Emden/Leer

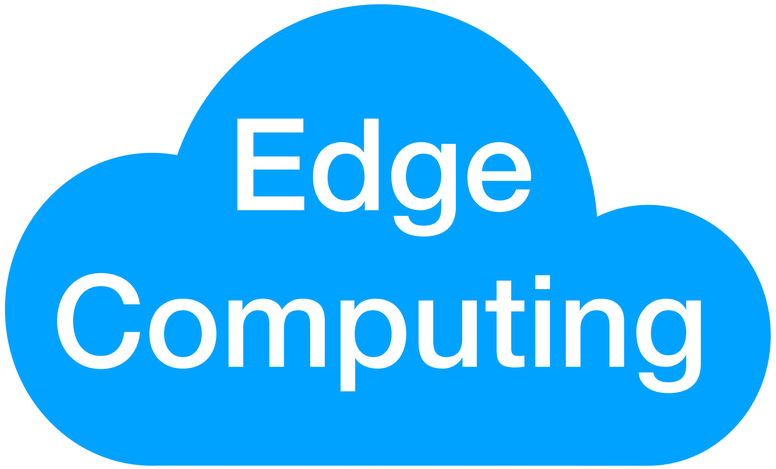

IoT


IoT


Edge
Computing

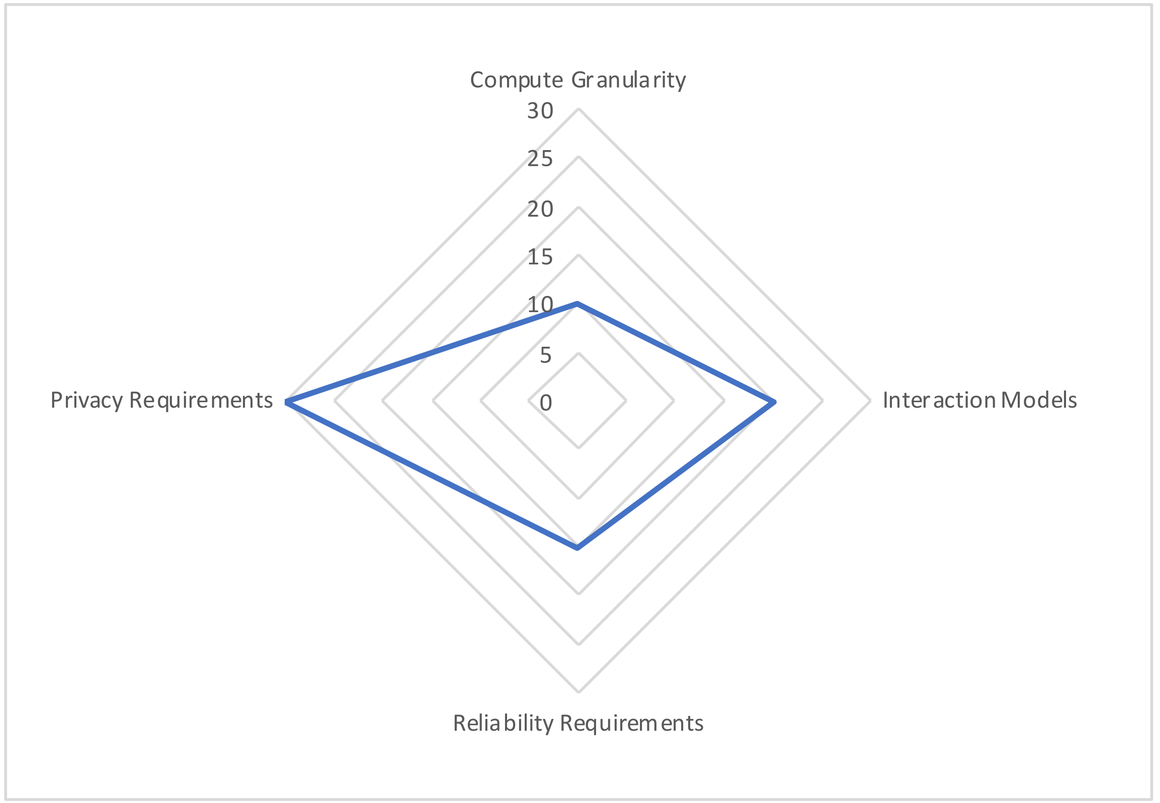
Bingo!



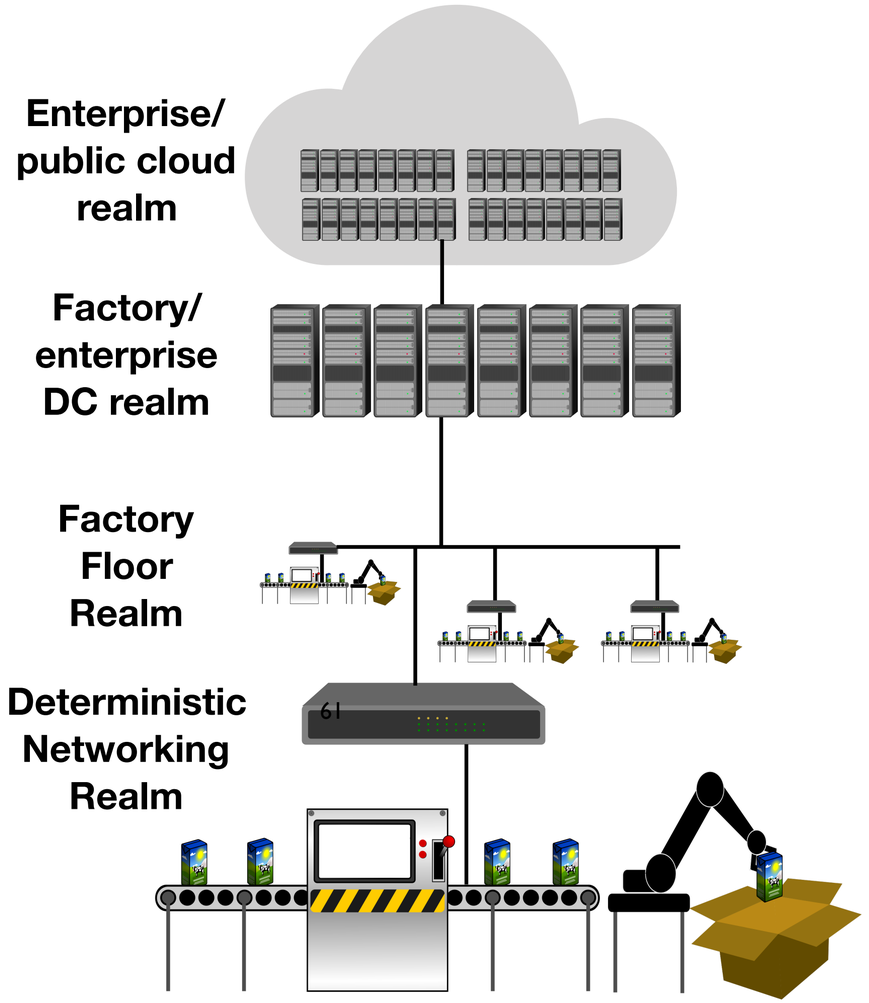


IoT

- Industrial IoT
- Home networks
- Smart City
- Agriculture
- Automotive



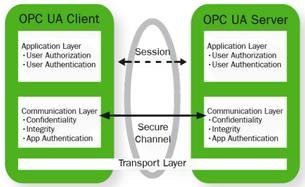
Example: Industrial IoT



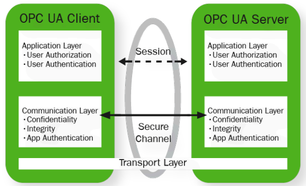
MQTT.ORG

AMQP Advanced Message Queuing Protocol

Data analytics, archival



Cloudified control apps (virtual PLC etc.)



Data exchange & control (OPC UA, DDS)

Ethernet Time Sensitive Networking (TSN)

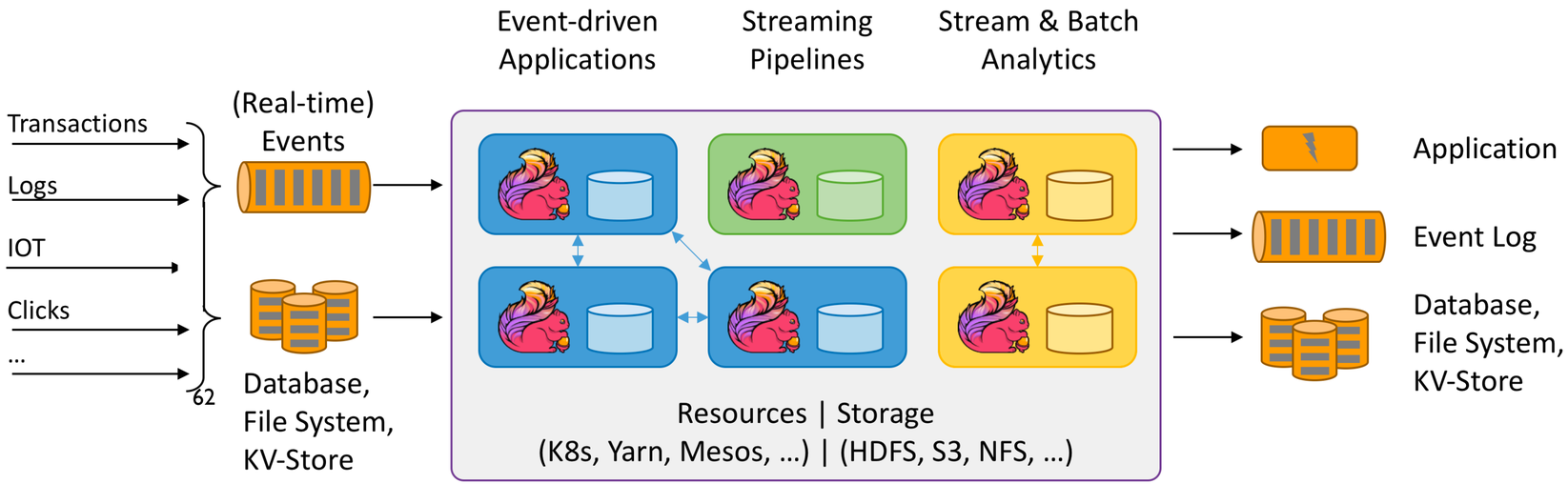
Standard	Description
802.1ASrev	Timing & Synchronization
802.1Qbv	Enhancements for Scheduled Traffic (Timed Gates for Egress Queues)
802.1Qbu	Frame Preemption
802.1Qca	Path Control and Reservation
802.1Qcc	Central Configuration Management
802.1Qci	Per-Stream Time-based Ingress Filtering and Policing
802.1CB	Redundancy, Frame Replication & Elimination

