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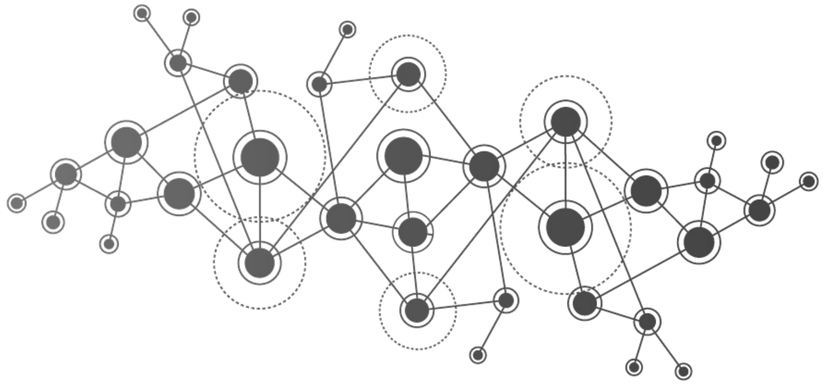

Intelligent Internet of Things

IoT Smart Object Design

Prof. Marco Picone

A.A 2023/2024

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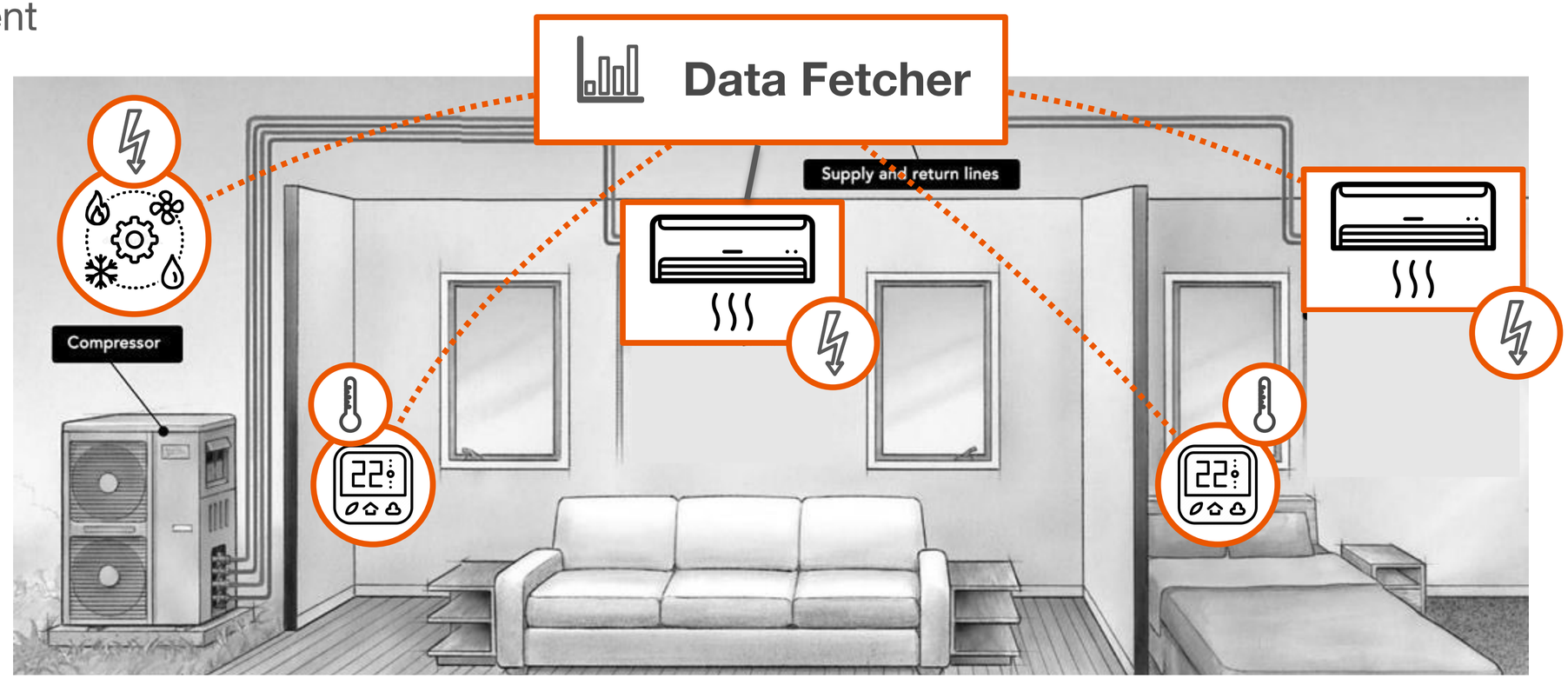
CoAP Smart Object Design

- Use Case Presentation
- Resource, Data & Communication
- Smart Object Resource Modelling
- Software Libraries
- Development :)

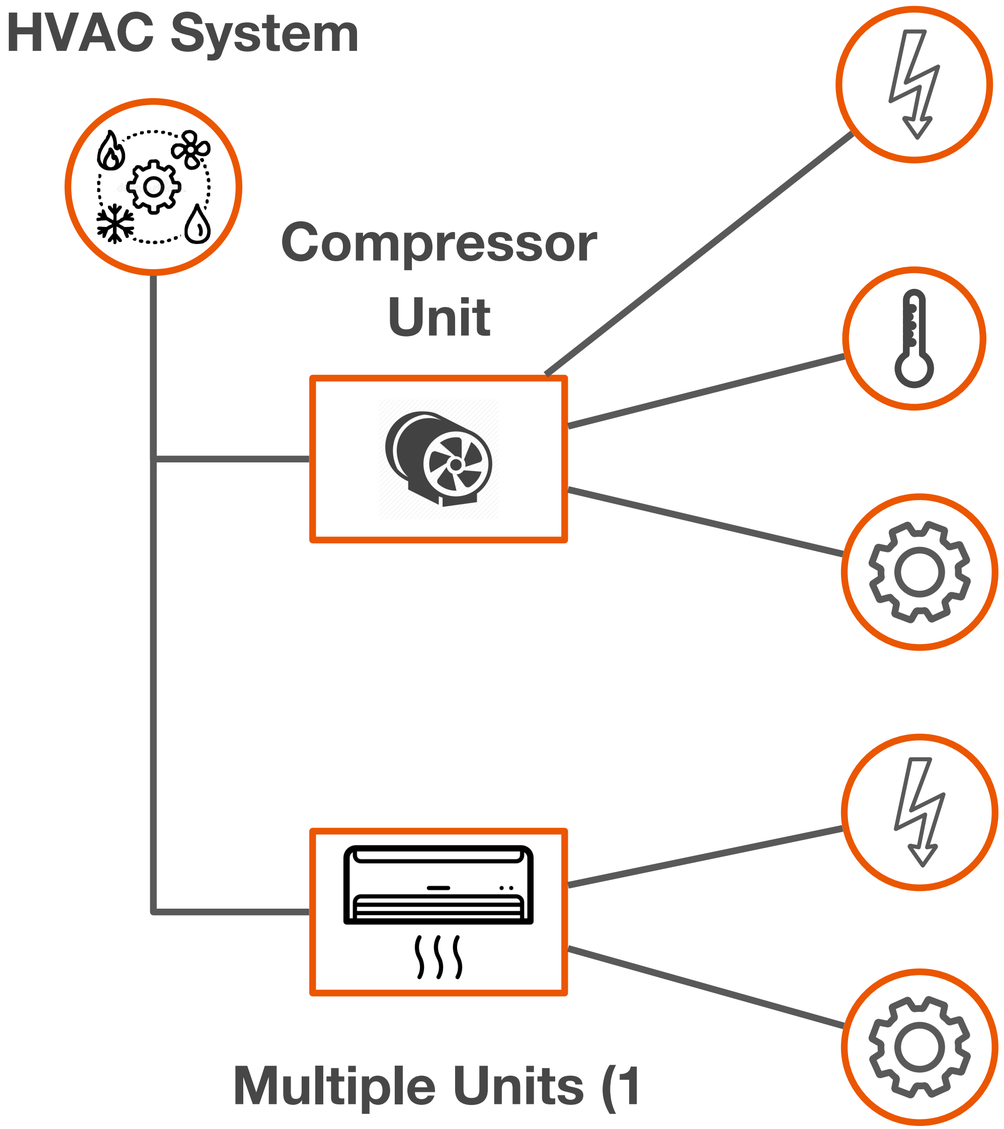
2023 - Marco Picone, Ph.D. (marco.picone@unimore.it)

