

Problem Statement of IoT integrated with Edge Computing

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

IETF105 T2TRG meeting in Montreal

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Contents

- History and major updates on draft
- IoT Edge computing demo show
 - To support the draft

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
- 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>

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3.	Background	
3.1.	Internet of Things (IoT)	
3.2.	Cloud computing	
3.3.	Edge computing	
4.	New challenges of IoT	
4.1.	Strict Latency and Jitter	
4.2.	Uplink Cost	
4.3.	Uninterrupted Services	
4.4.	Privacy and Security	

Changes of each chapters (2/3)

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

5.	IoT integrated with Edge Computing
5.1.	IoT Data in Edge Computing
5.1.1.	Data Storage
5.1.2.	Data Processing
5.1.3.	Data Analyzing
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5.3.	Edge Computing in IoT
6.	Architecture of IoT integrated with Edge Computing
7.	Use Cases of Edge Computing in IoT
7.1.	Smart Constructions
7.2.	Smart Grid
7.3.	Smart Water System
7.4.	Smart Buildings
7.5.	Smart Cities
7.6.	Connected Vehicles

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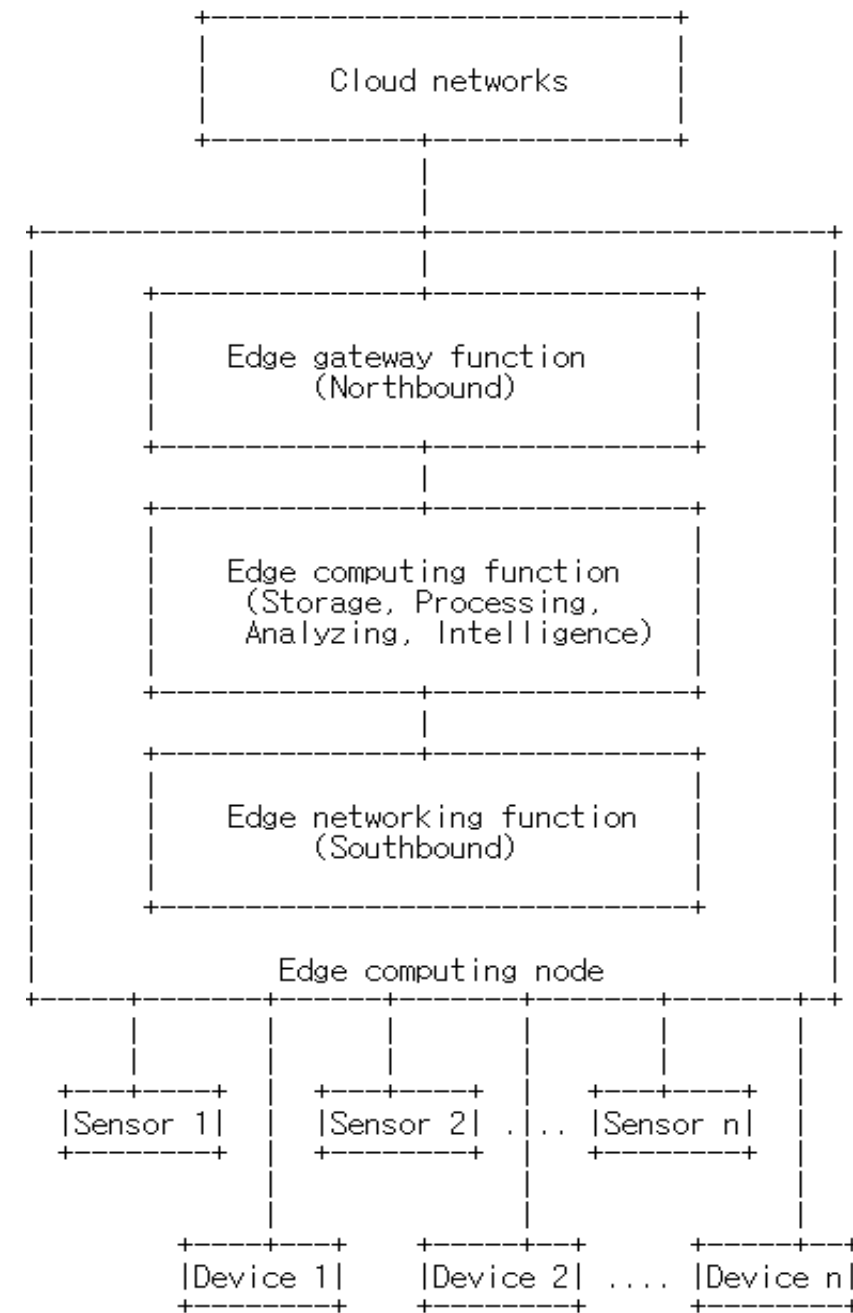
5.	IoT integrated with Edge Computing
5.1.	IoT Data in Edge Computing
5.1.1.	Data Storage
5.1.2.	Data Processing
5.1.3.	Data Analyzing
5.2.	IoT Device Management in Edge Computing
6.	Architecture of IoT integrated with Edge Computing
7.	State-of-the-art of IoT Edge Computing
7.1.	Common aspects of IoT edge computing service platforms
7.2.	Use Cases of IoT Edge Computing

Changes of each chapters (3/3)

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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?