PROFIBUS • PROFINET

EtherCAT Technology Group

Etc

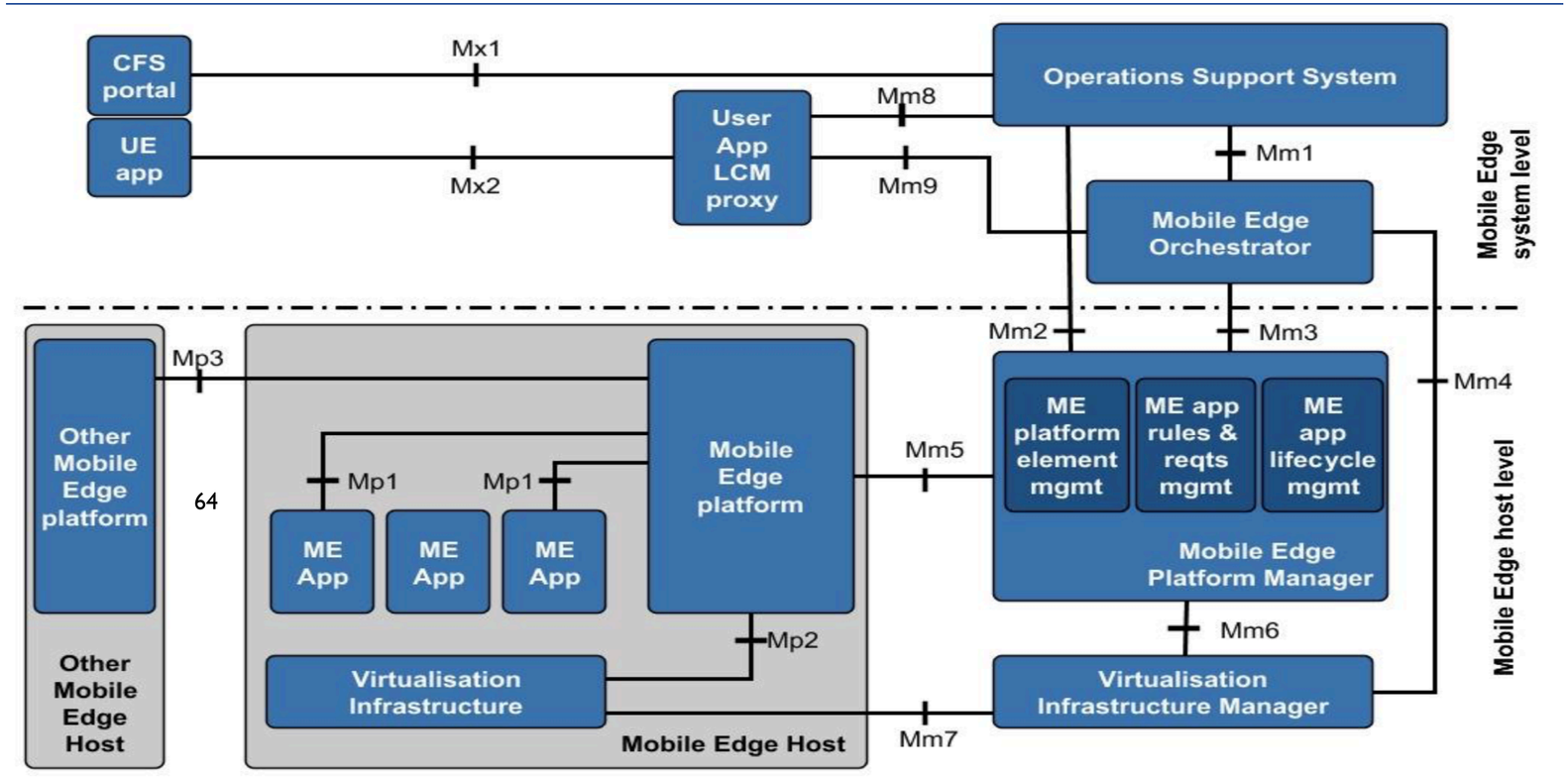
Example:
IoT Data Processing



Technical Criteria of Interest

- What are the interaction models?
  - I.e., stateless functions vs. server/actor model
- What are the objects of computation?
  - I.e., packets/flows, Application Data Units etc.
- What are the programs?
  - (Mobile)[63] code
- What is the security & trust model?
  - Postponing that discussion not acceptable

Edge Computing — Too Broad



Hannu Flinck: https://datatracker.ietf.org/meeting/98/materials/slides-98-nfvrg-sessb-12-multi-access-edge-computing-mec-applications-00

Do You Mean…

- Virtualized gateway platforms?
- Cloud-to-edge continuum?
- Compute offload in constrained networks?
- Distributed computing, stream processing?

Often, Edge Computing
seems to refer to Cloud Computing
with additional compute pods
outside a data center

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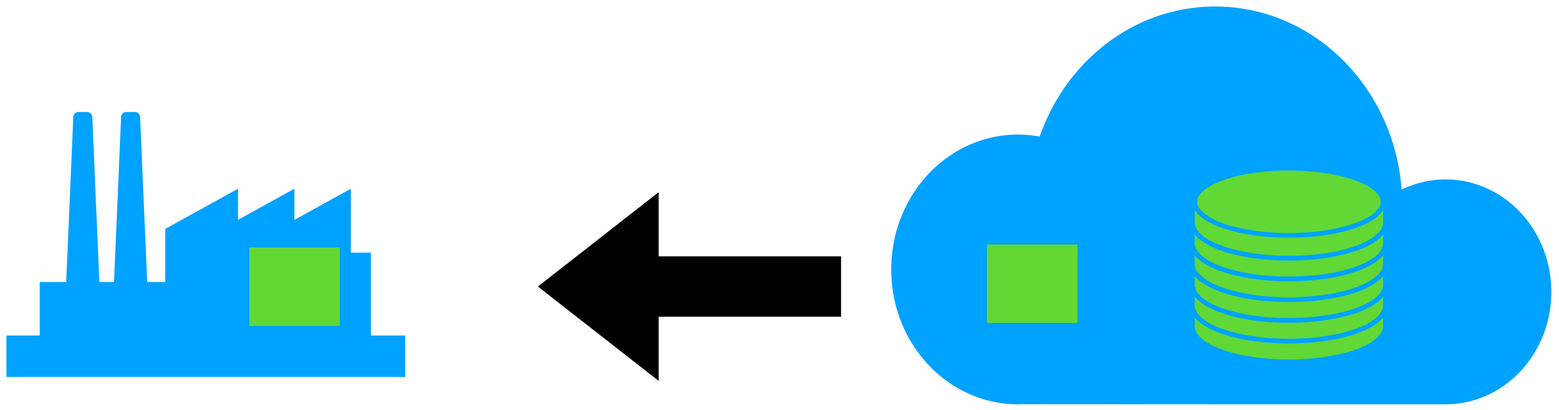
Is Edge Computing the Best Term?



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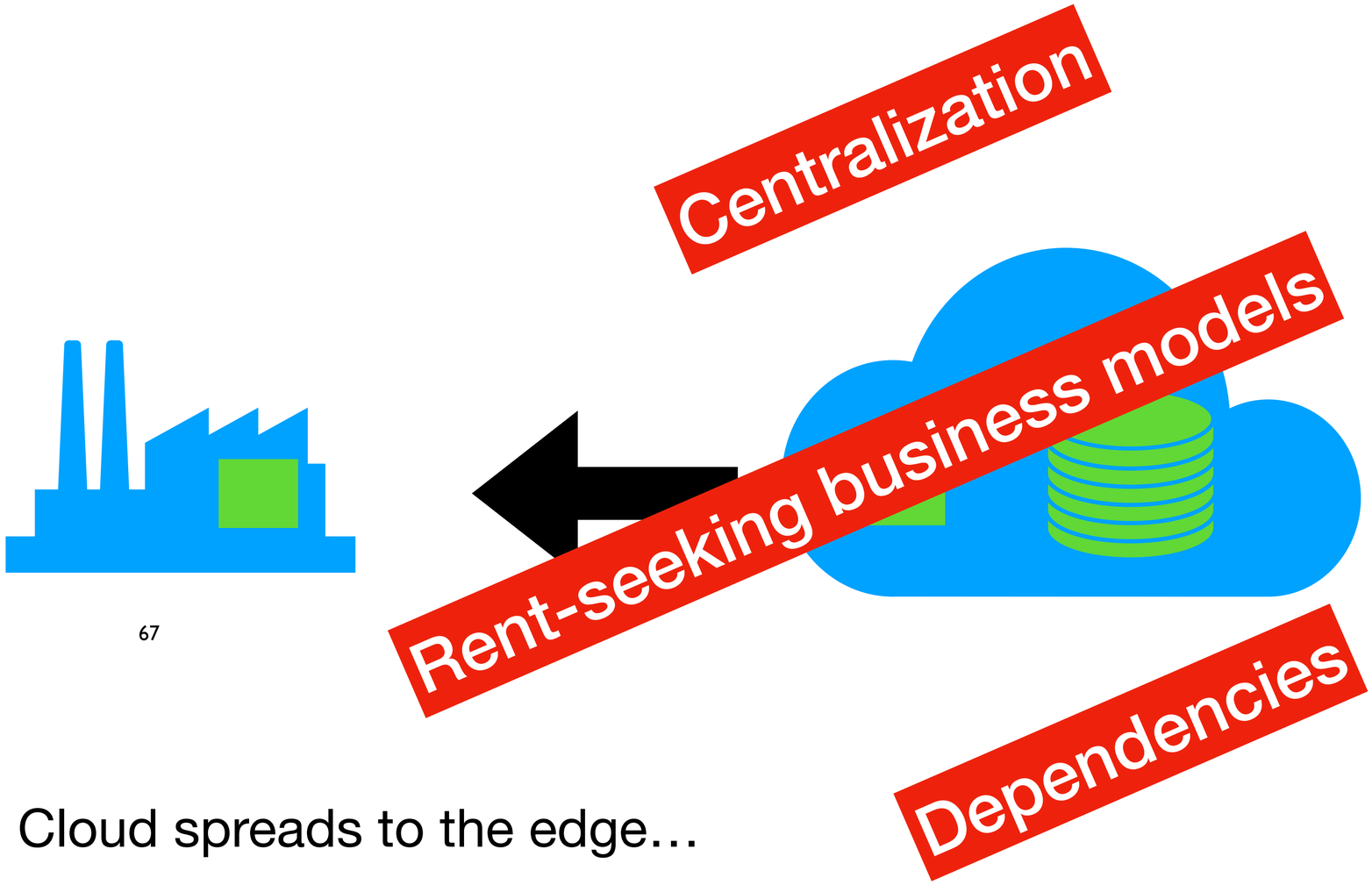
Cloud spreads to the edge…

Is Edge Computing the Best Term?