Application Use Case - Smart Home

- The target application scenario is associated to a Smart Home with the following sensors and actuator:
  - A thermostat with a temperature sensor for each room
  - An HVAC (Heating, Ventilation and Air Conditioning) appliance ables to operate independently in each room
  - Each device provides also a energy monitoring sensor in order to measure the consumed energy in real-time
  - A Data Fetcher application collect data from all the actors to monitor and log the behavioural history of the apartment



Resource Hierarchy - HVAC



Energy Consumption Sensor → Energy Consumption kWh (kilowatt-hour)

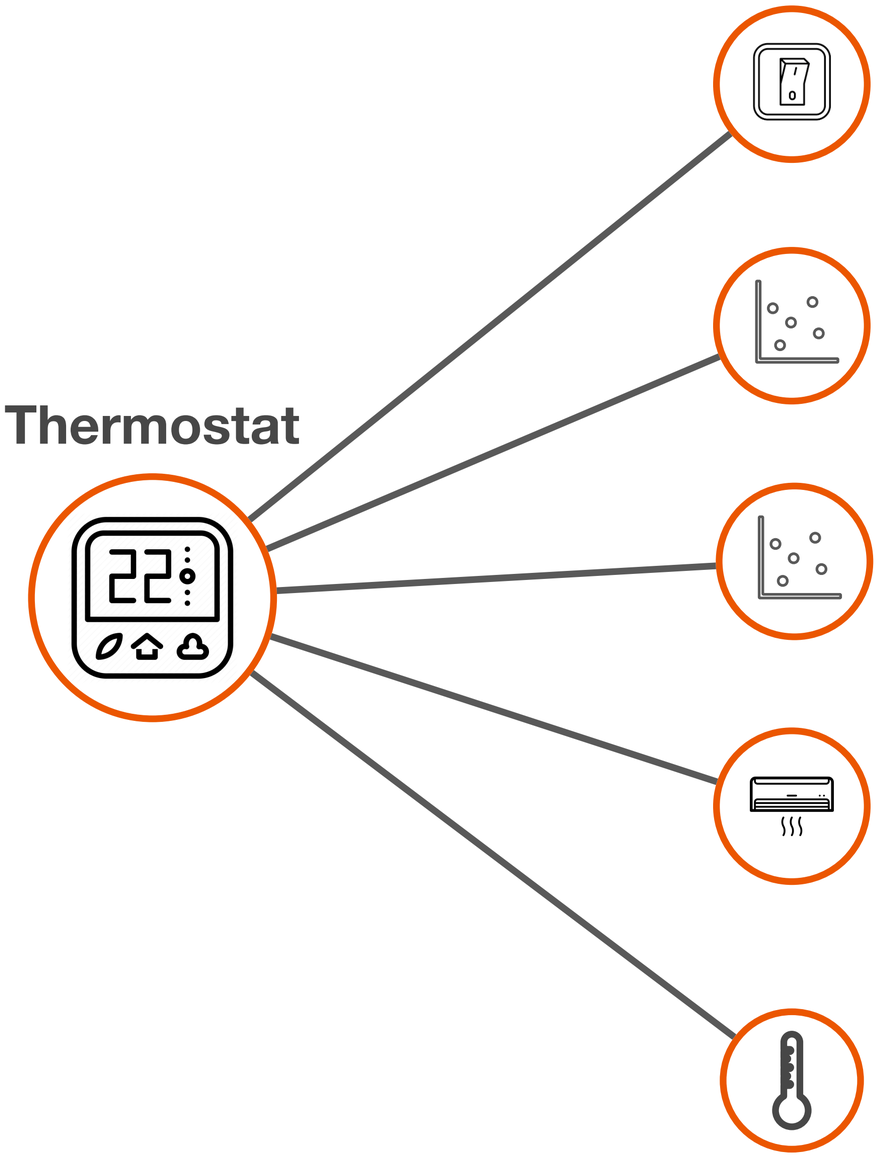
Outdoor Temperature Sensor → Temperature C (Celsius)

Engine Actuator → On/Off (Default On)

Energy Consumption Sensor → Energy Consumption kWh (kilowatt-hour)

Engine Actuator → Multiple Status
Operational Mode: Heating, Ventilation, AirConditioning
Intensity Level: Off, Low, Medium, High

Resource Hierarchy - Thermostat



Thermostat Switch → On/Off

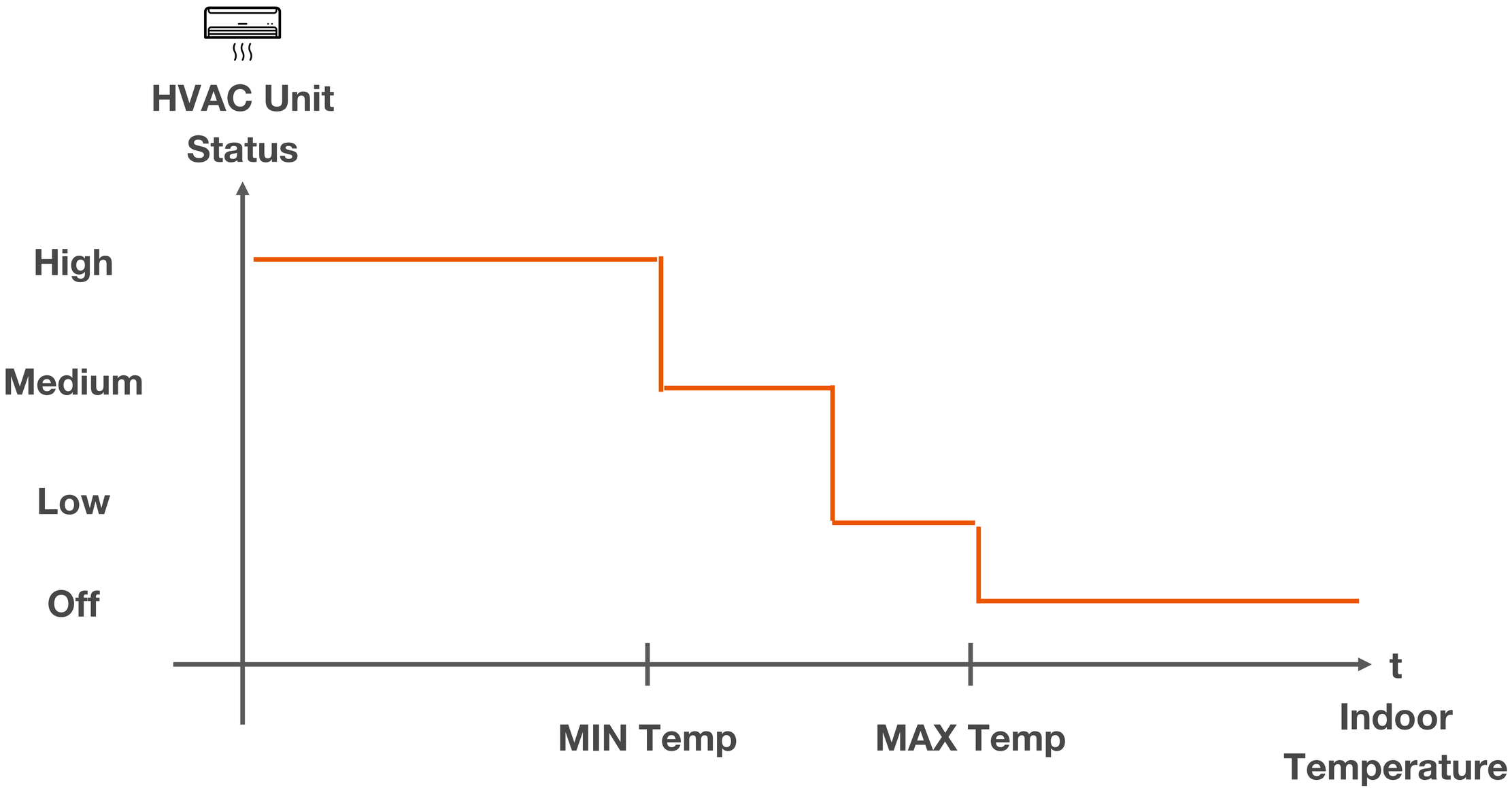
Target MAX Temperature Parameter → Temperature C (Celsius)