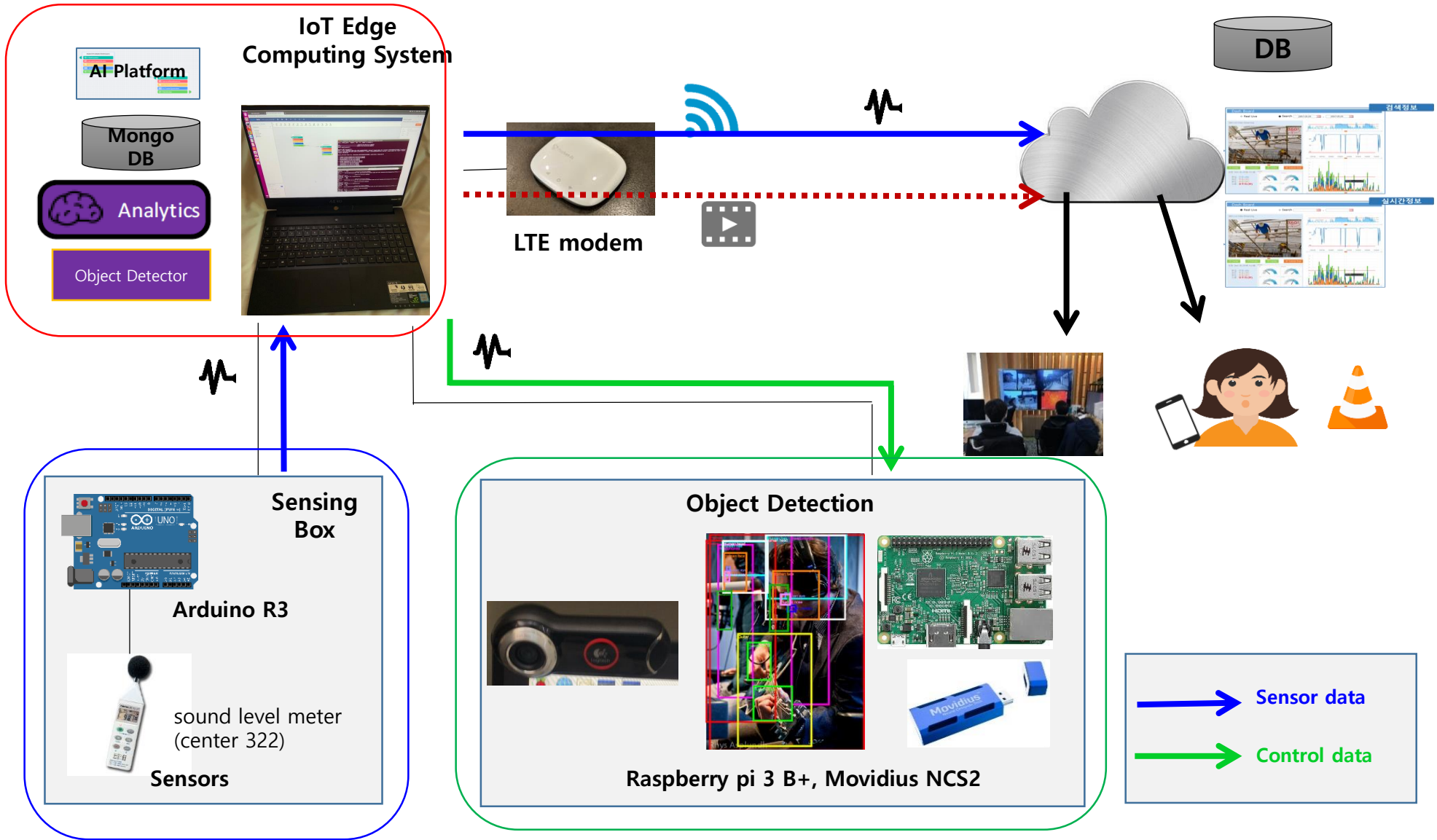
IoT Edge computing demo

- ETRI implementation -

Object of demonstration

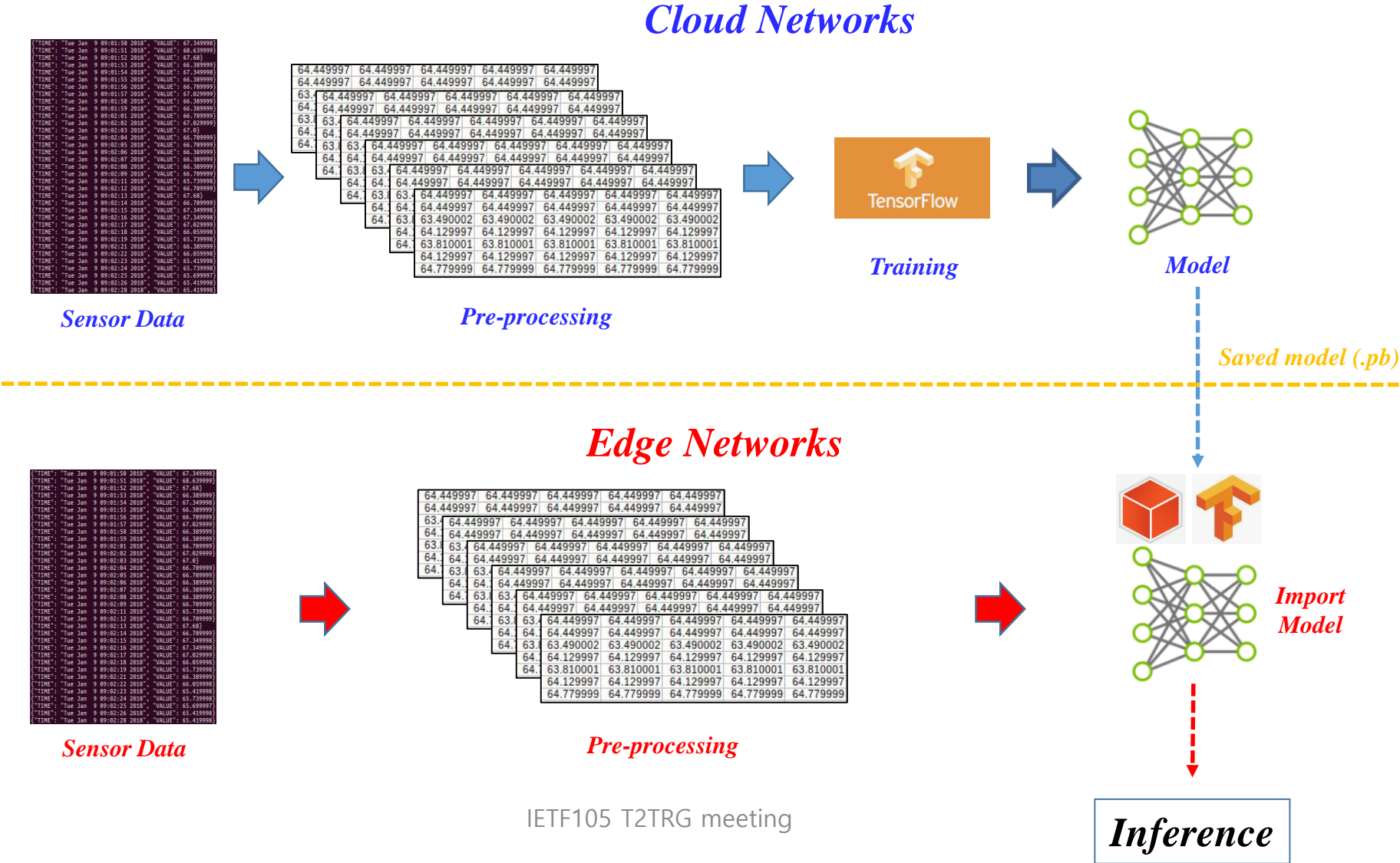
- Show an implementation of Edge computing based on open source EdgeX
- Provide a mapping between implementation & architecture in the draft
- T2TRG adoption support

