

# Middleware Support for Generic Actuation in the Internet of *Mobile* Things

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# Agenda

1. Introduction
2. Challenges
3. Generic Actuation
4. Our Approach
5. M-Act
6. SOM
7. Driver
8. Tests
9. Conclusions and Future Work



# Introduction

- Actuators are essential to IoT Applications
  - Smart Homes
  - Smart Industry
  - Smart Transportation
  - Healthcare
- Change their physical environment



# Challenges

- Process and memory limitations
- Short-Range Communication
- Need gateway to connect to the Internet



# Challenges

## ■ Diversity

- Different devices
- Different implementations
- Different command protocol



# Generic Actuation

- What?
  - Control any actuator
  - Independent protocol
  - Independent manufacturer
- How???



# Our Approach

- Taxonomy of Actuation
  - Blind
  - Reliable with active feedback
  - Reliable with passive feedback
  - Noticeable with indirect feedback
  - Noticeable with indirect and delayed feedback



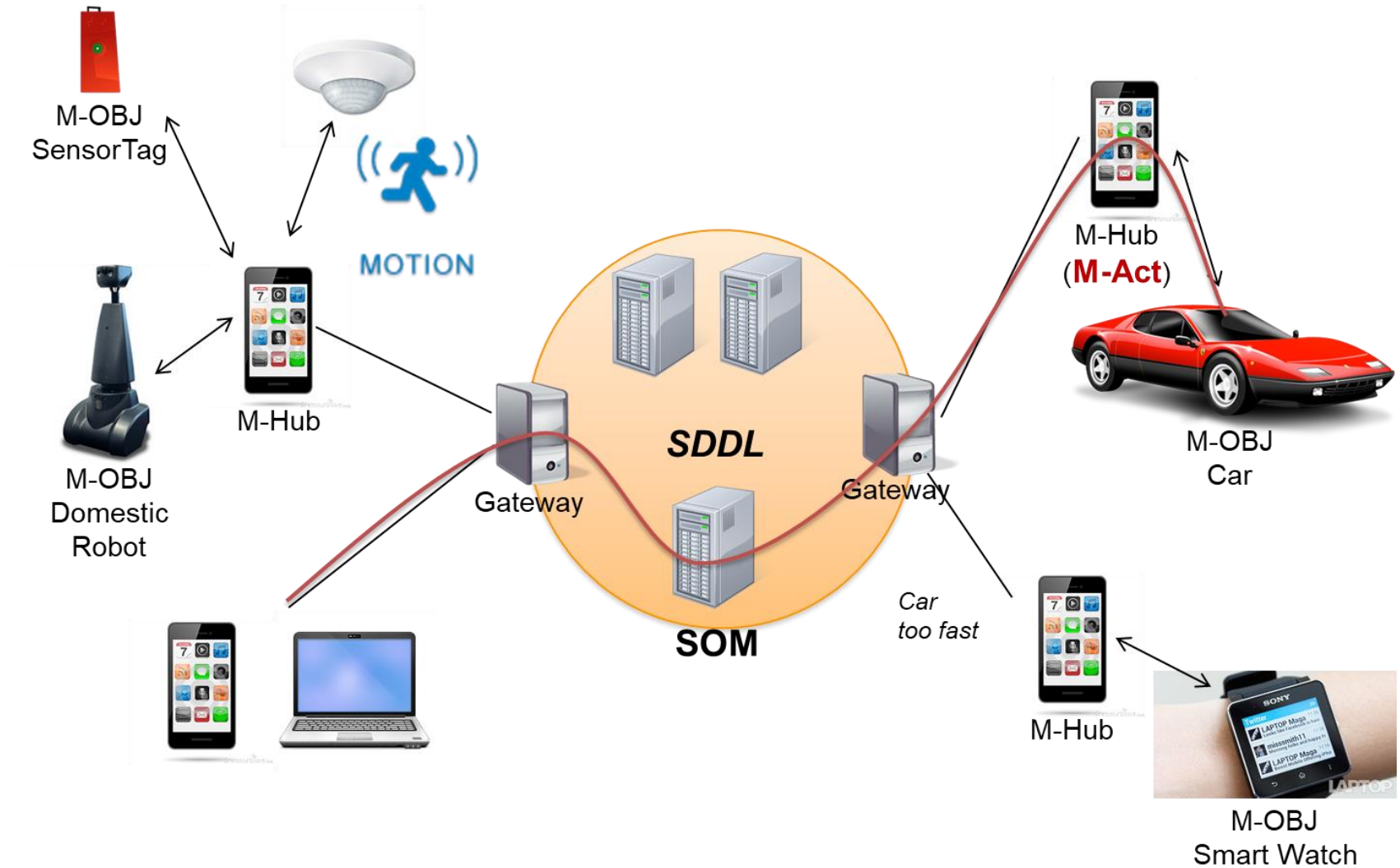
# Our Approach

- ContextNet Extension
- M-ACT
  - Microservice of M-Hub
  - Request drivers for the actuators
  - Translates generic commands to native protocol of actuators
- SOM (Smart Objects Manager)
  - Microservice of the ContextNet Core
  - Repository of drivers
  - List of devices registered
  - ConnectedTable
- Drivers to describe the native protocol





# Our Approach



# Our Approach

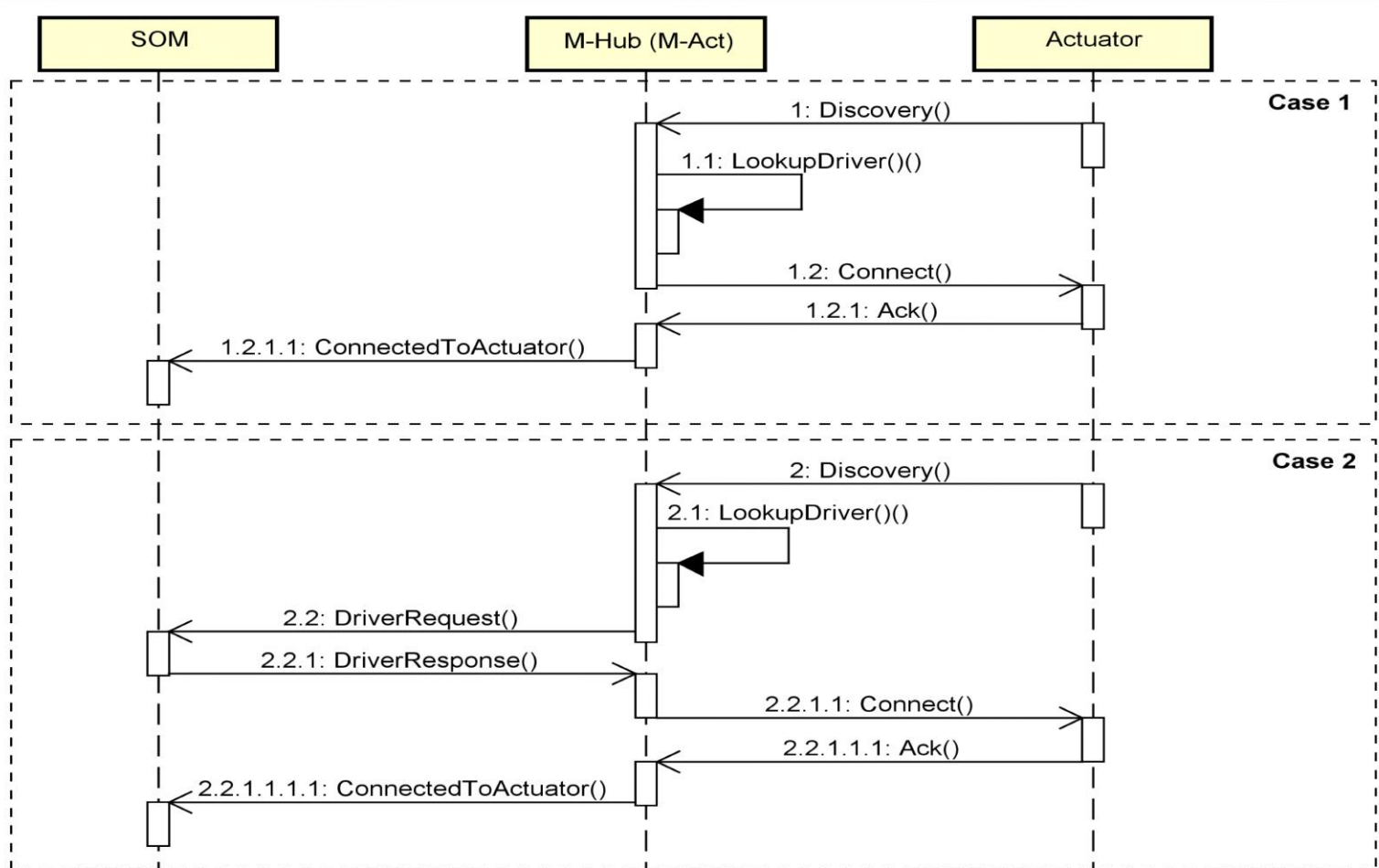
## ■ MACTQuery

```
{
  "MACTQuery" :
  {
    "type" : "cmd|driver",
    "label" : "command_label",
    "target" : "mobject id|mobject group id|...",
    "cmds" :
    [
      {
        "seq" : 0,
        "cmd" : "move|setColor|...",
        "args" : "cmd arguments accordingly to driver description"
      },
      {
        "seq" : 1,
        "cmd" : "move|setColor|...",
        "args" : "cmd arguments accordingly to driver description"
      }
    ]
  }
}
```