Target MIN Temperature Parameter → Temperature C (Celsius)

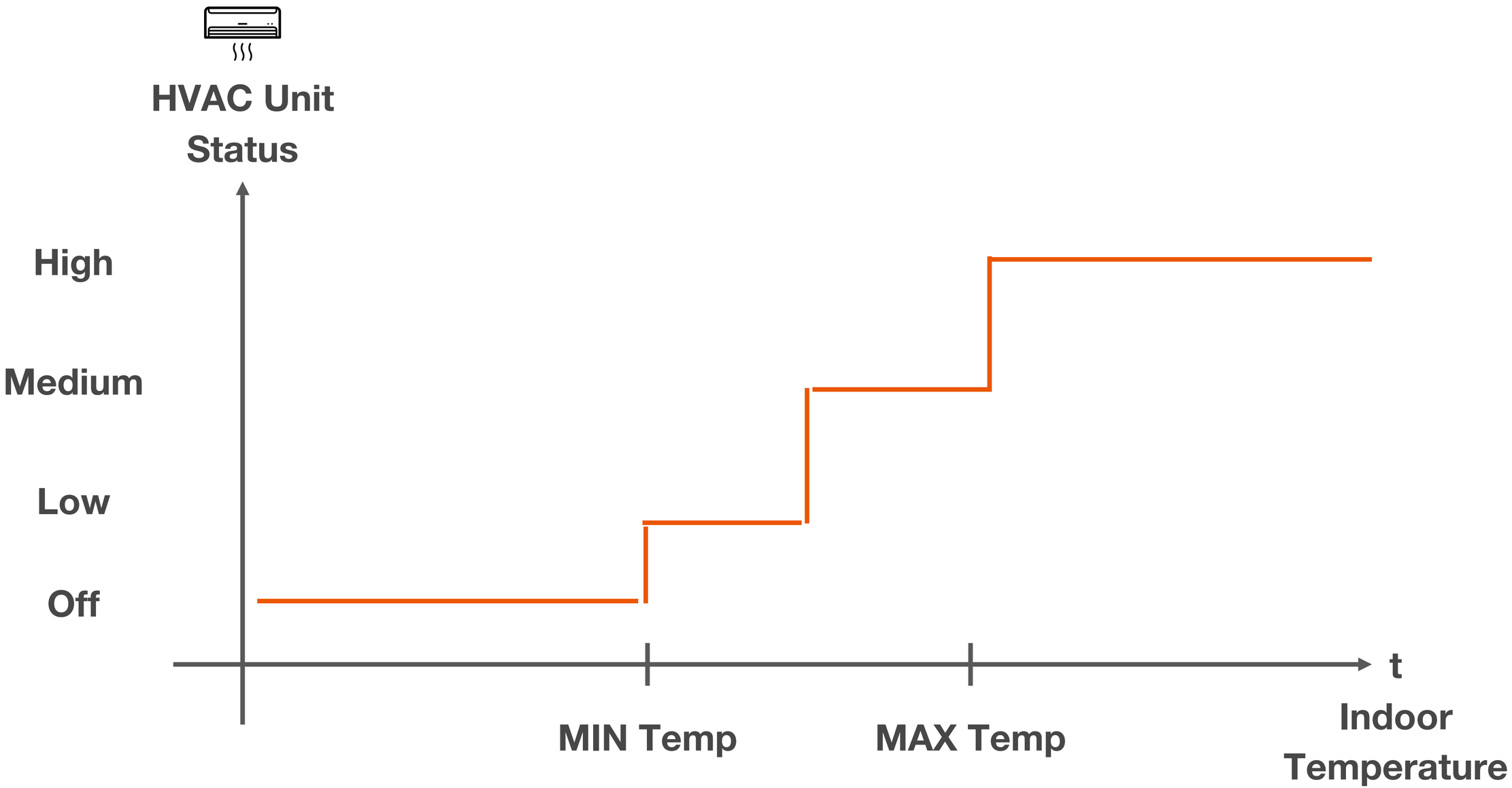
Target HVAC Unit Parameter → Resource URI Operational Mode (Heating, AirConditioning)

Indoor Temperature Sensor → Temperature C (Celsius)