Cloud spreads to the edge…

Restart Discussion: Computing with Things

- Computing for/with things
  - Without enforcing dependencies on centralized communication/computing, and security infrastructure
- CoAP mindset
  - Building blocks that can be used to realize different application/business requirements
  - Without solving all the problems in the world…

Potentially Interesting Directions

- Decentralized, secure Computing with Things
  - Connect things in local network
  - Establish trust
  - Offload computation
  - (Does not exclude talking to cloud, but that should not be the mental model to start with)

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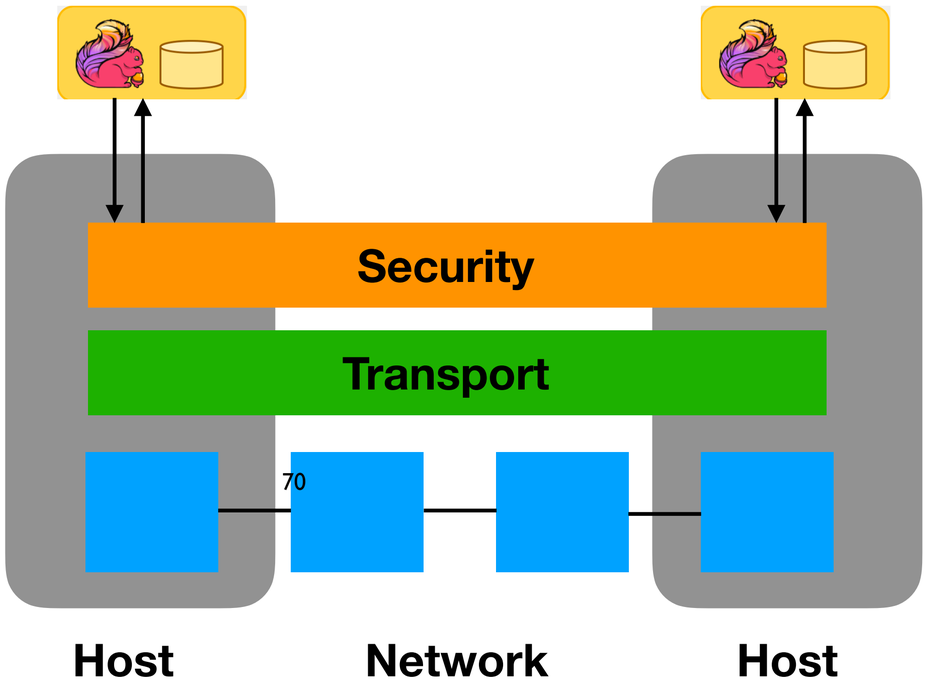
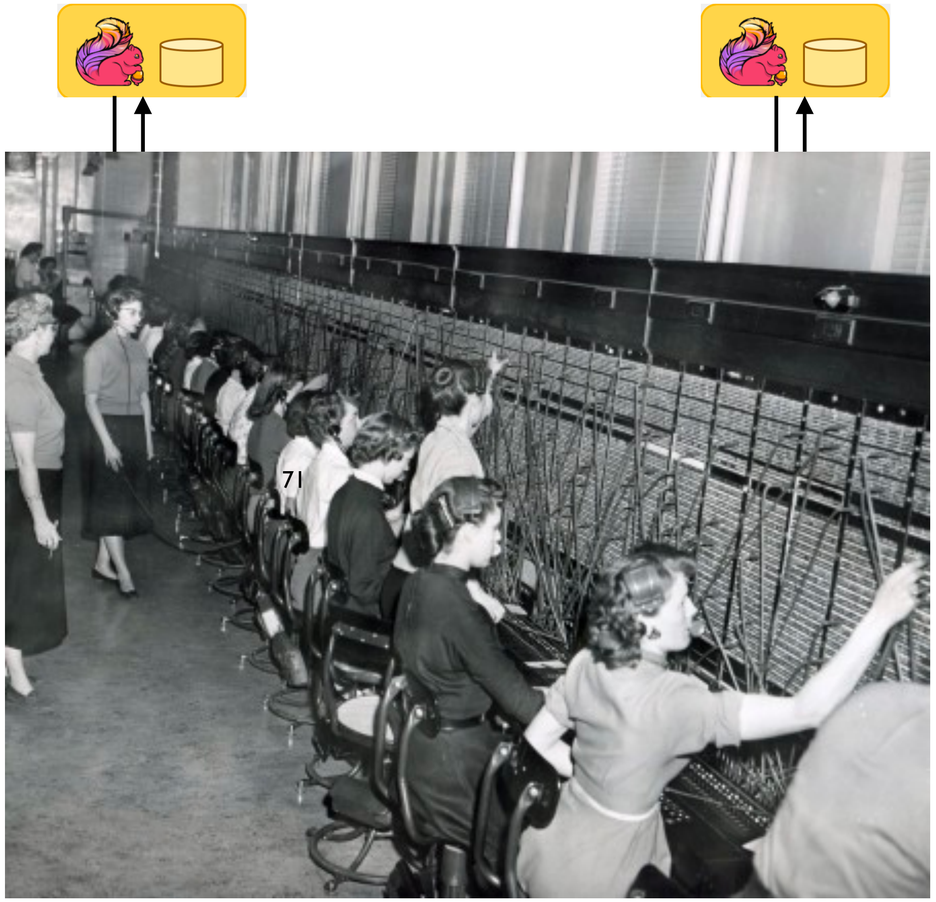
From Overlays…



From Overlays…



- Circuit-like connectivity
  - Limited visibility into network
- Different namespaces
  - Need additional infrastructure find things, compute platforms, functions
  - DNS, discovery

From Overlays…

To Computing in the Network with Joint Resource Optimization

- Do not require fixed locations of data and computation
- Lay out processing graphs flexibly
- Sometimes we can move functions (close to big data assets)
- At other times we gradually move data where it is needed (e.g., where specific computations run)
- Conditions may change dynamically and constantly: network to adapt to application requirements, network conditions etc.
- Avoiding dependencies on orchestrators

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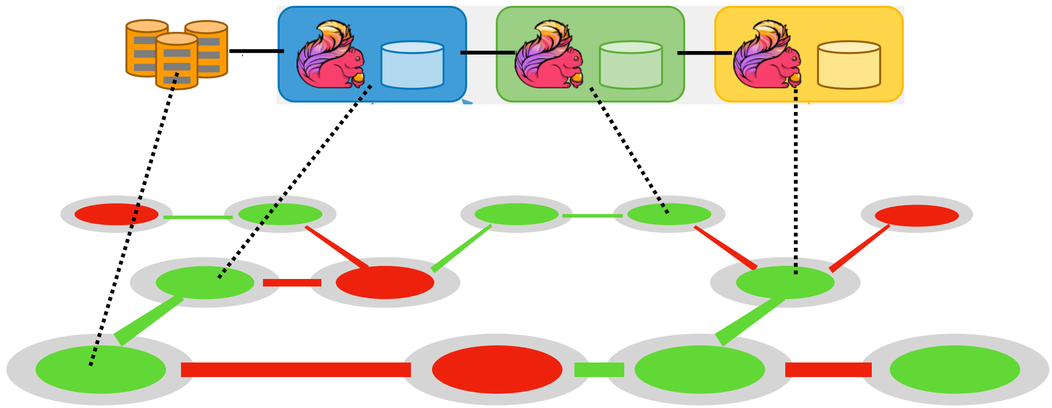

Suggested Environment: Computing with Constrained Things

- Function offloading (power saving, load management)
- Triggered execution, reactive programming, IFTTT
- Custodial transfer (data offloading)

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- Data processing pipelines

Summary

- Let’s not boil the ocean and survey all possible combinations of IoT and Edge Computing
- There are many forums, alliances etc. that do something in that space — where can we make a dent (and do good research)?
- Suggesting application-driven technology development for selected specific environments (e.g., constrained networks)
- Important to dive deeper than just to the business case level
- Interactions models, computation models etc.[74]
- Pillars: decentralized, leight-weight, joint optimisation of networking and computing, object security
- T2TRG activity could dove-tail with COIN work, but focus on these pillars

Problem Statement of IoT integrated with Edge Computing

(draft-hong-t2trg-iot-edge-computing-00)

IETF105 T2TRG meeting in Montreal

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J. Hong, **Y-G. Hong**, X. de Foy, M. Kovatsch, E. Schooler and D. Kutscher

Contents

- History and major updates on draft

- IoT Edge computing demo show
  - To support the draft

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History of the draft

- IETF 103
  - Presented first in T2TRG side meeting
  - draft-hong-iot-edge-computing-01
  - Showed two demo videos as use cases of IoT Edge computing
    - Smart constructions providing a monitoring service of construction site
    - Real-time control monitoring system by Rotary Inverted Pendulum system

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- IETF 104
  - Presented in Pre IETF 104 work meeting
  - draft-hong-iot-edge-computing-02

Major Updates

- Changed the filename to specify it under T2TRG
  - draft-hong-t2trg-iot-edge-computing-00
    - It was draft-hong-iot-edge-computing-02

- Integrated with *Survey and gap analysis*
  - It was presented and discussed at IETF100 T2TRG

- New authors are added
  - Xavier de Foy (InterDigital Communications)
  - Matthias Kovatsch (Huawei Technologies Duesseldorf GmbH)
  - Eve Schooler (Intel)
  - Dirk Kutscher (University of Applied Sciences Emden/Leer)

Changes of each chapters (1/3)

<draft-hong-iot-edge-computing-02>

<draft-hong-t2trg-iot-edge-computing-00>

Changes of each chapters (2/3)

