IEEE Education Society Standards Development and Virtual Graduate Study Consortium
Kick off Workshop , December 14th , satellite site or none

# *Smart Devices for Online Laboratories*


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# Online Labs

EPFL

- **Remote labs**: Remote access to physical facilities located at distance and integrating sensors and actuators
  - Real-time operation at distance
  - Sensitive to communication delay
  - Require sensing of the environment
  - Require permanent power supply and ambiance lightning
  - Safety constraints for the equipment itself and people around it
- **Virtual labs**: Web access to interactive simulation resources
  - Enable easy distribution of current and new versions
  - Experimentation time can be accelerated compare to remote labs
  - Require a mathematical model and meaningful parameters for the simulation
  - Can be superposed to remote labs for enabling augmented reality

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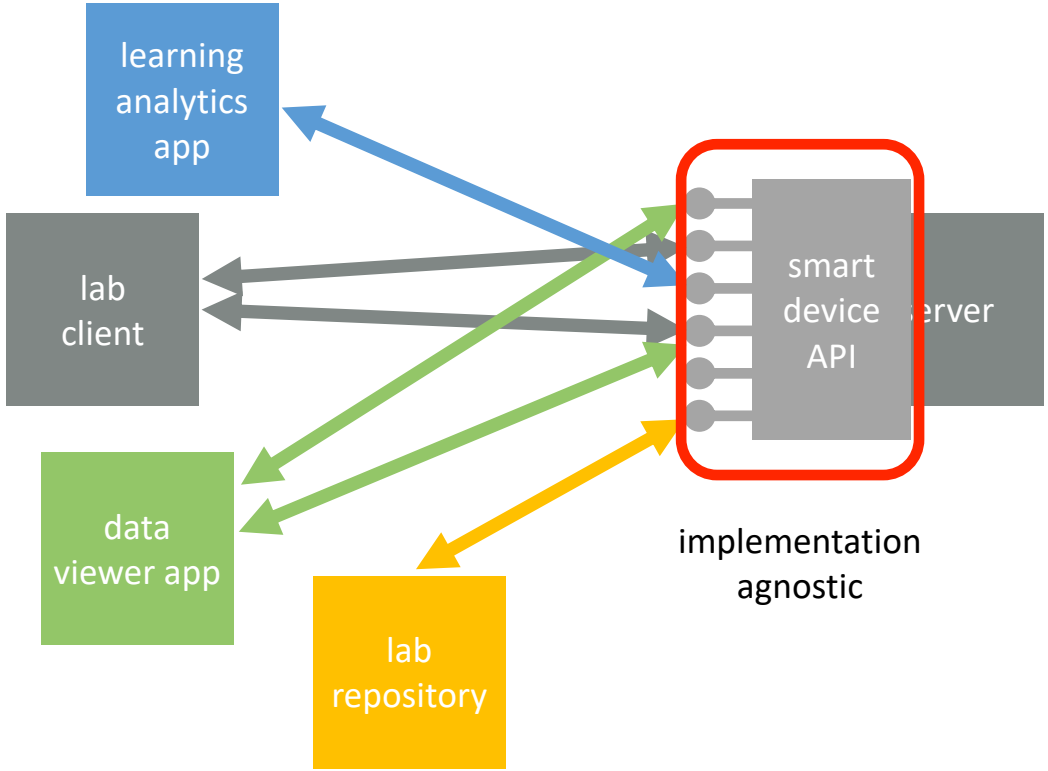
# Classic Client-Server Paradigm for Remote Labs

client often tightly linked to server

clients cannot be reused

server updates often require client updates

# Smart Device Paradigm for Remote Labs



# Smart Device Specifications

EPFL

- …consists of
  - **service description** and **metadata**
  - **services**, e.g. to control actuators & sensors
  - **configurations**, possible experiments
- and
  - **internal functionality**, best practices & guidelines
  - easily extensible with new services

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# Services and Functionalities

EPFL

| Services | Functionalities |
| --- | --- |
| getSensorMetadata | authentication |
| getSensorData | self and known state* |
| getActuatorMetadata | security and local control* |
| sendActuatorData | logging and alarms |
| getLoggingInfo | local simulation |
| getClients | |
| getModels | |