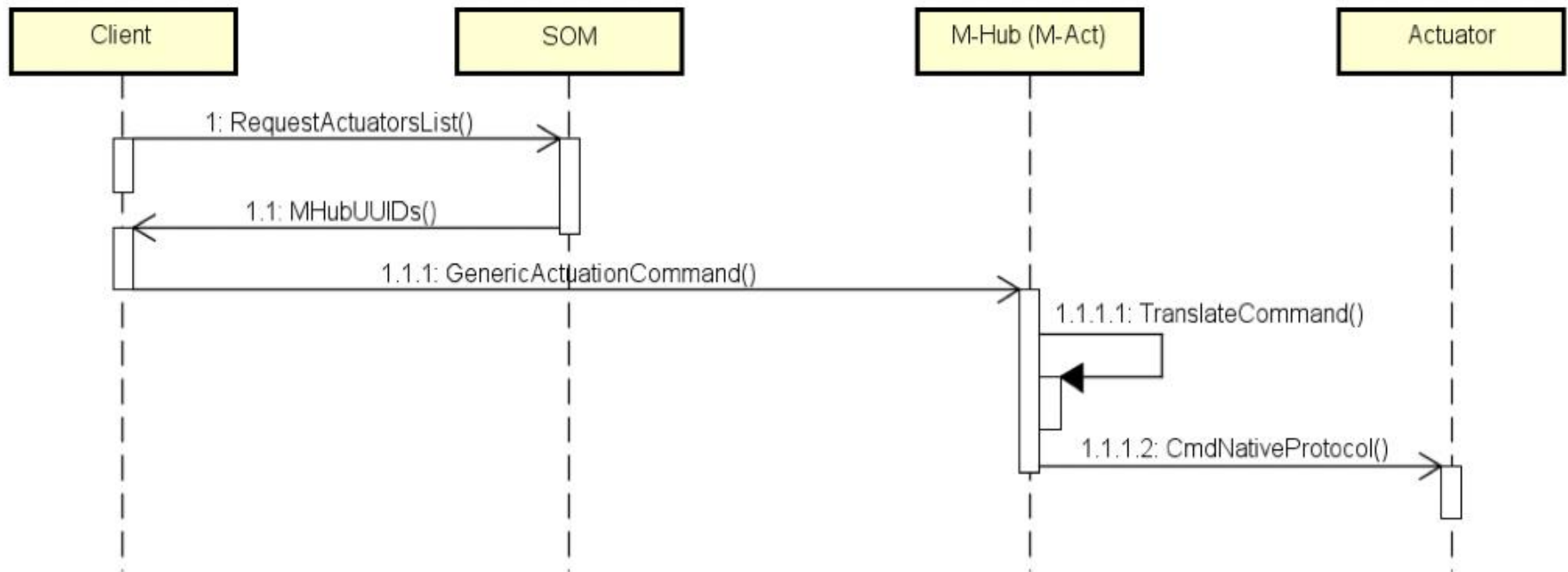
# Our Approach

## ■ Discovery and connection

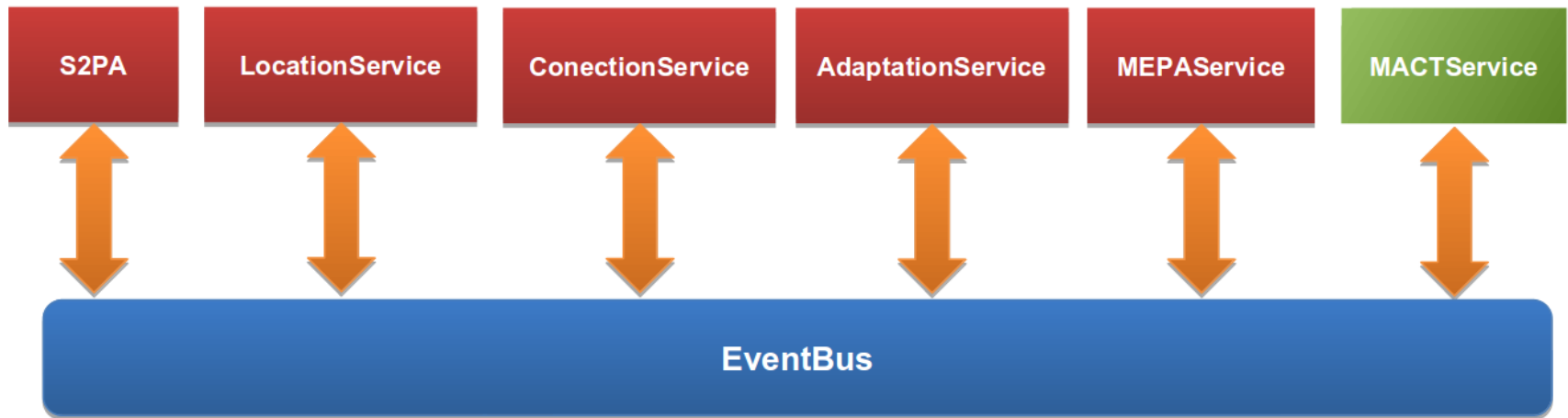


# Our Approach

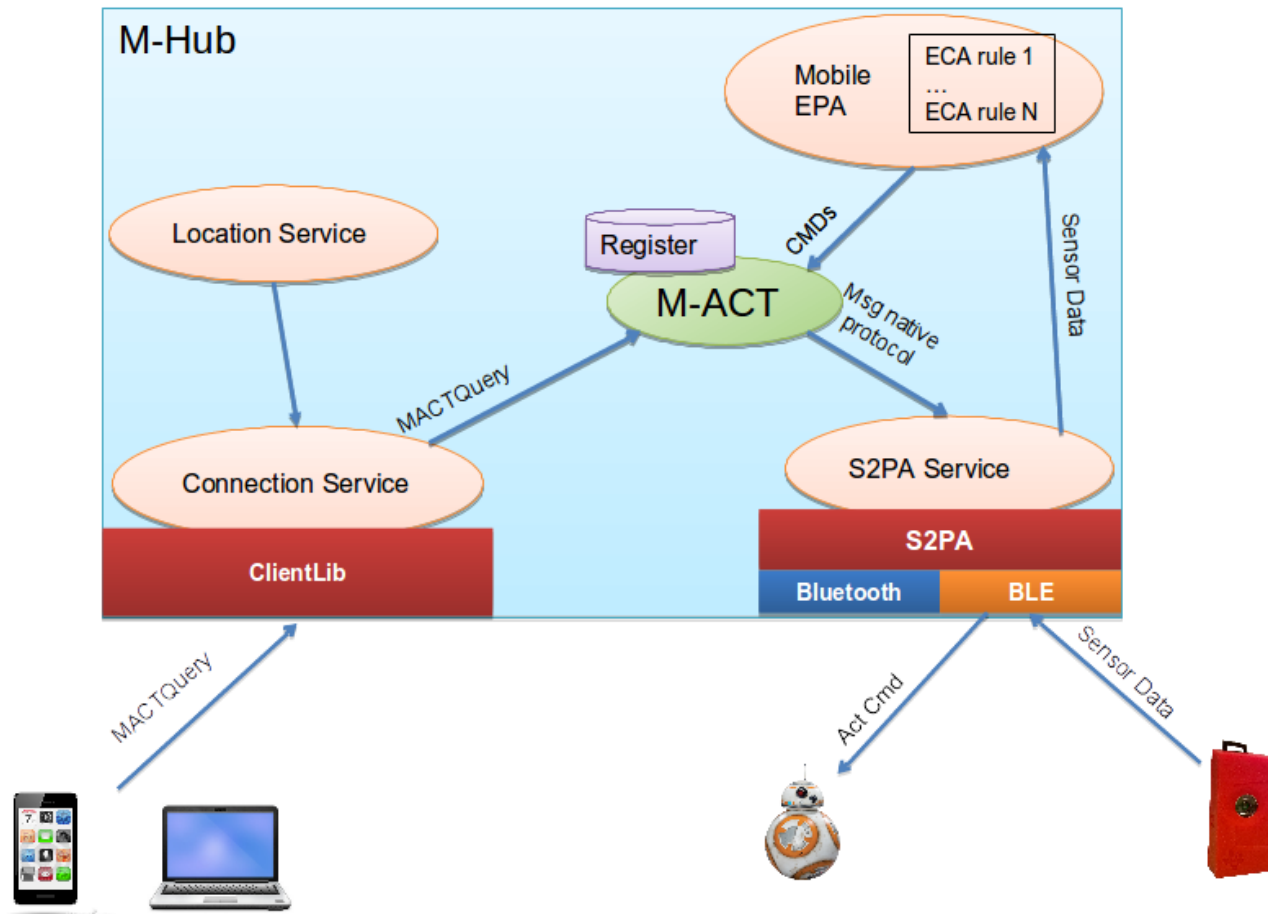
## ■ Actuation sequence



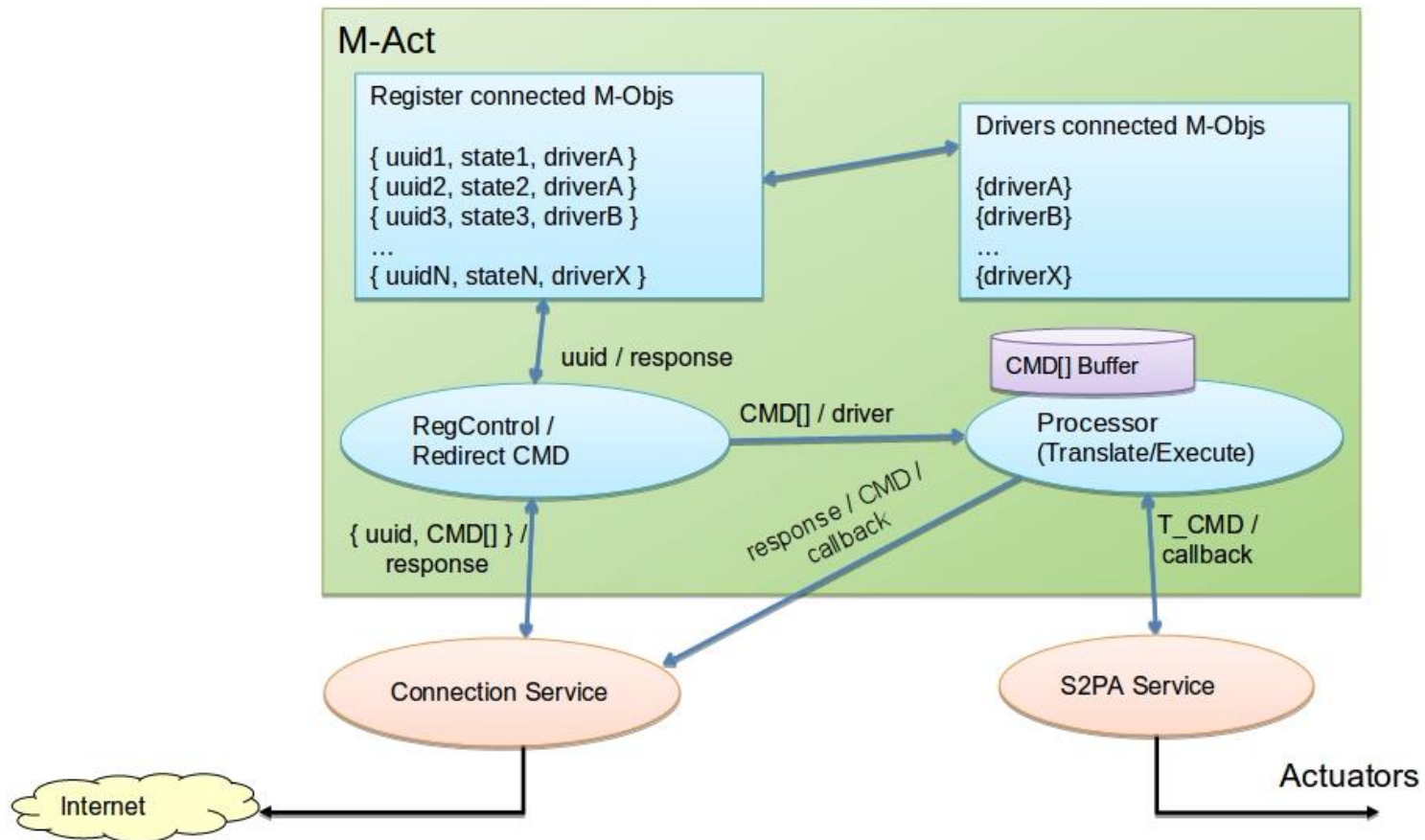
# M-Act

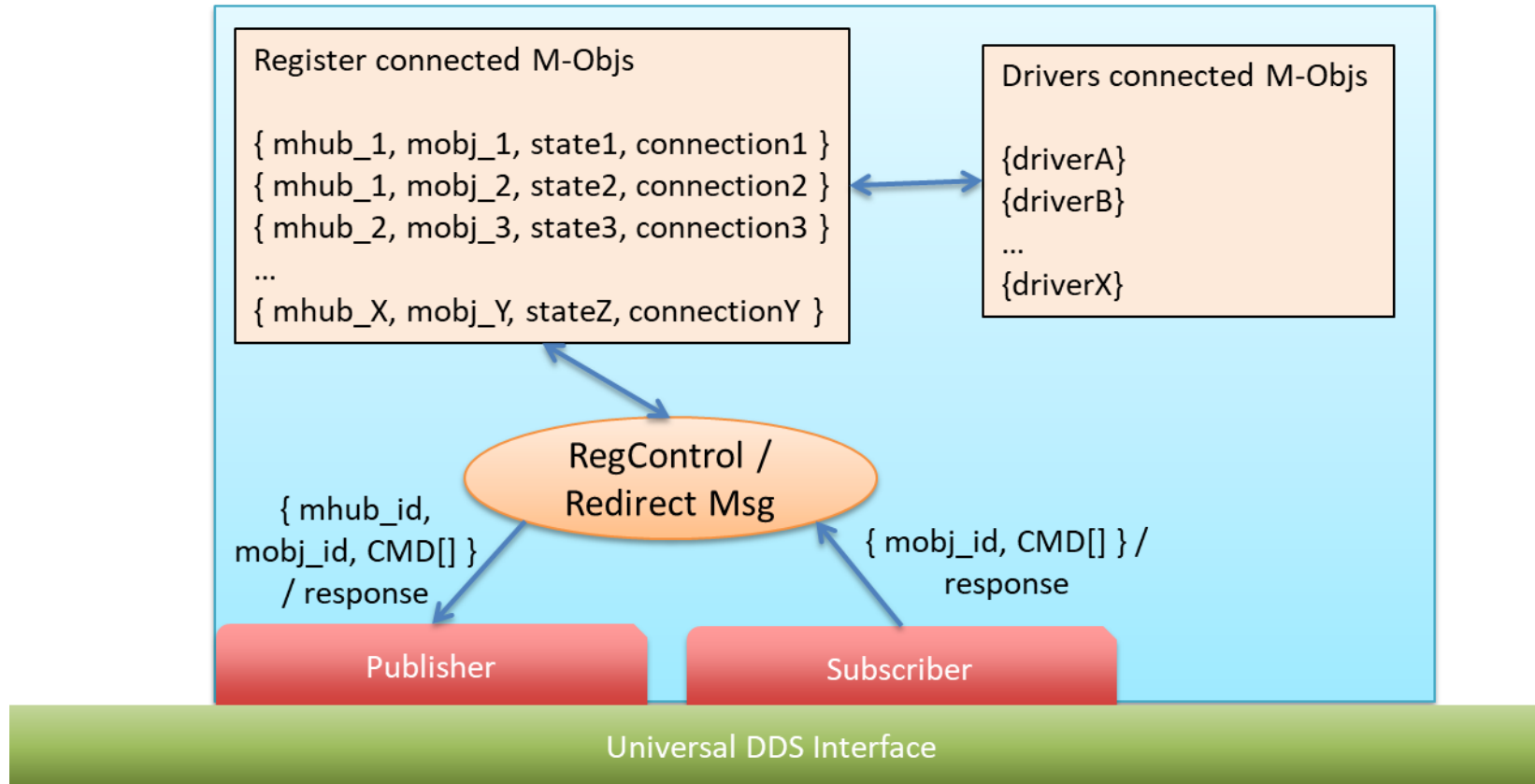


# M-Act



# M-Act







# Driver

## ■ JSON format

```