Service Scenario



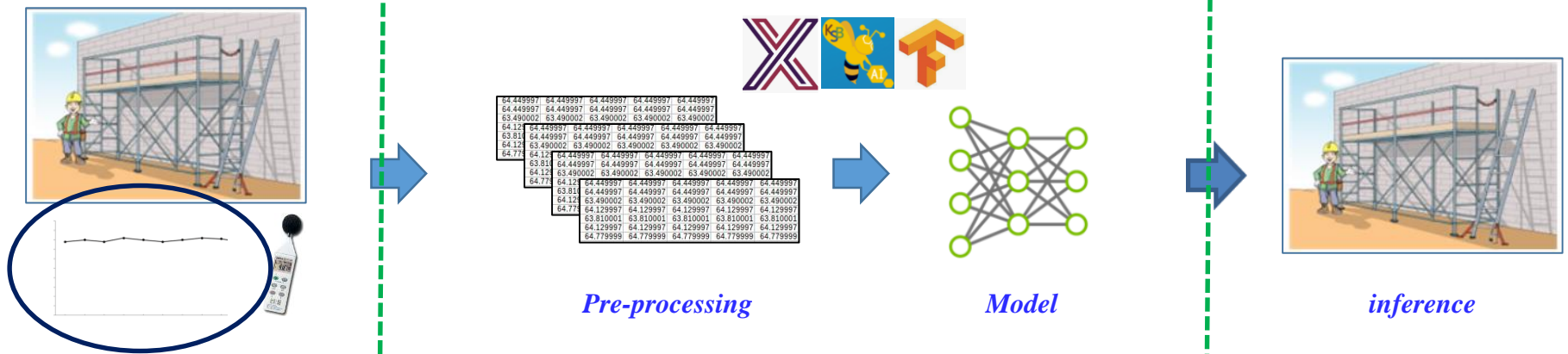
Example of Edge computing function : Intelligence

- Preprocessing, Prediction, Analyze & Control

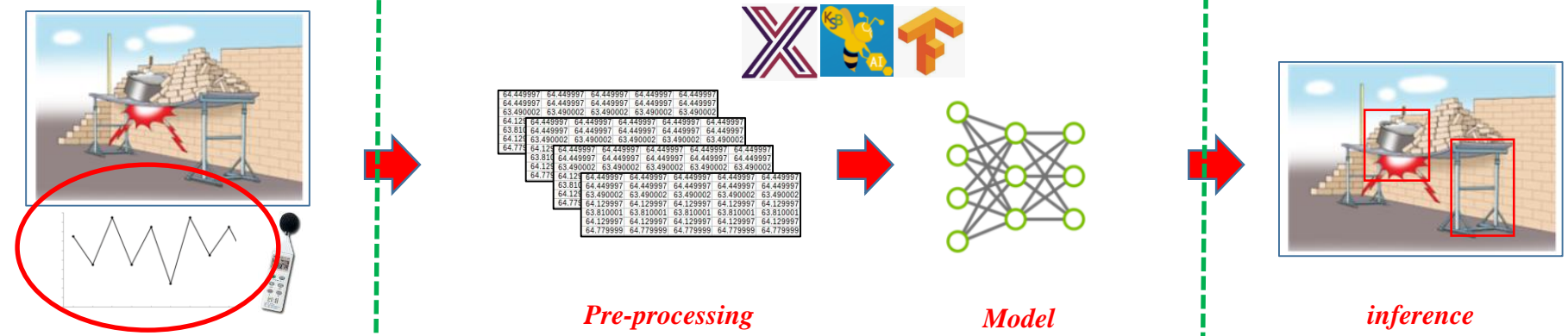


Service Scenario – Normal vs. Abnormal

Normal Situation



Abnormal Situation

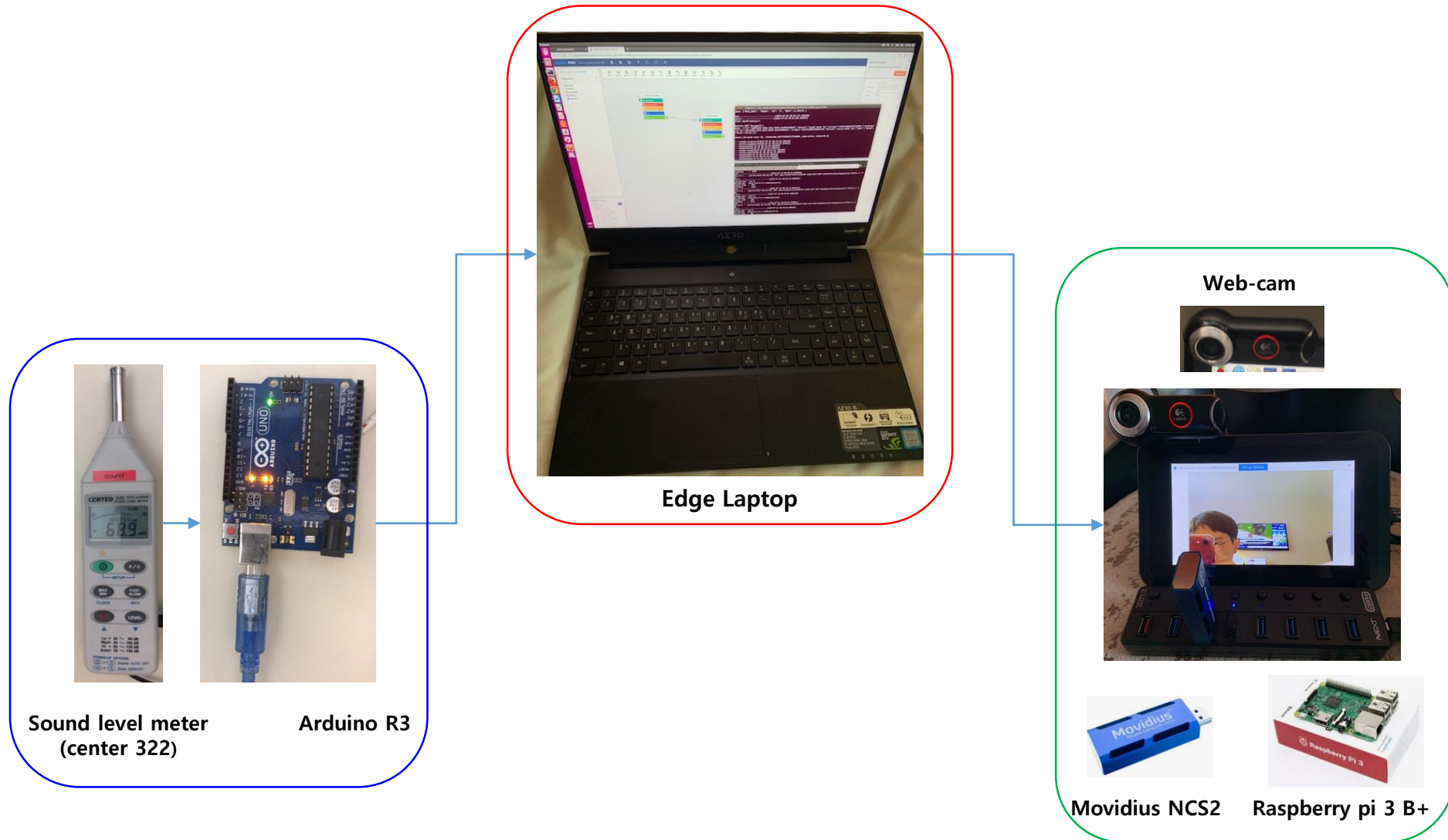


Thing 1 (Sensors)