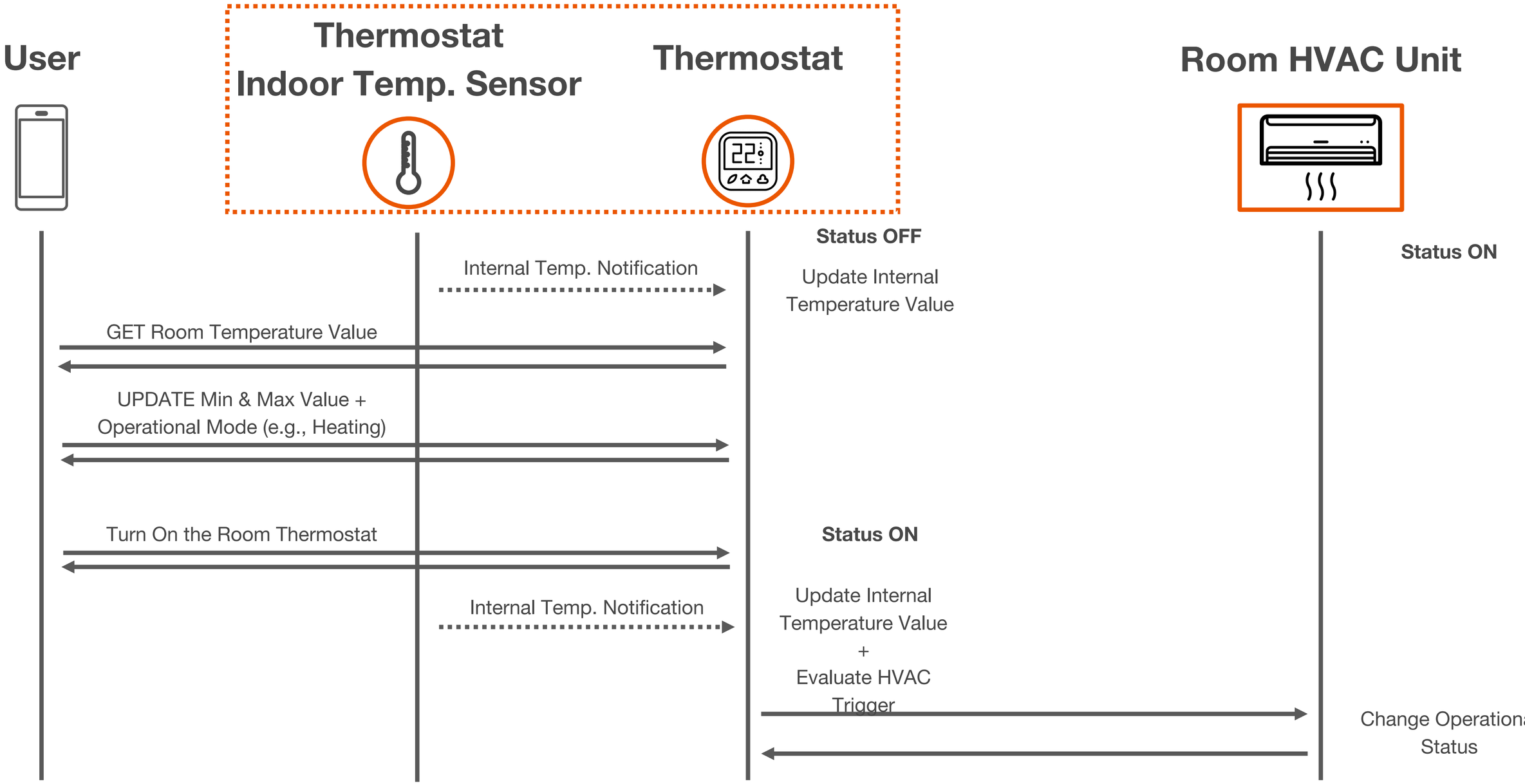
Thermostat - Heating Behaviour



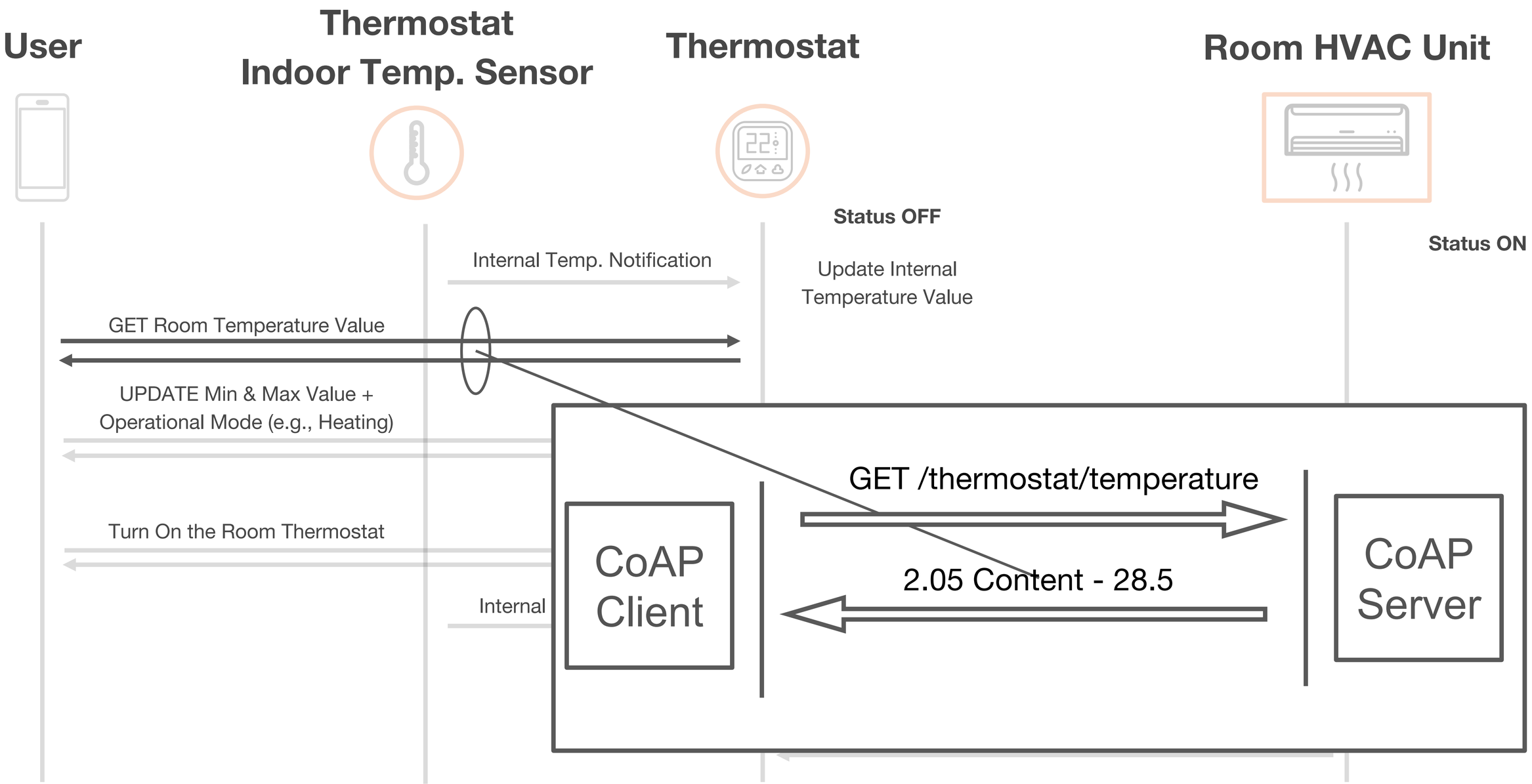
Thermostat - Air Conditioning Behaviour



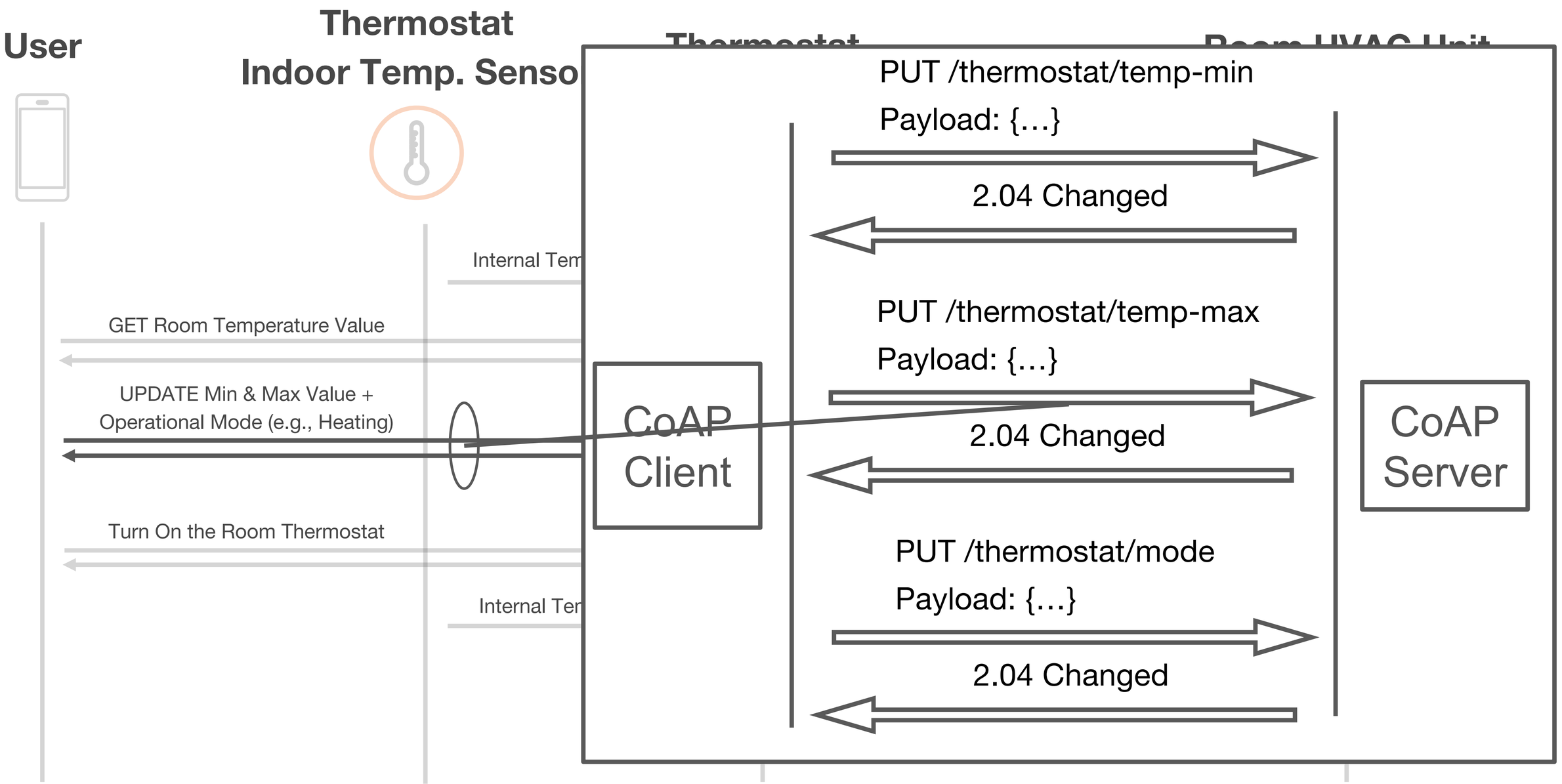
Behaviour (Example)