{
  "device_type" : "bb8",
  "interface": "ble",
  "connection":
  {
    "service": <uuid_service>,
    "characteristic": <uuid_characteristic>,
    "cmd" : <cmd_array>,
  },
  "commands":
  {
    "roll":
    {
      "service": <uuid_service>,
      "characteristic" : <uuid_characteristic>,
      "cmd" : "0x30",
      "arg_size" : "5",
      "arg_type" : "byte",
      "offset" : <offset_expression>,
      "cmd_line" : "0xFF, 0xFE, <cmd>, <args>, <arg_size>, <offset>"
    },
    <list_other_commands_available>,
  },
}
```



# Driver

## ■ JSON format

Device type and  
communication interface it uses

Connection Steps  
(e.g. To unlock the device)

List of available commands in a  
generic format and the  
specification to translate to the  
native protocol

```
{
  "device_type" : "bb8",
  "interface": "ble",
  "connection": {
    "service": <uuid_service>,
    "characteristic": <uuid_characteristic>,
    "cmd" : <cmd_array>,
  },
  "commands": {
    "roll": {
      "service": <uuid_service>,
      "characteristic" : <uuid_characteristic>,
      "cmd" : "0x30",
      "arg_size" : "5",
      "arg_type" : "byte",
      "offset" : <offset_expression>,
      "cmd_line" : "0xFF, 0xFE, <cmd>, <args>, <arg_size>, <offset>"
    },
    <list_other_commands_available>,
  },
}
```



# Tests

- Demonstrate the feasibility of our approach
- Control the Toy Robot BB-8
- Evaluate the overhead added
  - Average  $\sim 36\text{ms}$  added to translation