<draft-hong-iot-edge-computing-02>

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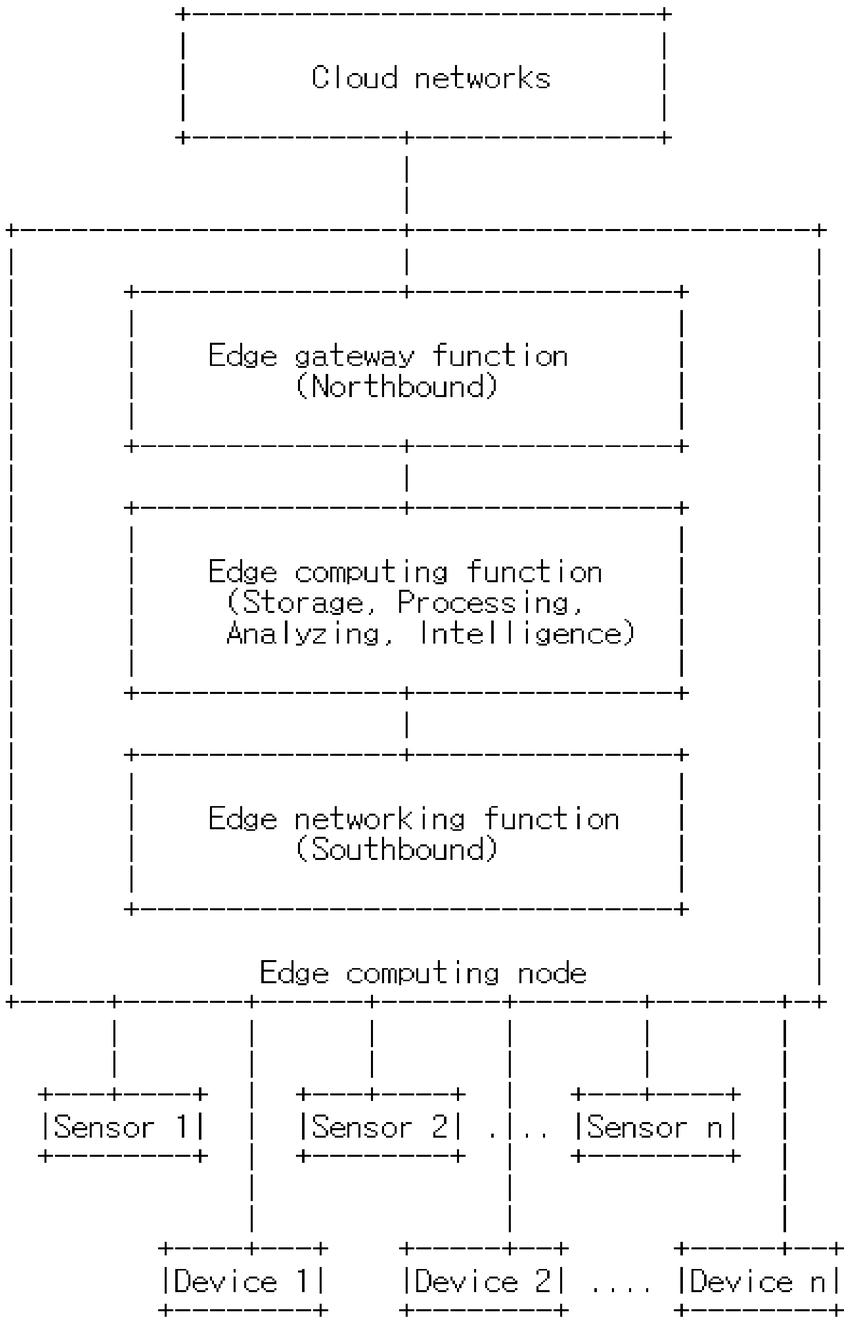
<draft-hong-t2trg-iot-edge-computing-00>

Changes of each chapters (3/3)

Gateway-based architecture of IoT Edge Computing

- This is one particular way of doing Edge computing
- Provides
  - downside connectivity to IoT sensors and devices (southbound connectivity)
  - upside connectivity to cloud networks (northbound connectivity)
  - function of data storage
  - computing function such as data processing, data analyzing, and intelligence



Next revision & Direction

- Provides the different Edge computing approaches
  - edge cloud, edge gateway, distributed edge nodes, device-embedded edge nodes, etc.

- T2TRG adoption?

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IoT Edge computing demo

- ETRI implementation -

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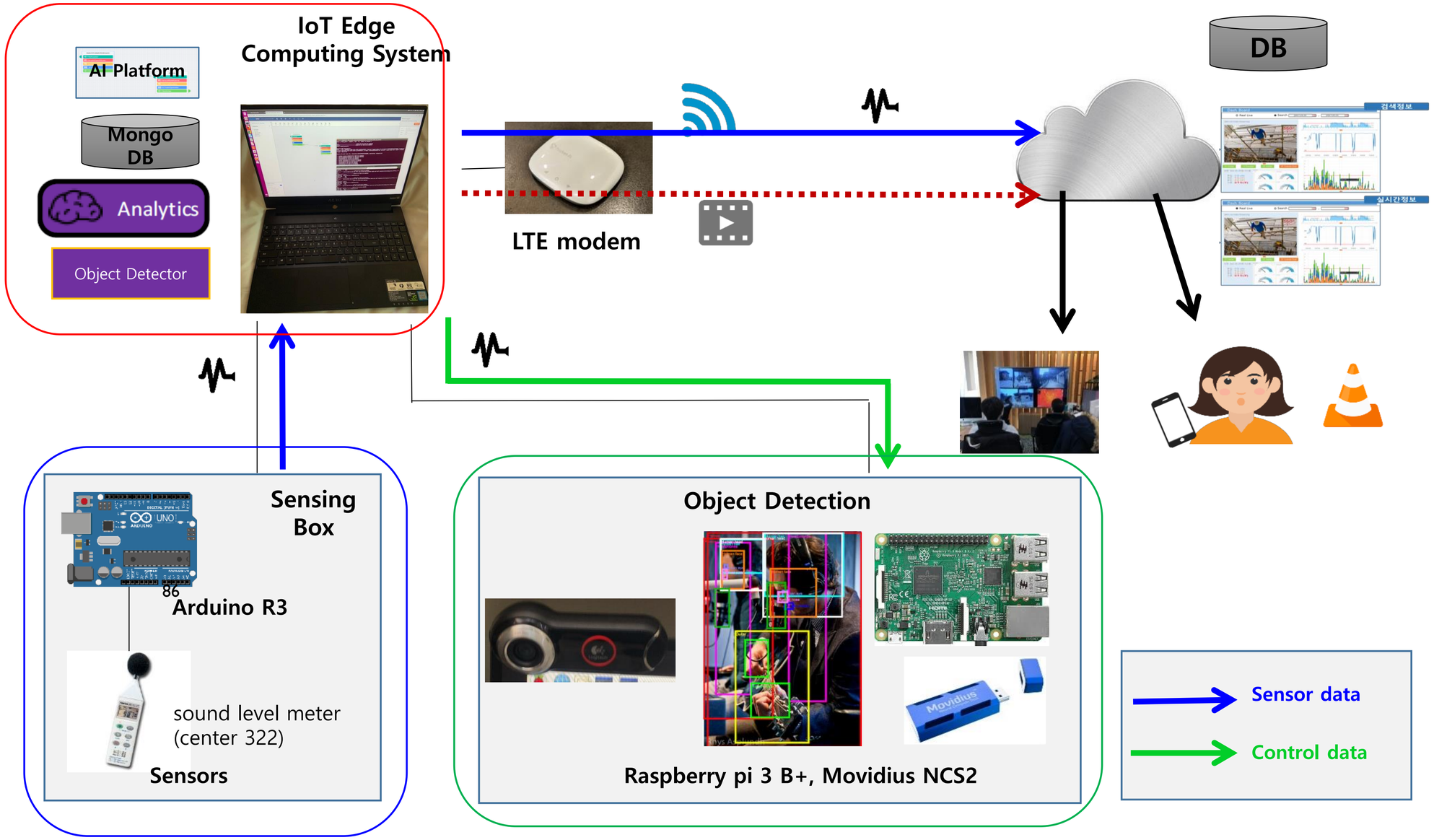
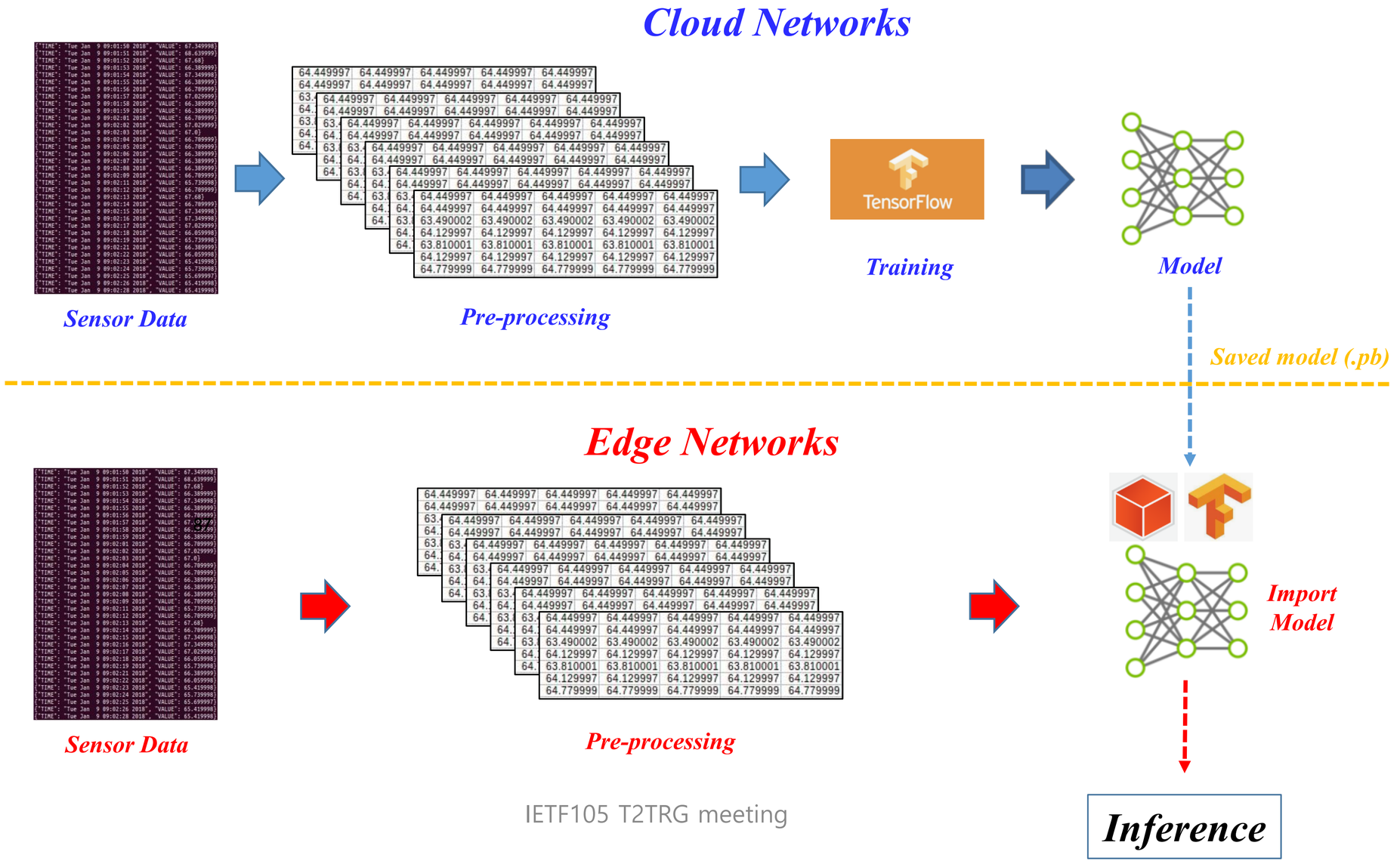
Object of demonstration