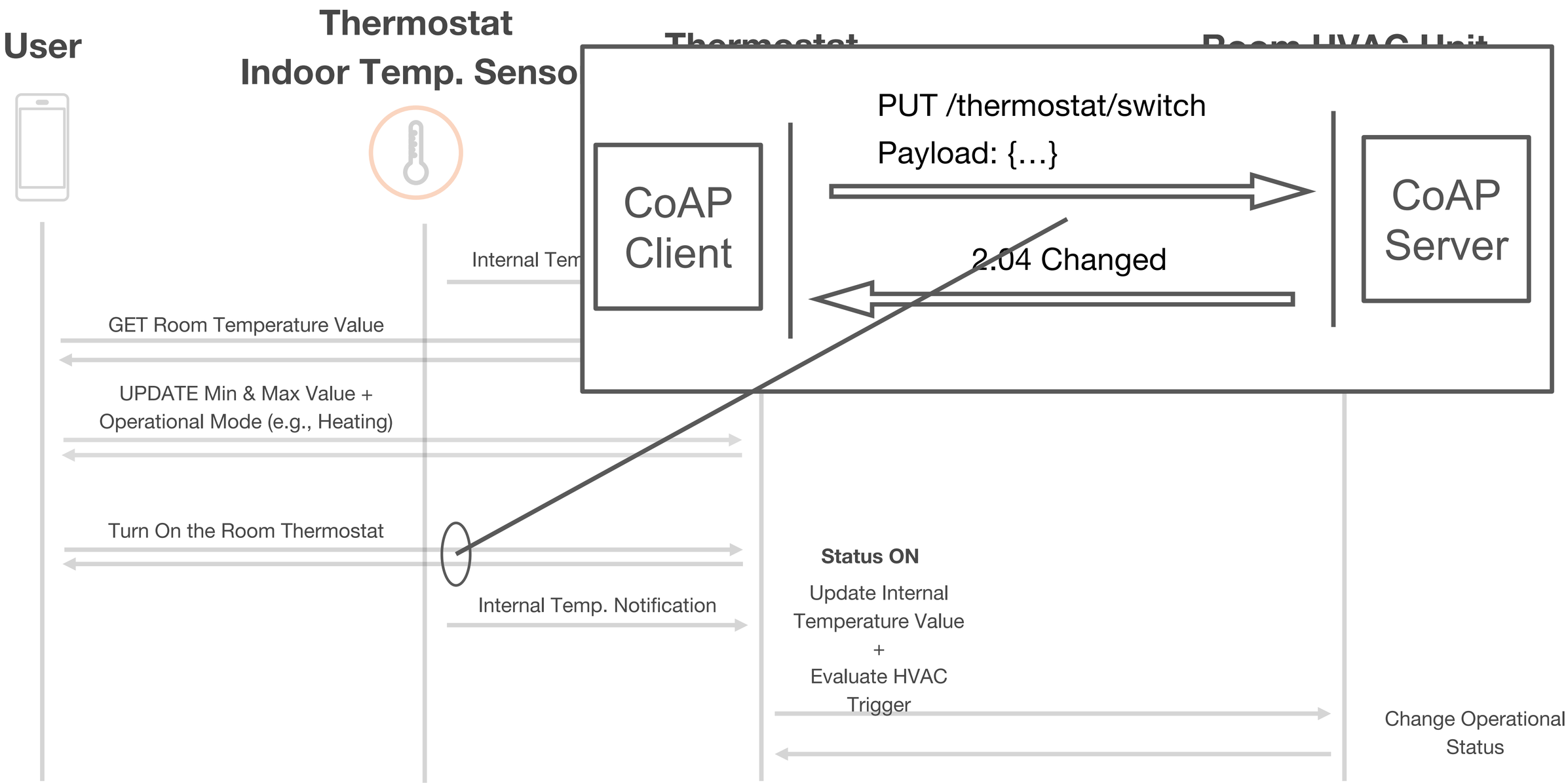
Behaviour (Example) - CoAP



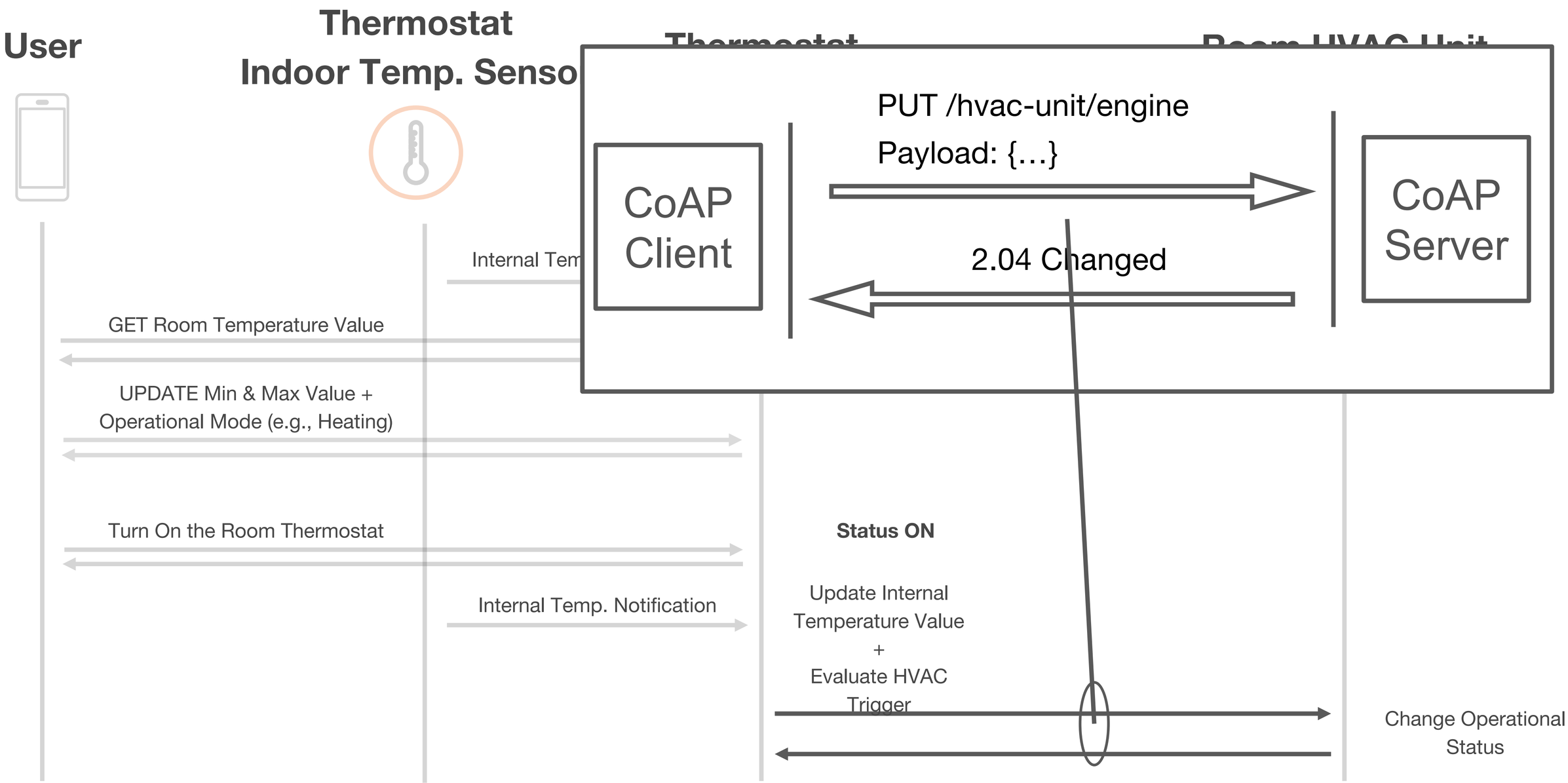
Behaviour (Example)