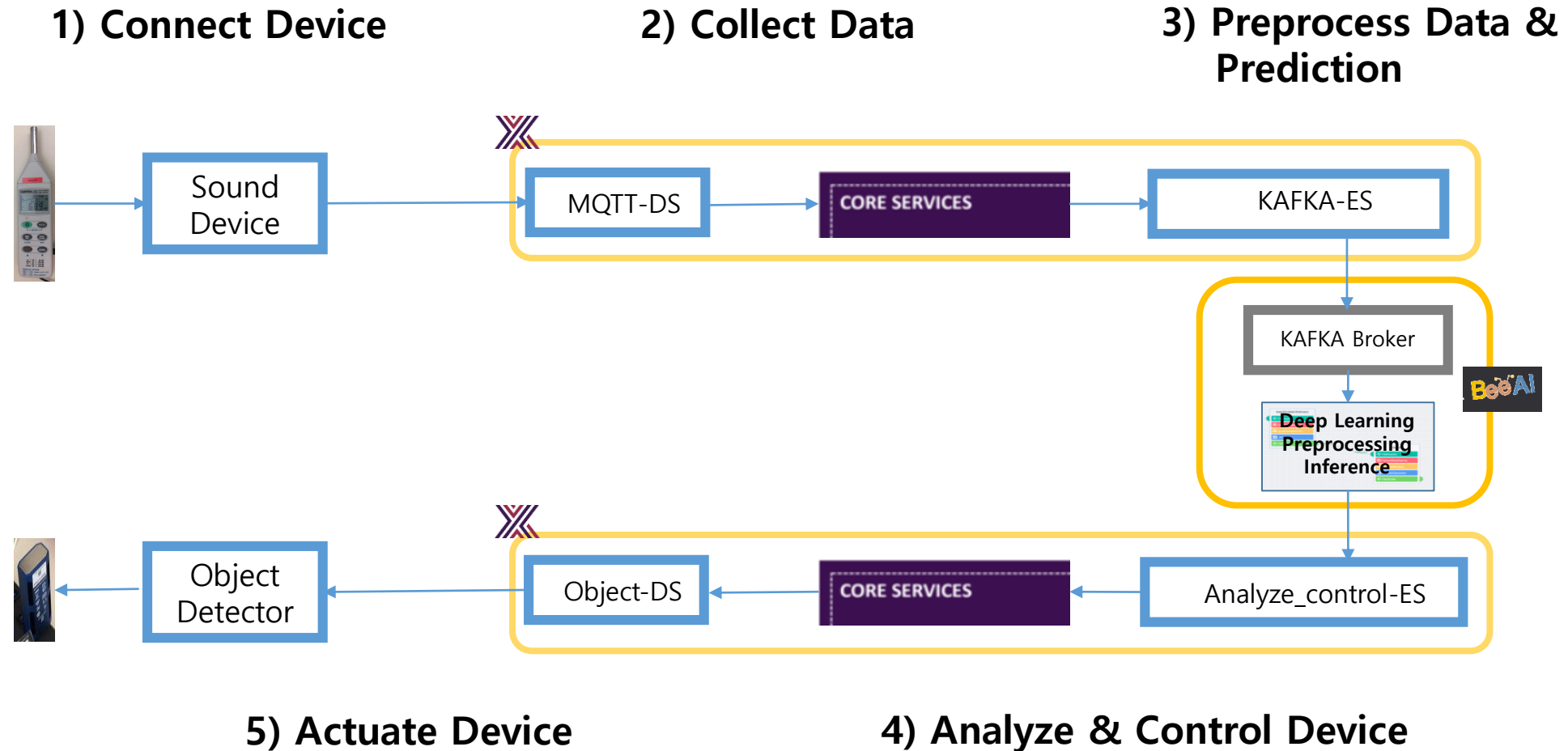
Thing 2 (Edge System)

Thing 3 (Actuator)