- Show an implementation of Edge computing based on open source EdgeX
- Provide a mapping between implementation & architecture in the draft
- T2TRG adoption support

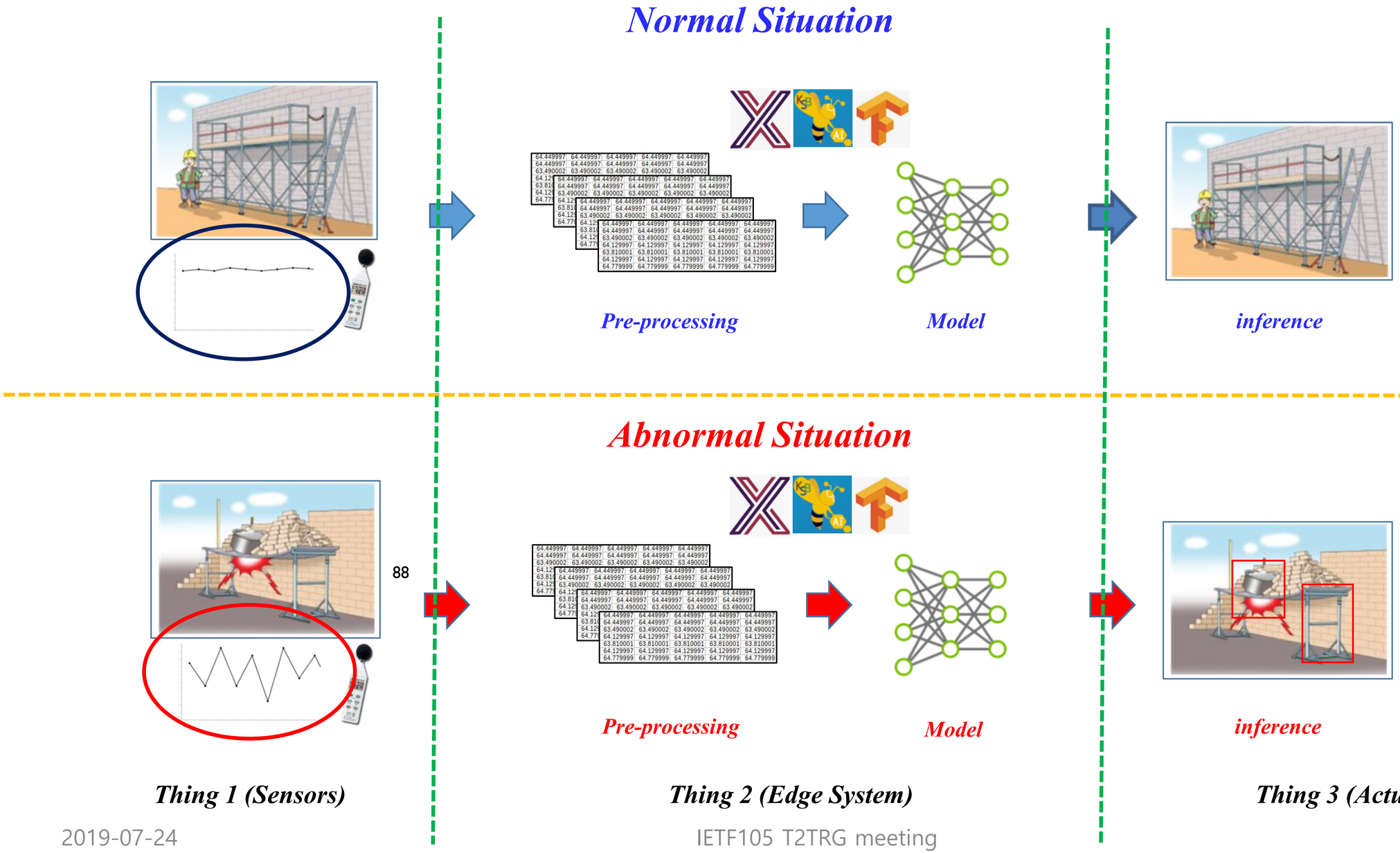
Service Scenario



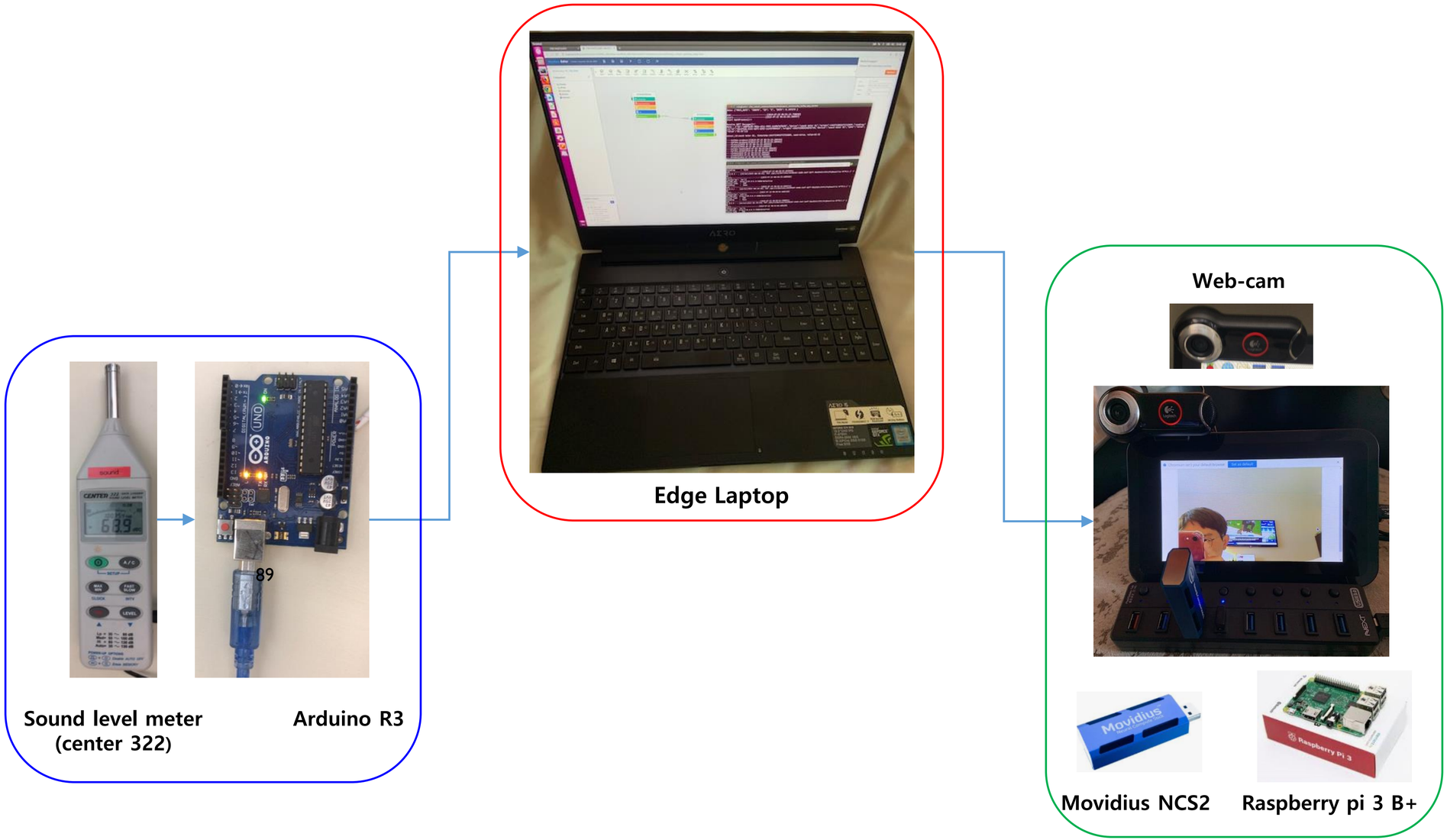
Example of Edge computing function : Intelligence - Preprocessing, Prediction, Analyze & Control