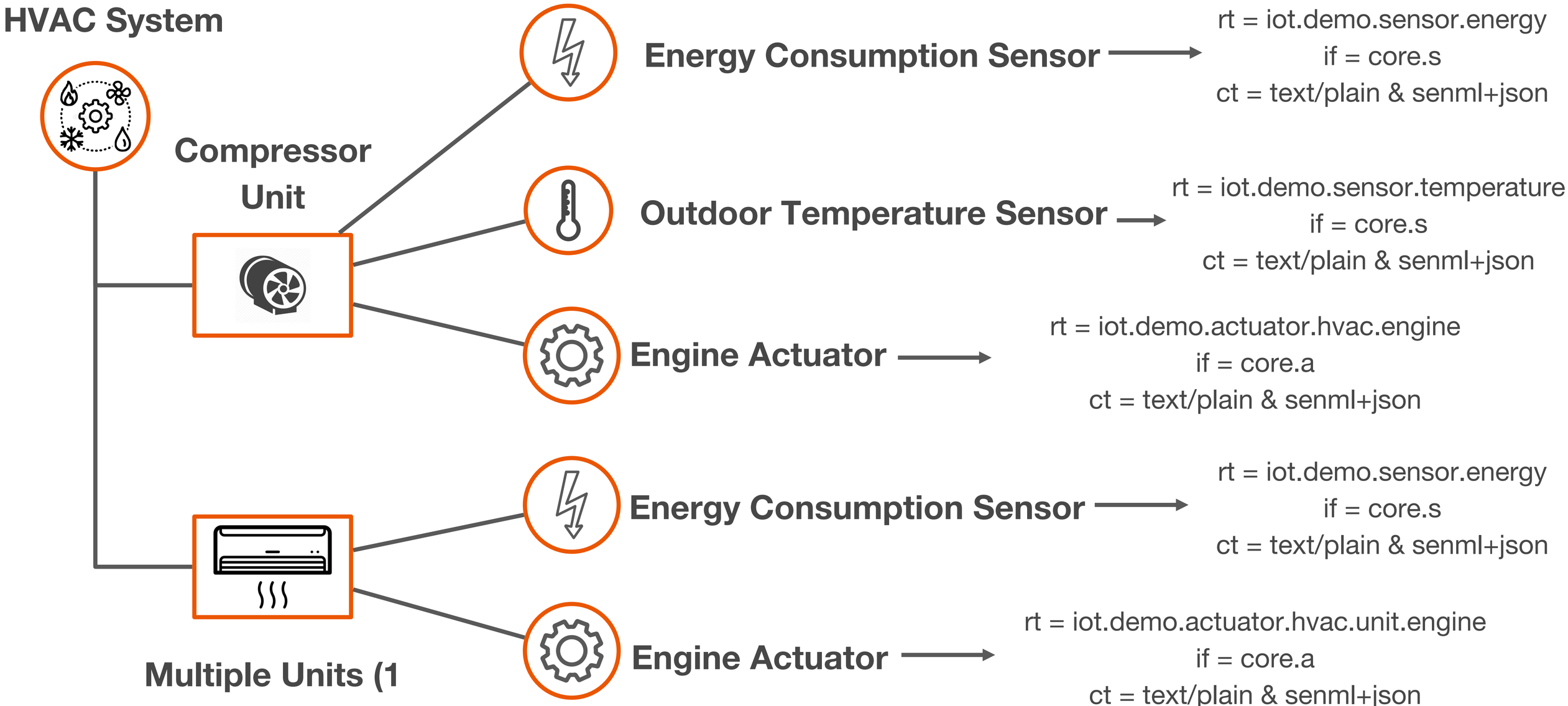
Behaviour (Example)



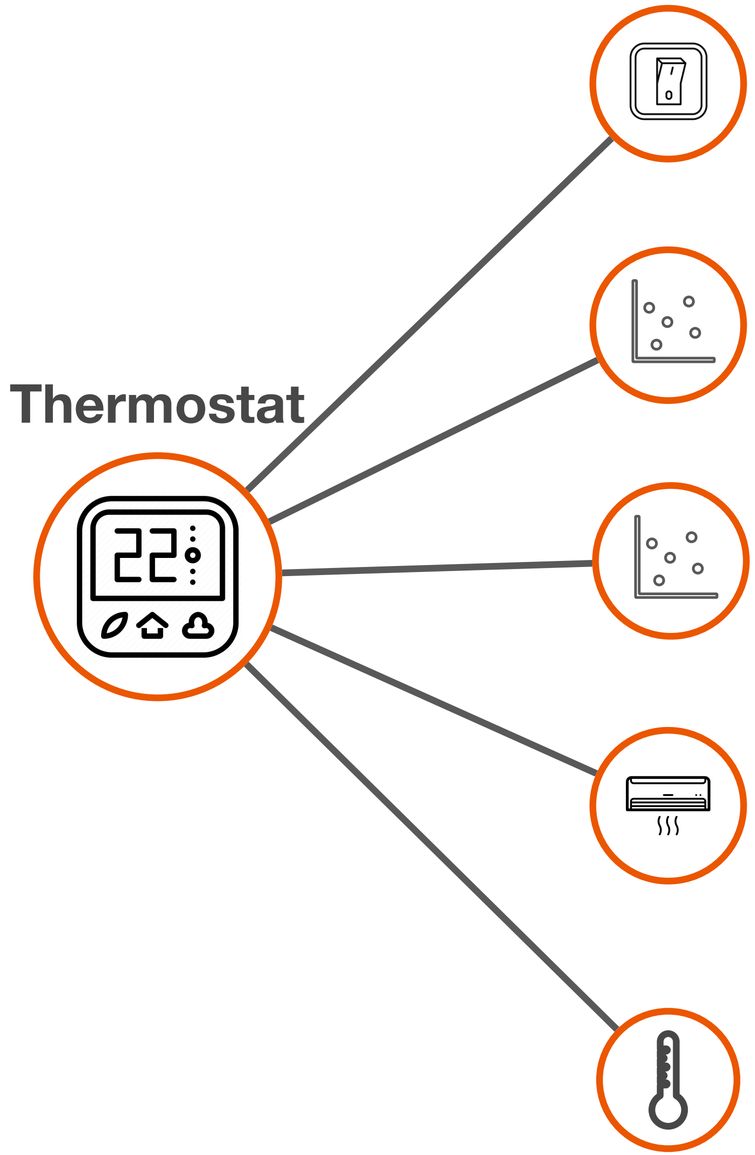
Behaviour (Example)



CoAP Resource Profiles



CoAP Resource Profiles



Thermostat Switch → rt = iot.demo.actuator.switch
if = core.a
ct = text/plain & senml+json

Target MAX Temperature Parameter → rt = iot.demo.param.maxtemp
if = core.p
ct = text/plain & senml+json

Target MIN Temperature Parameter → rt = iot.demo.param.mintemp
if = core.p
ct = text/plain & senml+json

Target HVAC Unit Parameter → rt = iot.demo.param.hvac.uri
if = core.p
ct = text/plain & senml+json