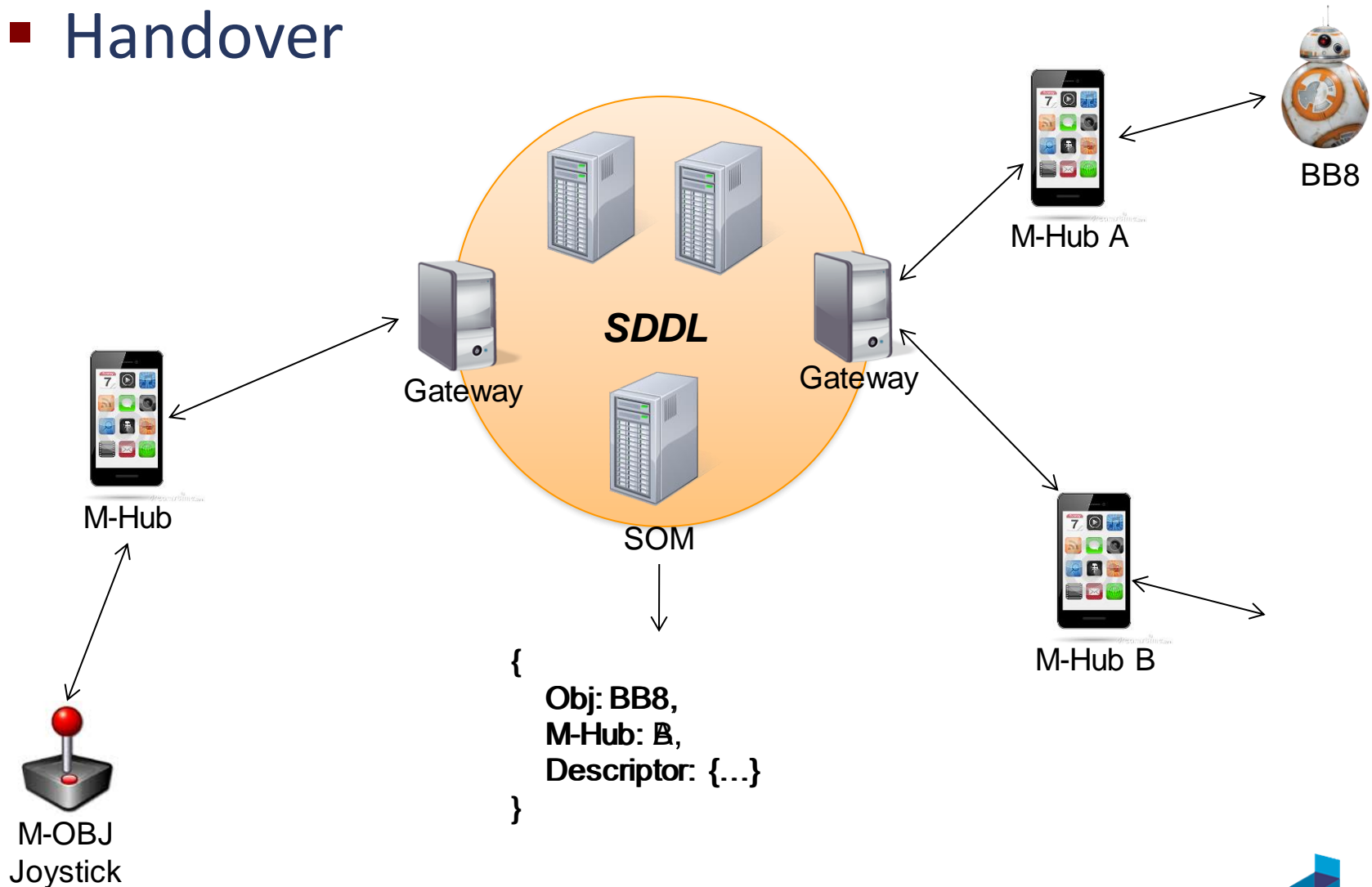
# Conclusions and Future Work

- Demonstrated the feasibility of the approach
- Mobile gateways can incur in actuation failures due to disconnection
- Suitable for smart homes, smart buildings, and systems where realtime are not required



# Conclusions and Future Work

## ■ Handover



# Thank You!