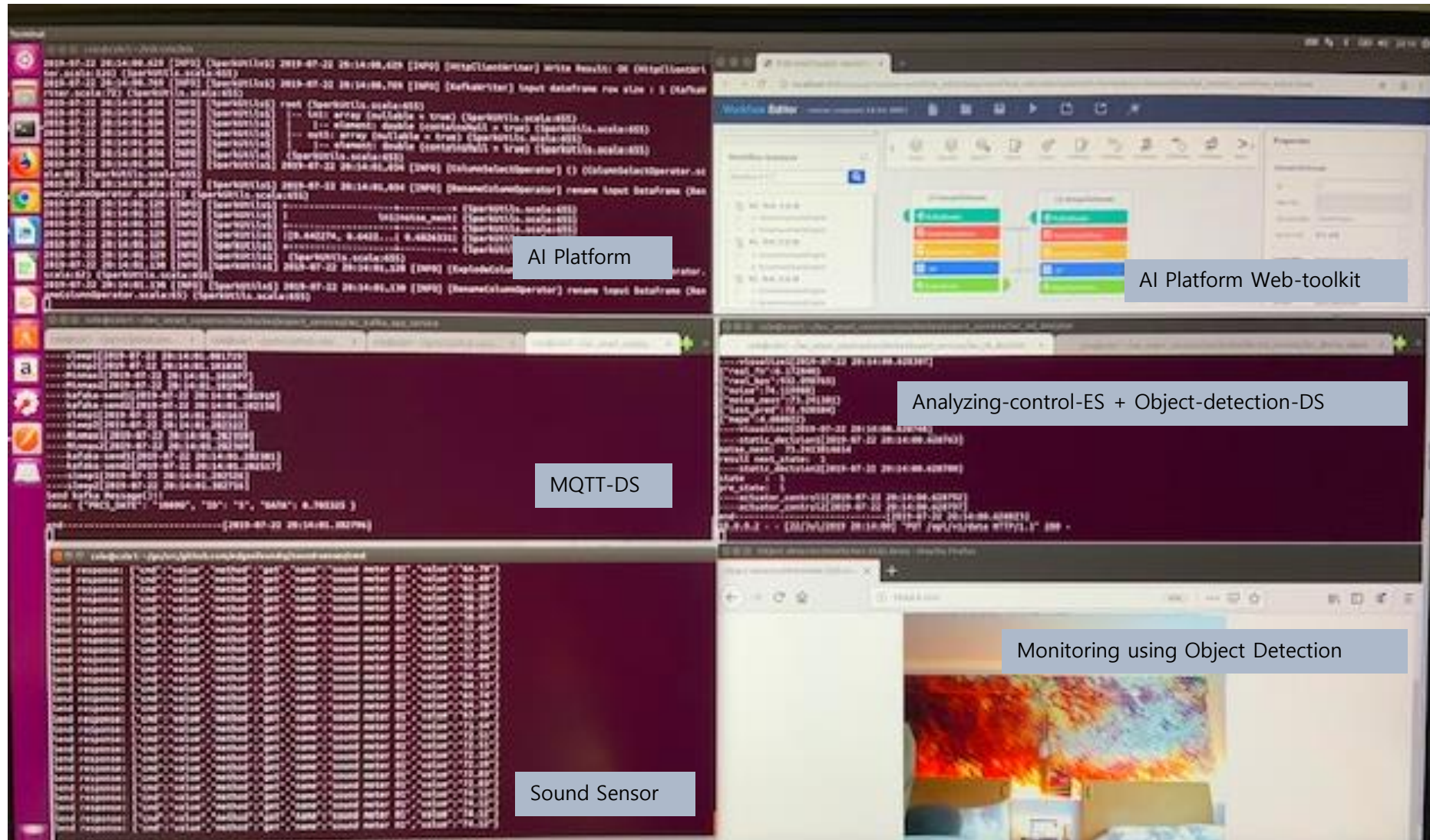
Testbed Configuration



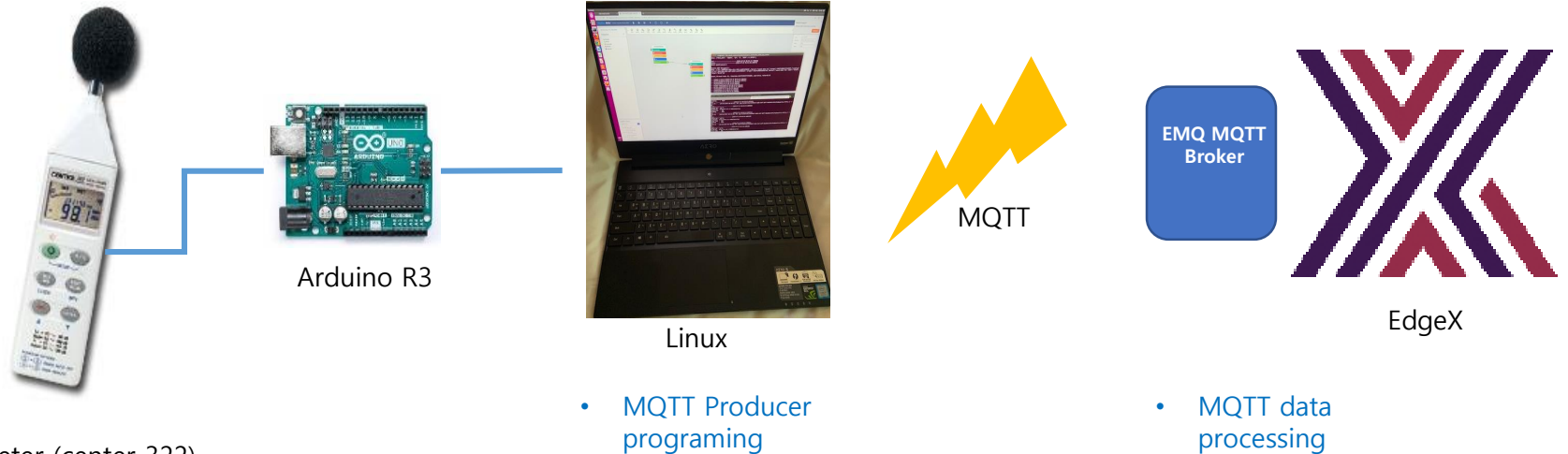
Software Configuration (based on EdgeX)



Screenshot of each process



1) Connect Device

[illegible]

sound level meter (center 322)

- MQTT Producer programming
- MQTT data processing

2) Collect Data

```

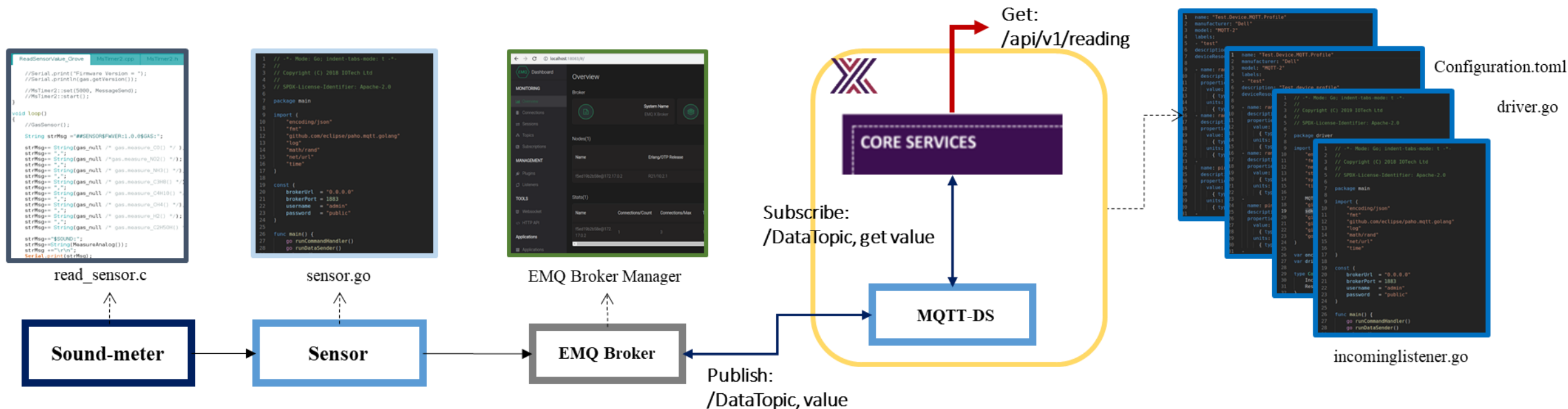
{
##SENSOR$FWVER:1.0
:GAS:0.0,
:SOUND: 65.32\r\n
}