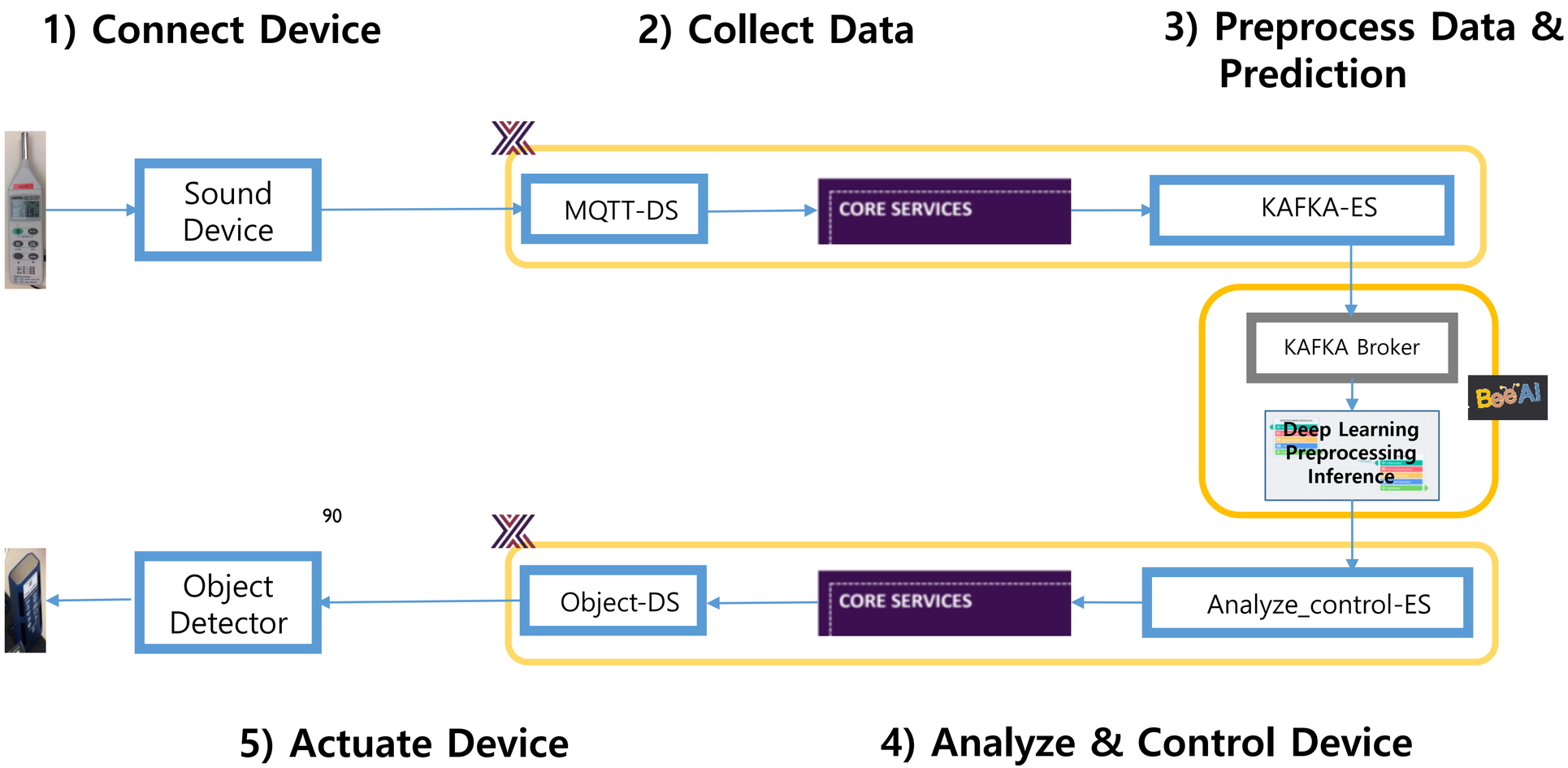
Service Scenario – Normal vs. Abnormal



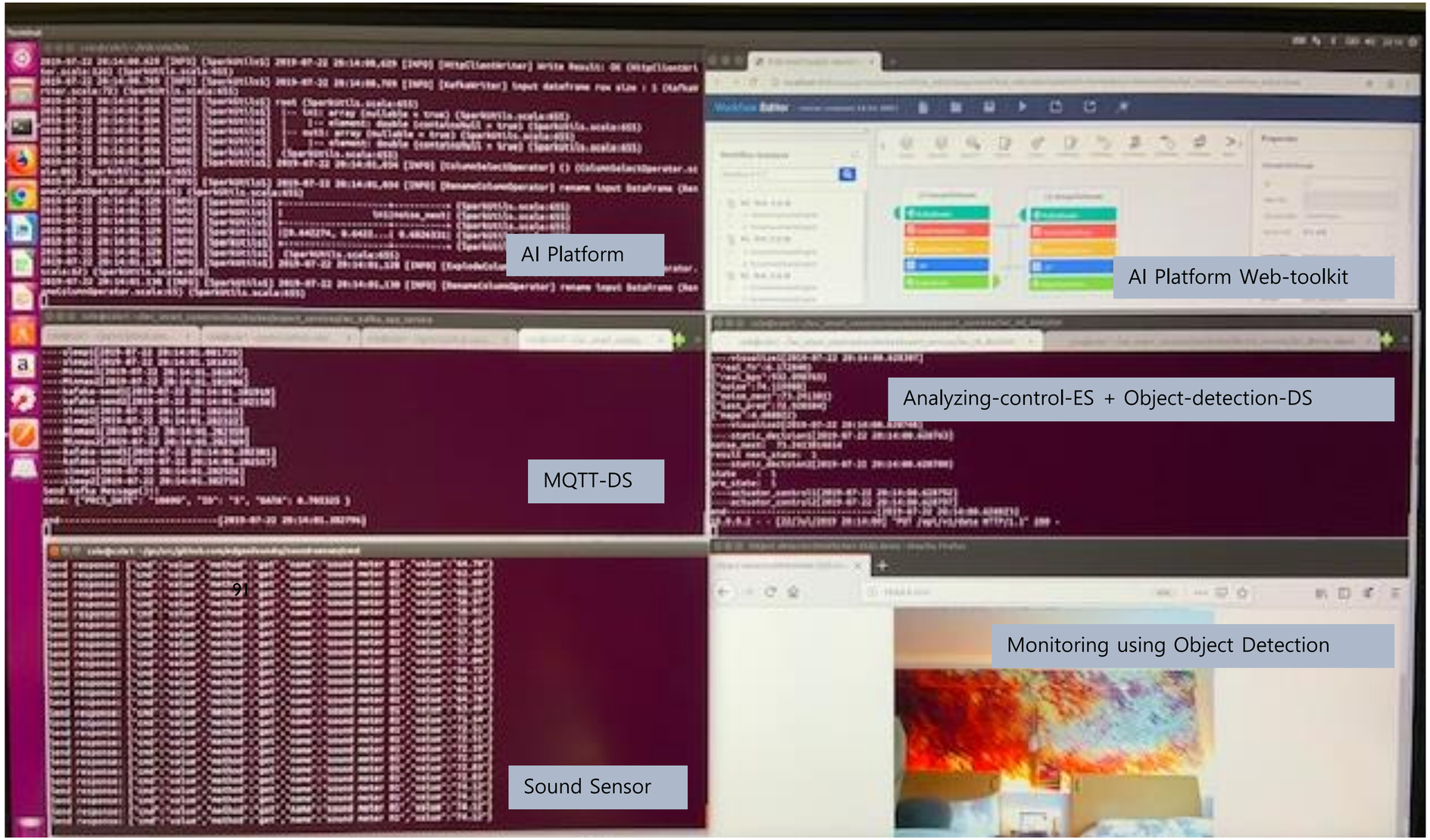
Testbed Configuration



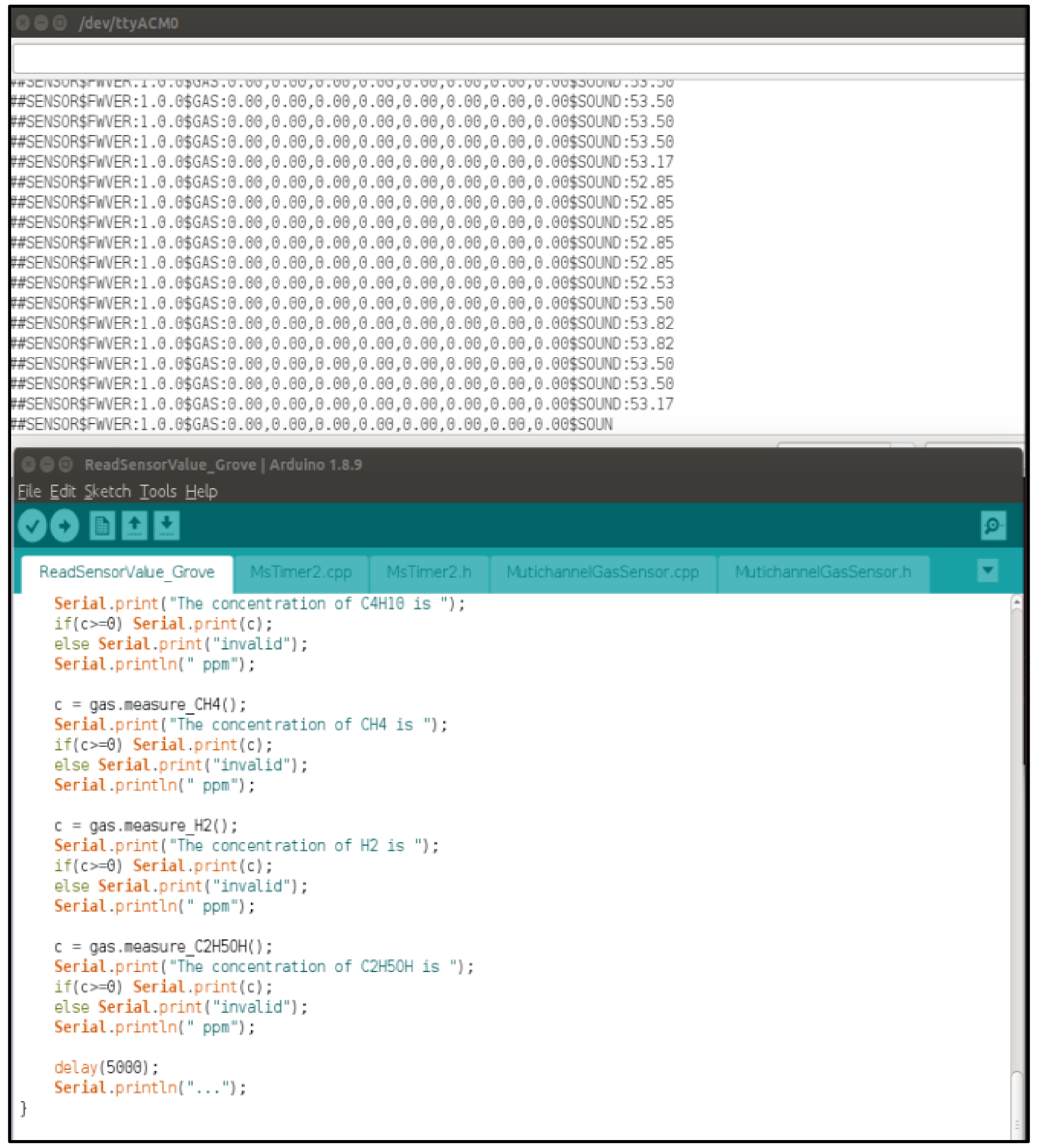
Software Configuration (based on EdgeX)