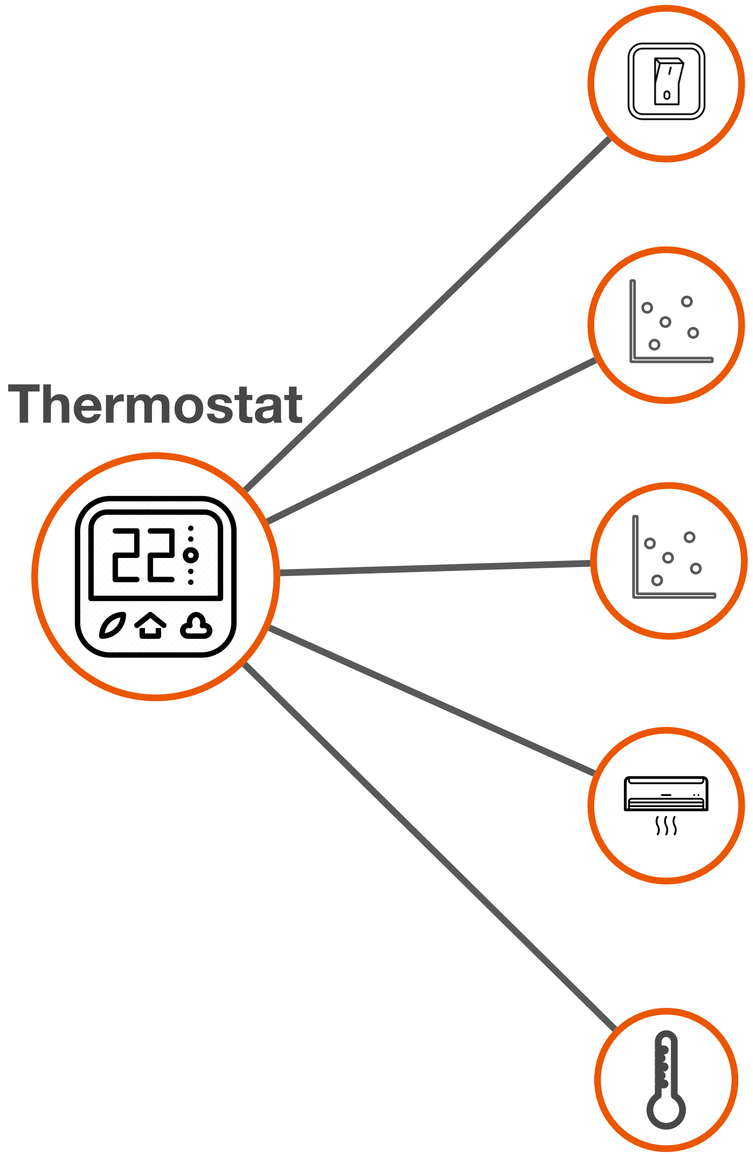
Indoor Temperature Sensor → rt = iot.demo.sensor.temperature
if = core.s
ct = text/plain & senml+json

CoAP & SenML

- Each modelled resource should use the SenML + Json MediaType both for reading measurements and for the actuation part
- The following example shows how SenML can be used to set the current set point of a typical residential thermostat that has a temperature set point

```
[
  {"bn":"urn:dev:ow:10e2073a01080063:"},
  {“n":"temp","u":"Cel","v":23.1}
]
```

CoAP Resource - Option 2



Target MAX Temperature Parameter

Target MIN Temperature Parameter

Target HVAC Unit Parameter

rt = iot.demo.thermostat.configuration
if = core.p
ct = text/plain & senml+json

Use a single resource to map all the parameters.

Pro: Simplified and structured solution

Limit: We need to now how the body is structured to interact with the parameter (e.g., using the rt)

CoAP & SenML - Change Multiple Parameters

- The following example shows how SenML can be used to set the current set point of a typical residential thermostat that has a temperature set point, a switch to turn on and off the heat

```
[
  {"bn":"urn:dev:ow:10e2073a01080063:"},
  {"n":"temp","u":"Cel","v":23.1},
  {"n":"heat","u":"/","v":1},
  {"n":"fan","u":"/","v":0}
]
```

The same structure and model can be used also to read the current parameter configuration

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MQTT Smart Object Design

- Use Case Presentation
- Resource, Data & Communication
- Message and Topics Design
- Smart Object Resource Modelling
- Software Libraries
- Development :)

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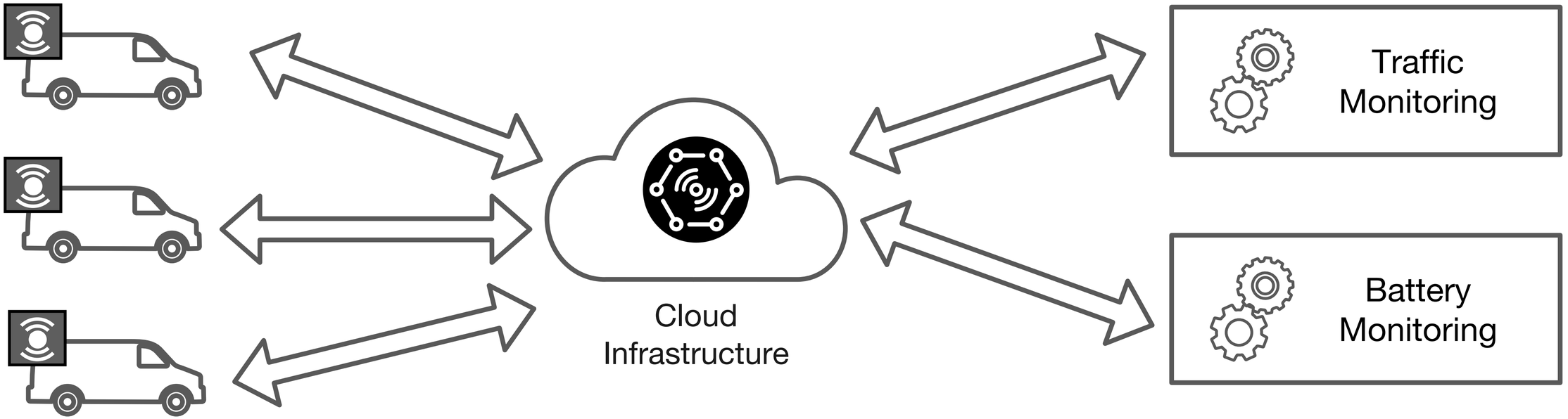
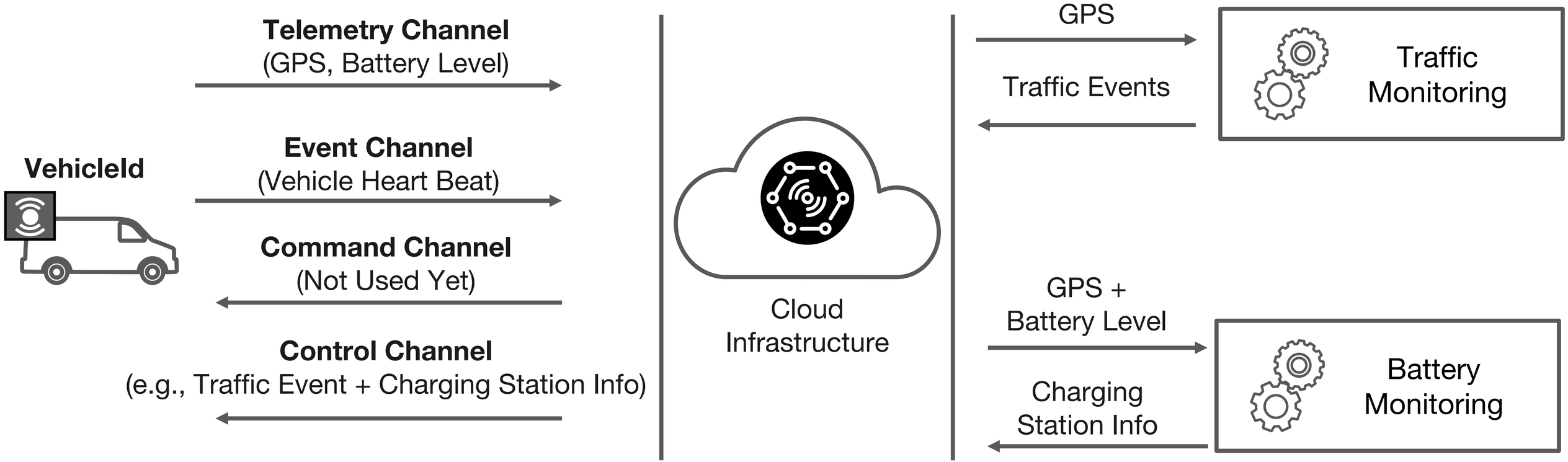
Application Use Case - Fleet Monitoring