```

```
ID: adfb32432dbf3
Name: sound-meter-01
Value: 65.34
```

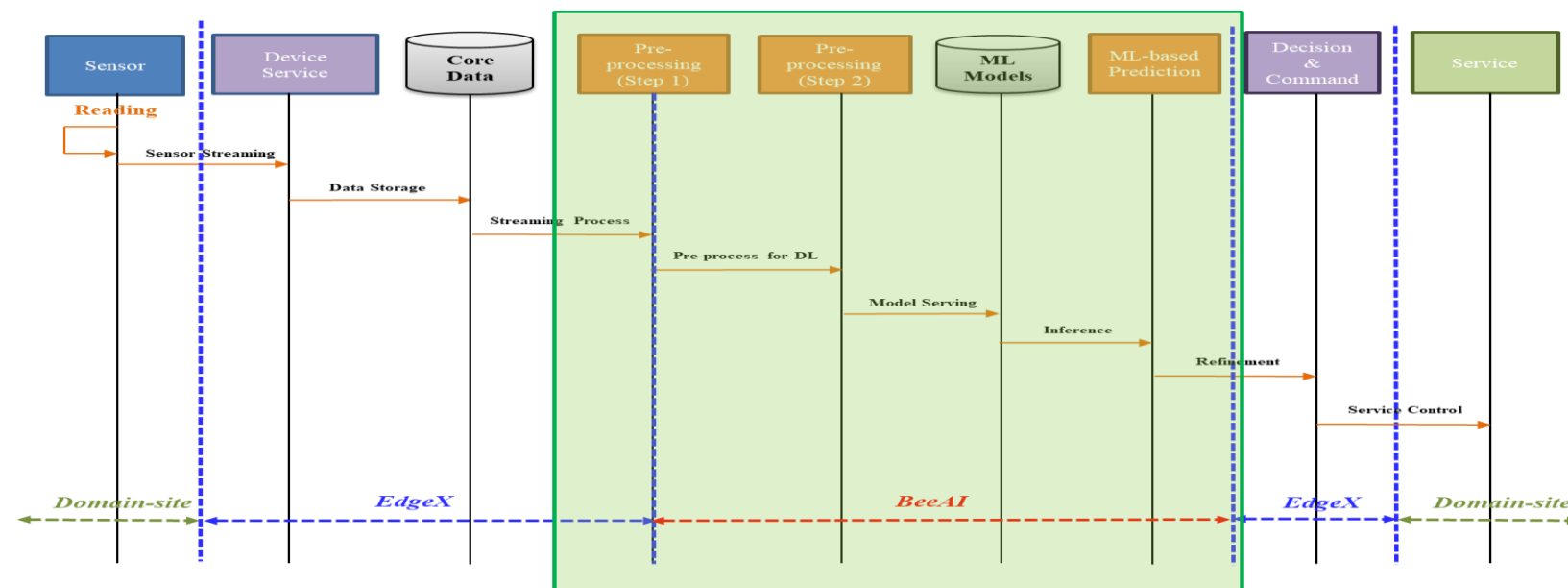
Topic: DataTopic
Payload: data

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



3) Preprocess Data & Prediction

```
scala:116) (SparkUtils.scala:655)
2019-07-11 10:43:53.078 [INFO] [SparkUtils$] 2019-07-11 10:43:53,077 [INFO] [HttpClientWriter] Write Result: OK (HttpClientWriter.scala:126) (SparkUtils.scala:655)
2019-07-11 10:43:54.056 [INFO] [SparkUtils$] 2019-07-11 10:43:54,055 [INFO] [GroupByFilterOperator] OpId 3 : GroupByFilter (GroupByFilterOperator.scala:64) (SparkUtils.s
cala:655)
2019-07-11 10:43:54.135 [INFO] [SparkUtils$] 2019-07-11 10:43:54,135 [INFO] [GroupByFilterOperator] Row Count : 35 (GroupByFilterOperator.scala:73) (SparkUtils.scala:655)
2019-07-11 10:43:54.135 [INFO] [SparkUtils$] 2019-07-11 10:43:54,135 [INFO] [OrderByFilterOperator] OpId 4 : OrderByFilter (OrderByFilterOperator.scala:53) (SparkUtils.s
cala:655)
2019-07-11 10:43:54.228 [INFO] [SparkUtils$] 2019-07-11 10:43:54,228 [INFO] [OrderByFilterOperator] Row Count : 35 (OrderByFilterOperator.scala:64) (SparkUtils.scala:655)
2019-07-11 10:43:54.229 [INFO] [SparkUtils$] 2019-07-11 10:43:54,228 [INFO] [PivotOperator] OpId 5 : Pivot (PivotOperator.scala:59) (SparkUtils.scala:655)
2019-07-11 10:43:54.333 [INFO] [SparkUtils$] 2019-07-11 10:43:54,333 [INFO] [VectorAssembleColumnAddOperator] OpId 7 : AddVectorAssembleColumn (VectorAssembleColumnAddOp
erator.scala:51) (SparkUtils.scala:655)
2019-07-11 10:43:54.566 [INFO] [SparkUtils$] 2019-07-11 10:43:54,566 [INFO] [KafkaWriter] Send string message to Topic: smart_output (KafkaWriter.scala:71) (SparkUtils.s
cala:655)
2019-07-11 10:43:54.749 [INFO] [SparkUtils$] 2019-07-11 10:43:54,749 [INFO] [KafkaWriter] input dataframe row size : 1 (KafkaWriter.scala:72) (SparkUtils.scala:655)
2019-07-11 10:43:55.041 [INFO] [SparkUtils$] 2019-07-11 10:43:55,041 [INFO] [RenameColumnOperator] rename input DataFrame (RenameColumnOperator.scala:65) (SparkUtils.sca
la:655)
2019-07-11 10:43:55.043 [INFO] [SparkUtils$] 2019-07-11 10:43:55,043 [INFO] [RenameColumnOperator] rename input DataFrame (RenameColumnOperator.scala:65) (SparkUtils.sca
la:655)
2019-07-11 10:43:55.591 [INFO] [SparkUtils$] 2019-07-11 10:43:55,591 [INFO] [RenameColumnOperator] rename input DataFrame (RenameColumnOperator.scala:65) (SparkUtils.sca
la:655)
2019-07-11 10:43:56.033 [INFO] [SparkUtils$] 2019-07-11 10:43:56,033 [INFO] [HttpClientWriter] Request target Url: http://129.254.170.245:50003/apl/v1/data (HttpClie
ntWriter.scala:115) (SparkUtils.scala:655)
2019-07-11 10:43:56.034 [INFO] [SparkUtils$] 2019-07-11 10:43:56,033 [INFO] [HttpClientWriter] Request body: {"noise":0.897419,"noise_next":0.6976139} (HttpClie
ntWriter.scala:116) (SparkUtils.scala:655)
2019-07-11 10:43:56.040 [INFO] [SparkUtils$] 2019-07-11 10:43:56,040 [INFO] [HttpClientWriter] Write Result: OK (HttpClientWriter.scala:126) (SparkUtils.scala:655)
2019-07-11 10:44:10.658 [INFO] [Group Metadata Manager on Broker 1]: Removed 0 expired offsets in 0 milliseconds. (kafka.coordinator.GroupMetadataManager)
2019-07-11 10:54:10.658 [INFO] [Group Metadata Manager on Broker 1]: Removed 0 expired offsets in 0 milliseconds. (kafka.coordinator.GroupMetadataManager)
2019-07-11 11:04:10.658 [INFO] [Group Metadata Manager on Broker 1]: Removed 0 expired offsets in 0 milliseconds. (kafka.coordinator.GroupMetadataManager)
```