Screenshot of each process



1) Connect Device



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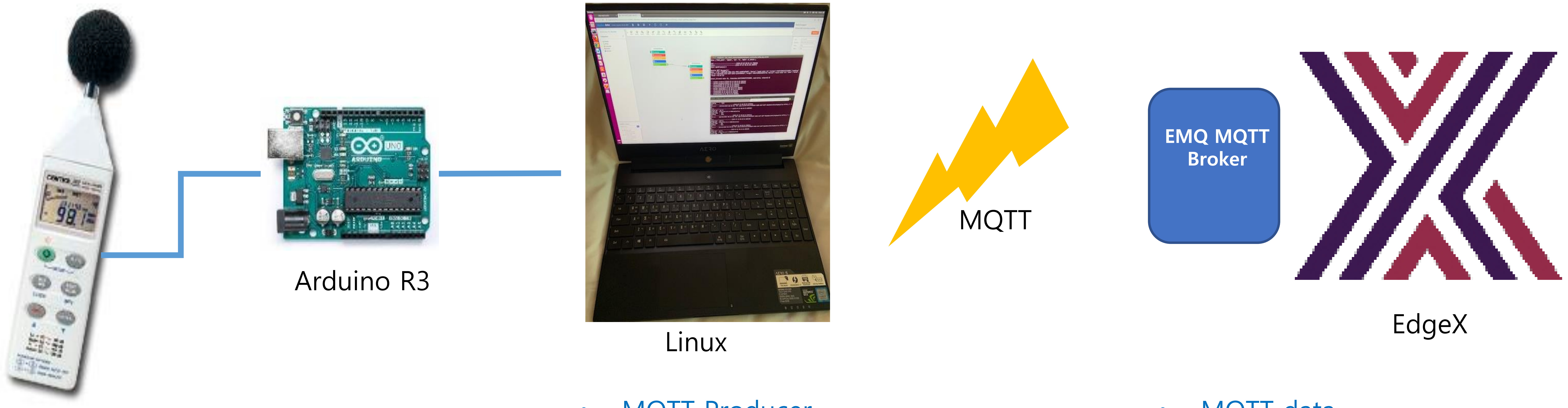


sound level meter (center 322)

- MQTT Producer programing

- MQTT data processing

2) Collect Data

##SENSOR$FWVER:1.0
:GAS:0.0,
:SOUND: 65.32\r\n

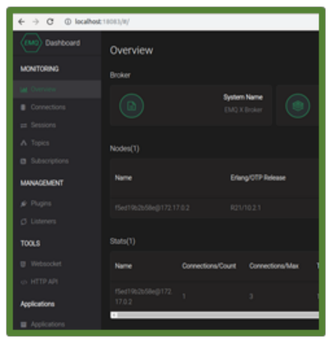
{
ID: adfb32432dbf3
Name: sound-meter-01
Value: 65.34
}

{
Topic: DataTopic
Payload: data
}

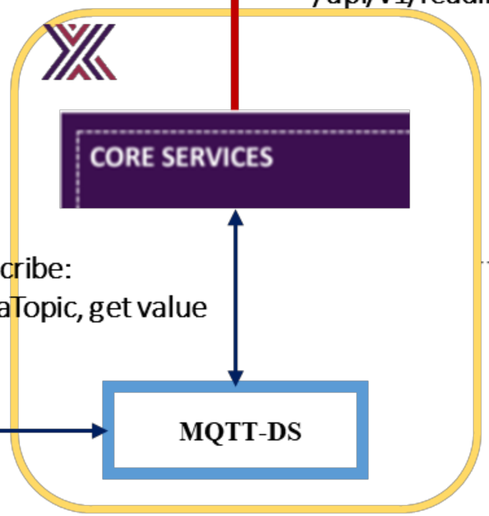
reading/
{
Origin: 124d56fad
Name: Value
Value: 65.34
}

read_sensor.c

sensor.go



EMQ Broker Manager

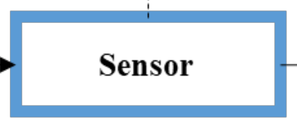


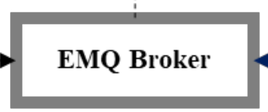
mqtt-device-profile.yaml

Configuration.toml

driver.go

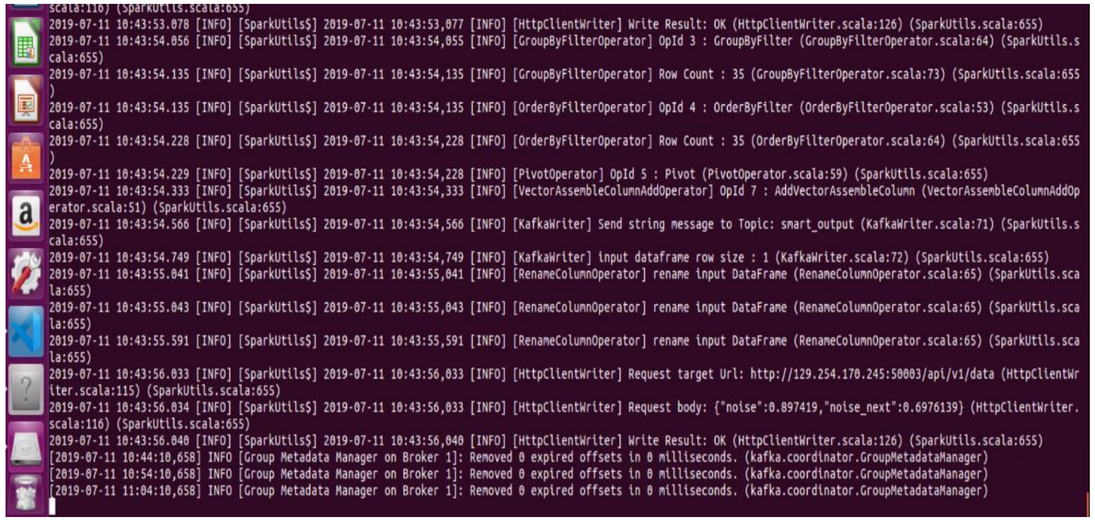
incominglistener.go





Publish:
/DataTopic, value

3) Preprocess Data & Prediction



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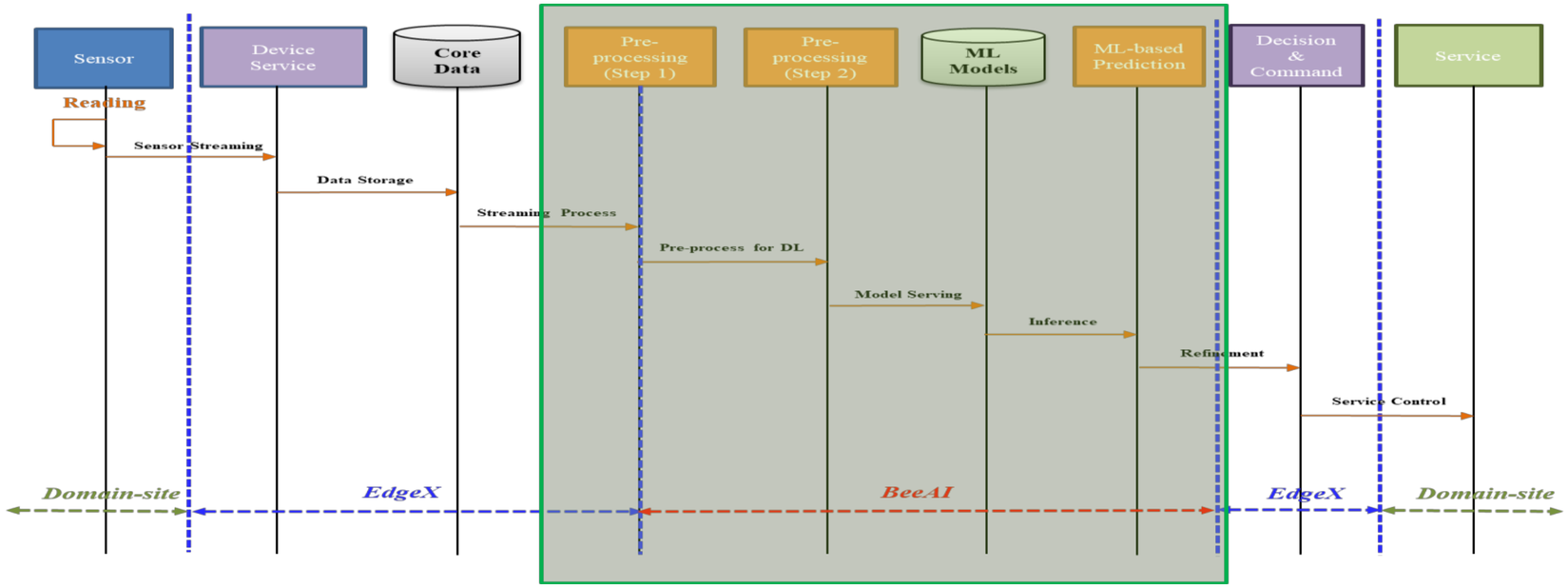

4) Analyze & Control Device

Analyze

Visualize

Control Device

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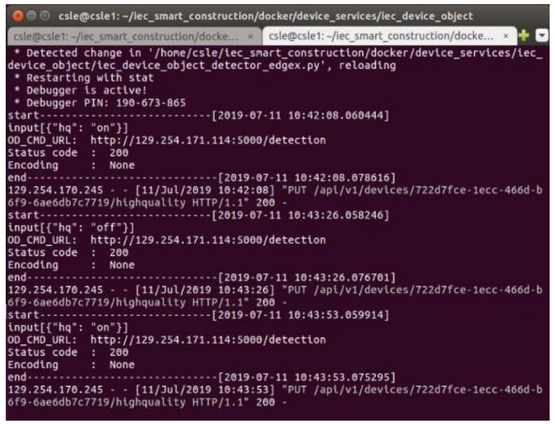
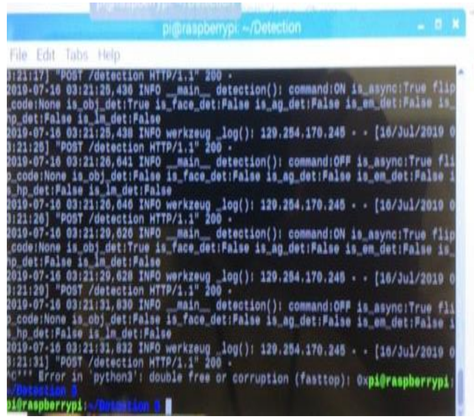
```
csle@csle1: ~/iec_smart_construction/docker/export_services/iec_ml_decision
csle@csle1: ~/iec_smart_construction/docker/exp...  csle@csle1: ~/iec_smart_construction/docker/exp...
start--------------------------[2019-07-16 16:19:40.371760]
received REST message()!!

{'noise': 0.642274, 'noise_next': 0.5807184}
noise      :  72.18999714
noise_next :  70.30578022399999
----analyze1[2019-07-16 16:19:40.372573]
================================================
analyze start!!
================================================
hq_video: 0 hq_sample: 317 lq_sample: 10650
HIGH - noise: 72.18999714 SS: 69.0 warn_sample: 740
f_neg: 527 f_pos: 103
================================================
Now: 72.18999714 Pred: 68.90266986099999 MAPE new: 4.553715762898297 MAPE total: 3.8826323443
86367 MAPE sum: 42580.82892088529
Total: 10967 CC: 0.95 HQ period: 317 LQ period: 10650
HQ rate: 2.890489650770493
False Neg: 527 False Pos: 103
----analyze2[2019-07-16 16:19:40.372777]
----visualize1[2019-07-16 16:19:40.372795]
{"real_fn":4.805325}
{"real_bps":572.262241}
{"noise":72.189997}
{"noise_next":70.305780}
{"last_pred":68.902670}
{"mape":3.882632}
----visualize2[2019-07-16 16:19:40.373686]
----static_decision1[2019-07-16 16:19:40.373724]
noise_next:  70.30578022399999
result next_state:  1
----static_decision2[2019-07-16 16:19:40.373766]
state    :  1
pre_state:  0
----actuator_control1[2019-07-16 16:19:40.373812]
MS_CMD_URL:  http://129.254.170.245:48082/api/v1/device/722d7fce-1ecc-466d-b6f9-6ae6db7c7719/
command/dbbd3fb8-bb8c-4347-ae39-951e9c73bb0e
Status code  :  200
Encoding     :  None
----actuator_control2[2019-07-16 16:19:40.414911]
end----------------------------[2019-07-16 16:19:40.414950]
129.254.170.245 - - [16/Jul/2019 16:19:40] "PUT /api/v1/data HTTP/1.1" 200 -
```