- The target of the application use case is to monitor in real-time electric vehicles of a company's fleet while they are moving during the working hours
- Each vehicle is equipped with sensor to monitor:
  - GPS Position
  - Battery Level
- Two centralized application receive real-time data to:
  - Provide traffic information feedback if the vehicle is close to a Traffic Jam
  - Analyze the battery level to communicate a set of possible charging station for the vehicle



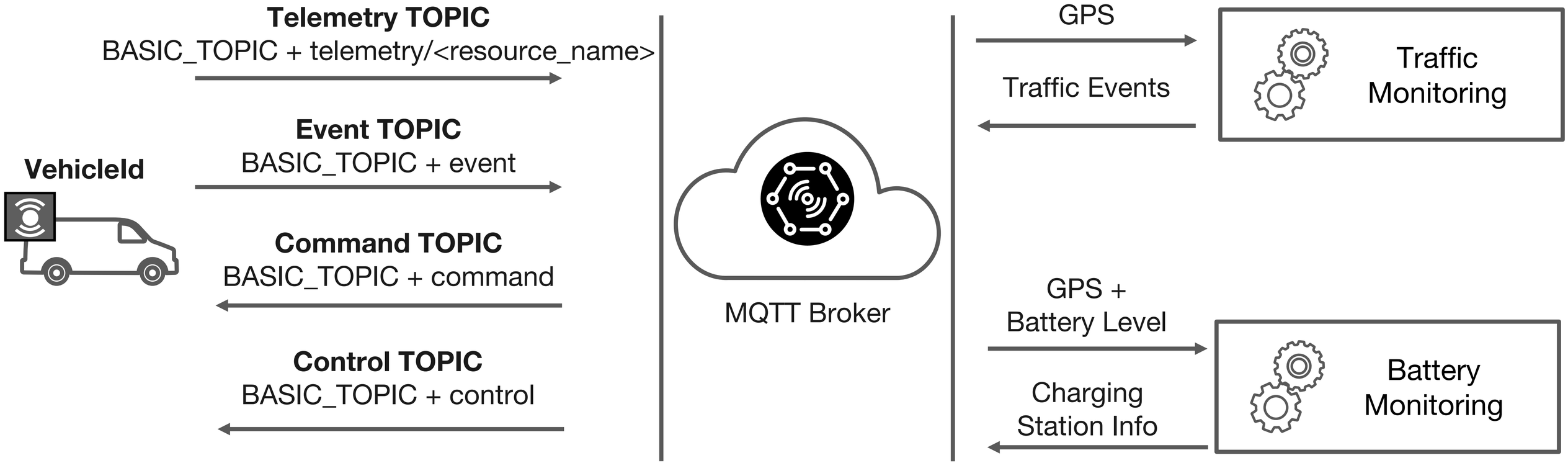
Data & Communications



Note: At this stage we are not considering security and authentication for involved vehicles

MQTT Design Overview

BASIC TOPIC: fleet/vehicle/<vehicleId>/



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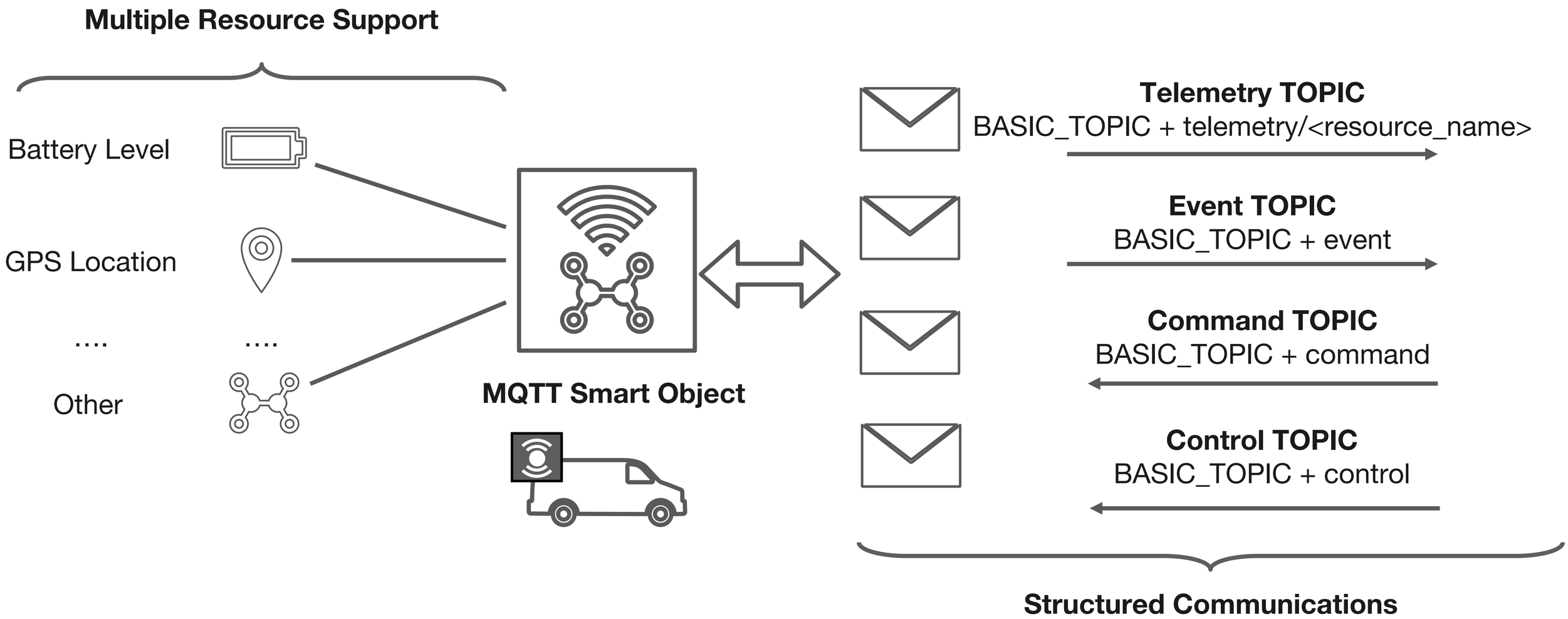
Smart Object Modelling



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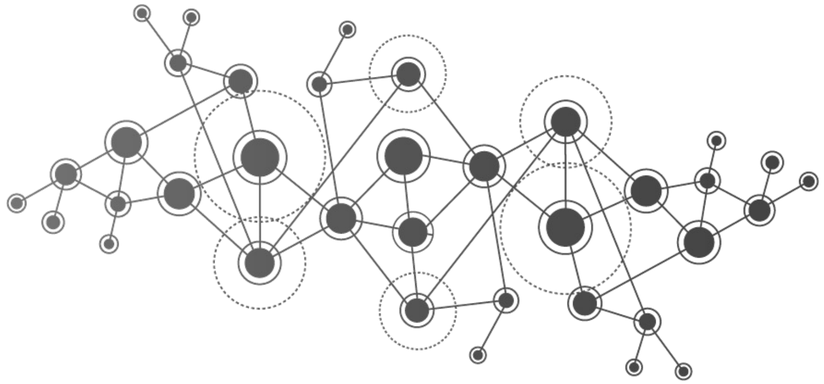

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