4) Analyze & Control Device

Analyze	<pre>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]</pre>
Visualize	<pre>----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]</pre>
Control Device	<pre>----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 -</pre>

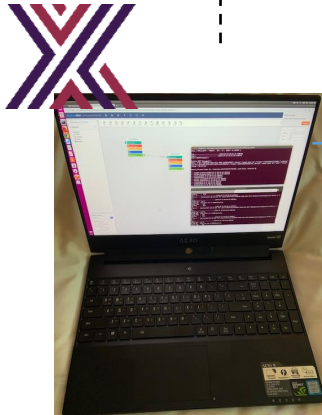
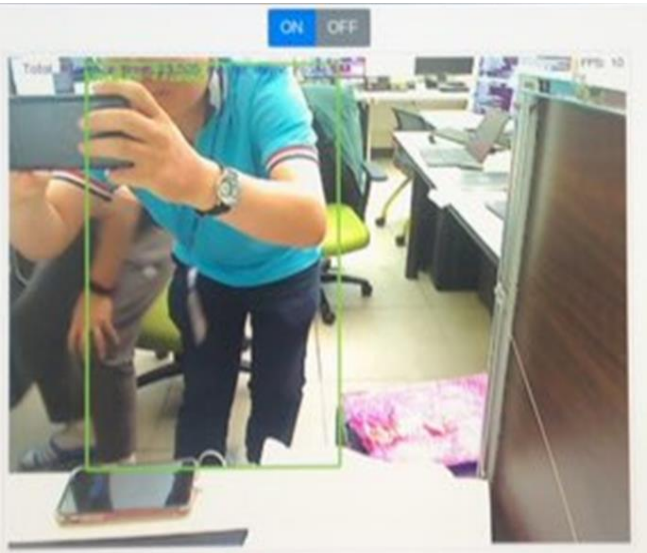
5) Actuate Device

```
csle@csle1: ~/iec_smart_construction/docker/device_services/iec_device_object
csle@csle1:~/iec_smart_construction/docker/device_services/iec_device_object
* Detected change in '/home/csle/iec_smart_construction/docker/device_services/iec_device_object/iec_device_object_detector_edgex.py', reloading
* Restarting with stat
* Debugger is active!
* Debugger PIN: 190-673-865
start-----[2019-07-11 10:42:08.060444]
input[{"hq": "on"}]
OD_CMD_URL: http://129.254.171.114:5000/detection
Status code : 200
Encoding : None
end-----[2019-07-11 10:42:08.078616]
129.254.170.245 - - [11/Jul/2019 10:42:08] "PUT /api/v1/devices/722d7fce-1ecc-466d-b6f9-6ae6db7c7719/highquality HTTP/1.1" 200 -
start-----[2019-07-11 10:43:26.058246]
input[{"hq": "off"}]
OD_CMD_URL: http://129.254.171.114:5000/detection
Status code : 200
Encoding : None
end-----[2019-07-11 10:43:26.076701]
129.254.170.245 - - [11/Jul/2019 10:43:26] "PUT /api/v1/devices/722d7fce-1ecc-466d-b6f9-6ae6db7c7719/highquality HTTP/1.1" 200 -
start-----[2019-07-11 10:43:53.075295]
input[{"hq": "on"}]
OD_CMD_URL: http://129.254.171.114:5000/detection
Status code : 200
Encoding : None
end-----[2019-07-11 10:43:53.075295]
129.254.170.245 - - [11/Jul/2019 10:43:53] "PUT /api/v1/devices/722d7fce-1ecc-466d-b6f9-6ae6db7c7719/highquality HTTP/1.1" 200 -
```

Object-DS

```
File Edit Tabs Help
p@raspberrypi: ~/Detection
11:21:17 "POST /detection HTTP/1.1" 200 -
2019-07-10 03:21:20,430 INFO _main__ detection(): command:ON is_async:True flip
code:None is_obj_det:True is_face_det:False is_ag_det:False is_en_det:False is
hp_det:False is_lm_det:False
2019-07-10 03:21:20,430 INFO werkzeug _log(): 129.204.170.245 - - [10/Jul/2019 0
11:21:20] "POST /detection HTTP/1.1" 200 -
2019-07-10 03:21:20,841 INFO _main__ detection(): command:OFF is_async:True flip
code:None is_obj_det:False is_face_det:False is_ag_det:False is_en_det:False i
hp_det:False is_lm_det:False
2019-07-10 03:21:20,841 INFO werkzeug _log(): 129.204.170.245 - - [10/Jul/2019 0
11:21:20] "POST /detection HTTP/1.1" 200 -
2019-07-10 03:21:20,820 INFO _main__ detection(): command:ON is_async:True flip
code:None is_obj_det:True is_face_det:False is_ag_det:False is_en_det:False is
hp_det:False is_lm_det:False
2019-07-10 03:21:20,820 INFO werkzeug _log(): 129.204.170.245 - - [10/Jul/2019 0
11:21:20] "POST /detection HTTP/1.1" 200 -
2019-07-10 03:21:31,830 INFO _main__ detection(): command:OFF is_async:True flip
code:None is_obj_det:False is_face_det:False is_ag_det:False is_en_det:False i
hp_det:False is_lm_det:False
2019-07-10 03:21:31,832 INFO werkzeug _log(): 129.204.170.245 - - [10/Jul/2019 0
11:21:31] "POST /detection HTTP/1.1" 200 -
*** Error in 'python3': double free or corruption (fasttop): >pid@raspberrypi:
./Detection 0
./Detection 0
```