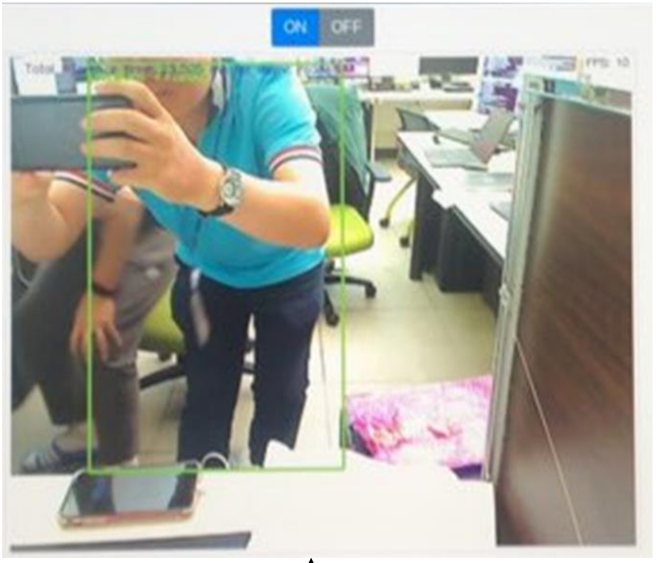
5) Actuate Device

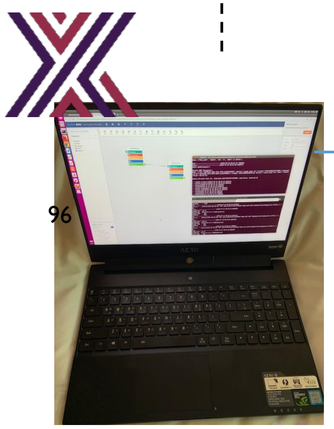


Object-DS



Object-Detector





Raspberry pi 3 B+

Movidius NCS2

Logitech camera

Gateway-based architecture of IoT Edge computing

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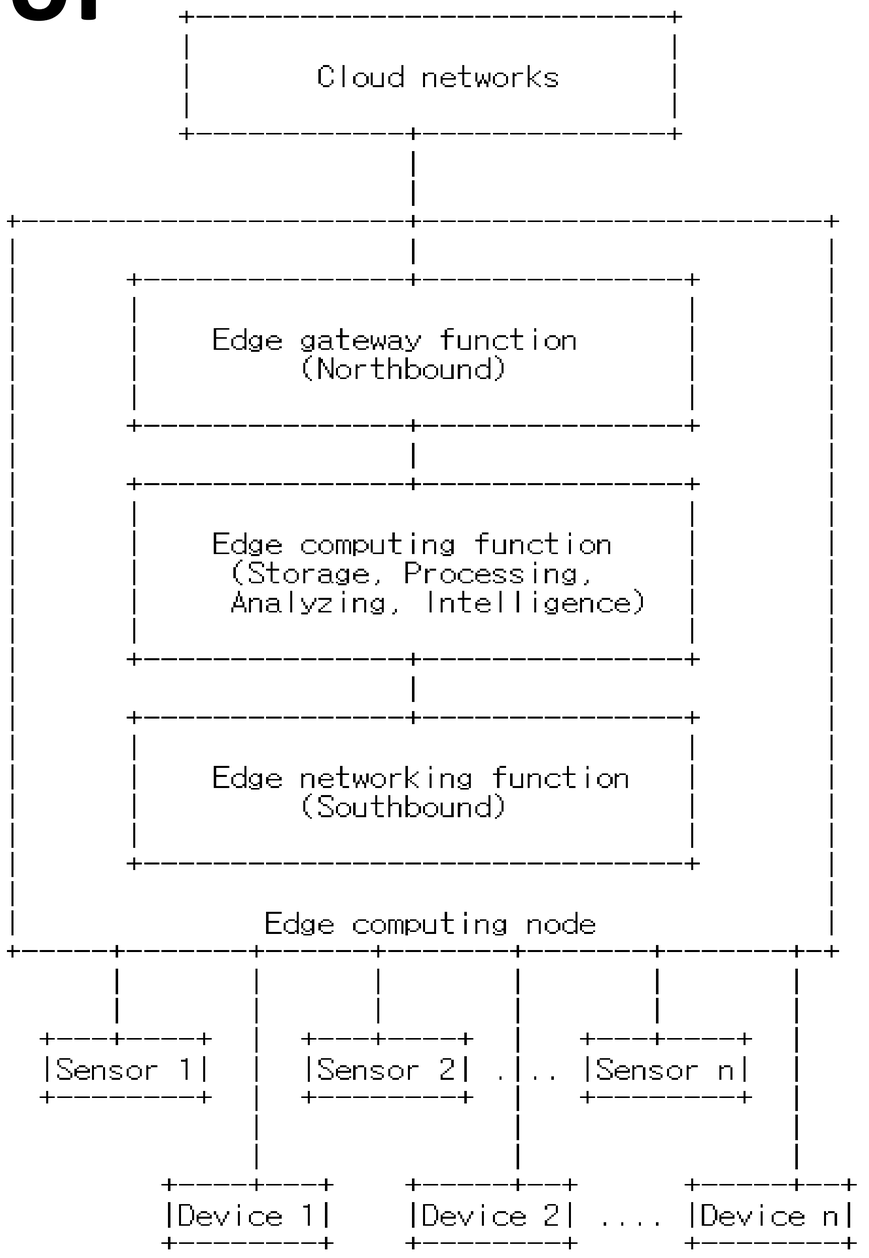
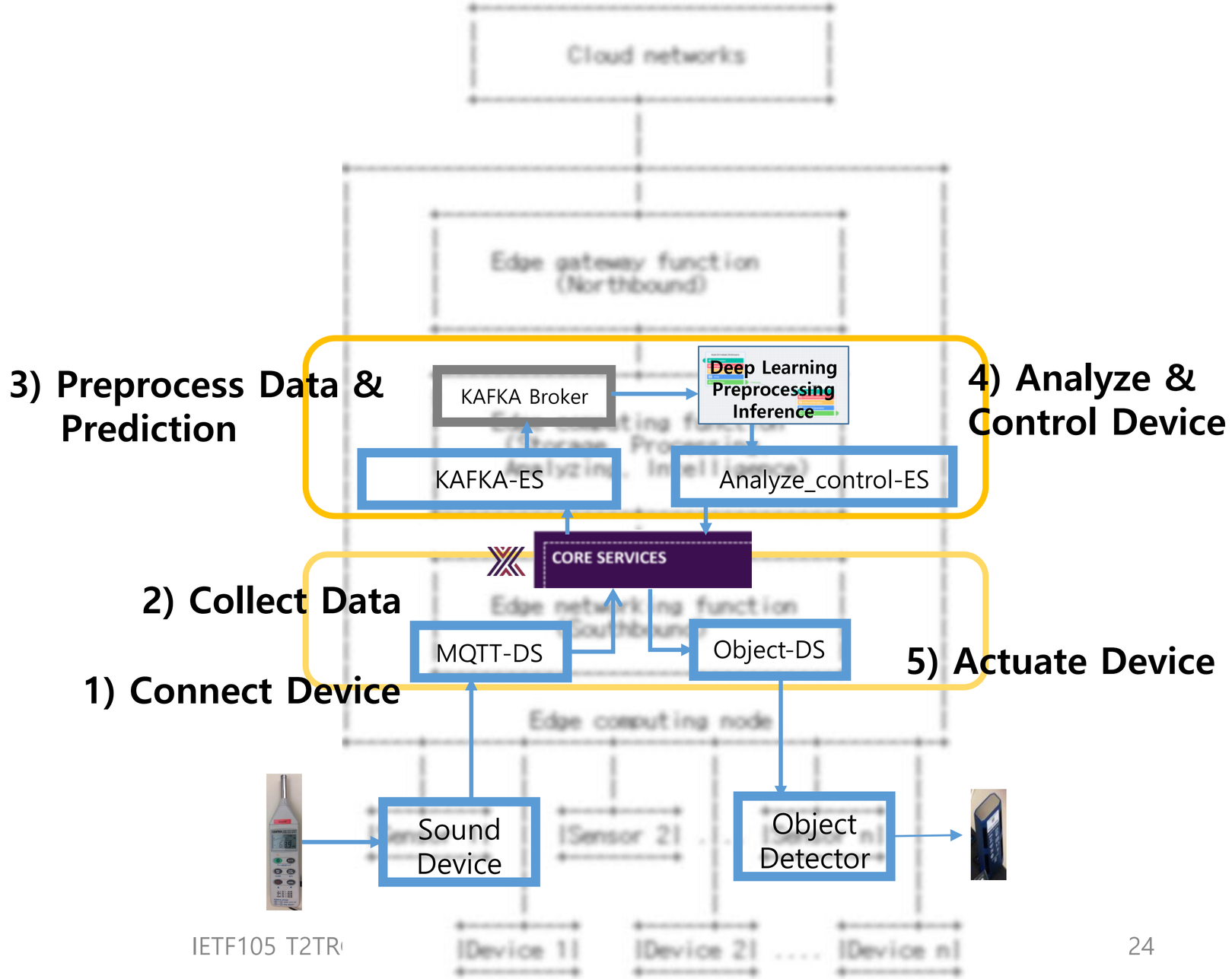


How our implementation is related to the draft



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Thanks!!

Questions & Comments

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