Object-Detector



Raspberry pi 3 B+

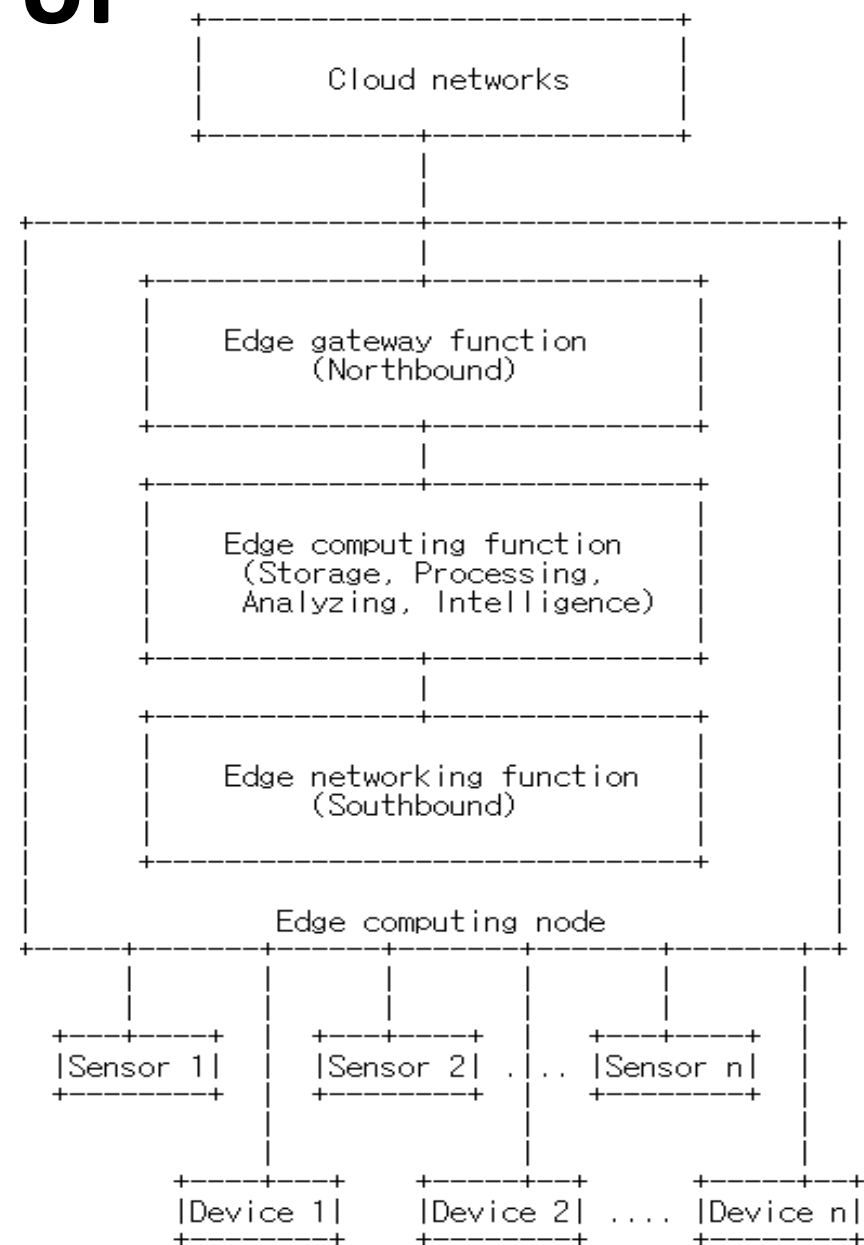


Movidius NCS2

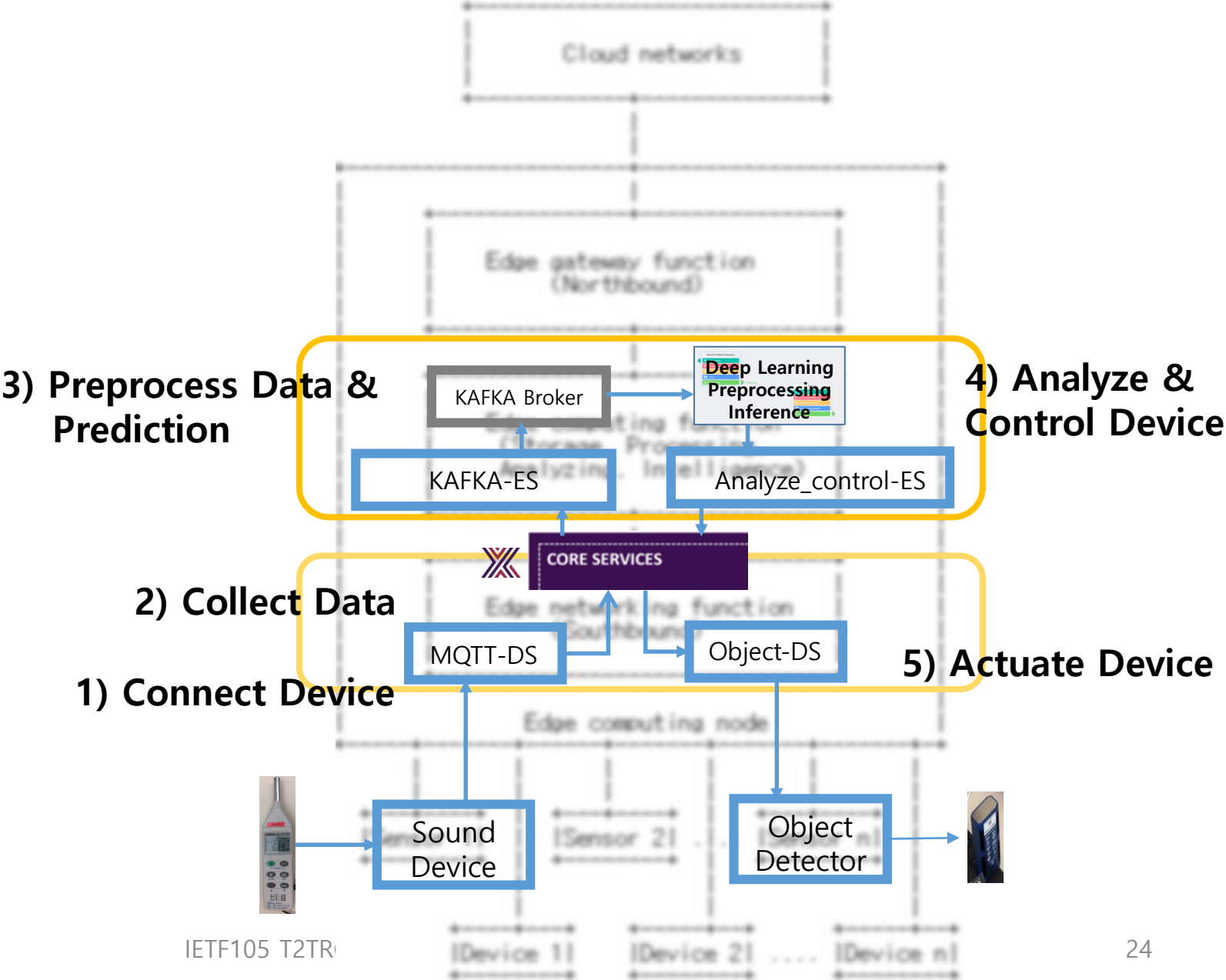


Logitech camera

Gateway-based architecture of IoT Edge computing



How our implementation is related to the draft



Thanks!!

Questions & Comments