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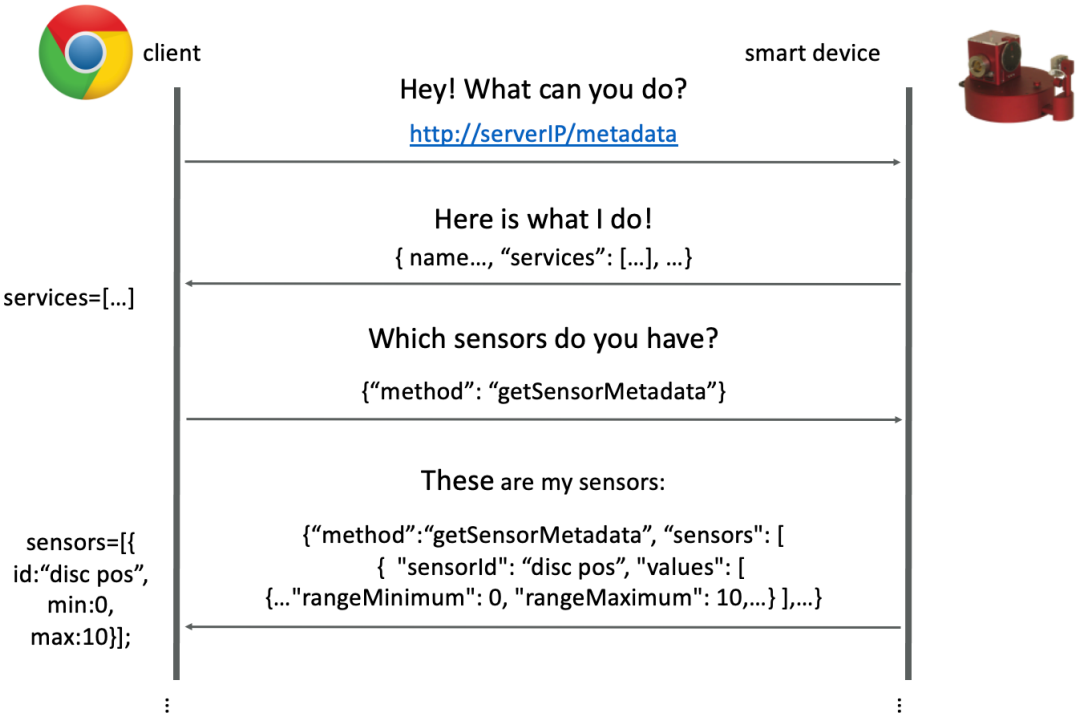
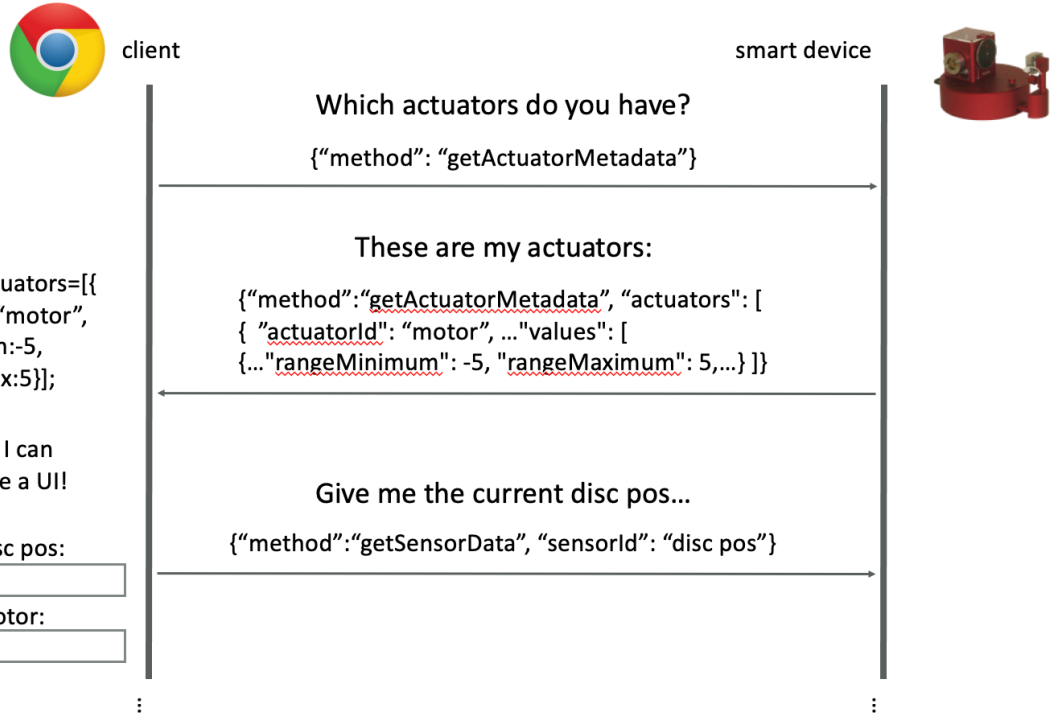
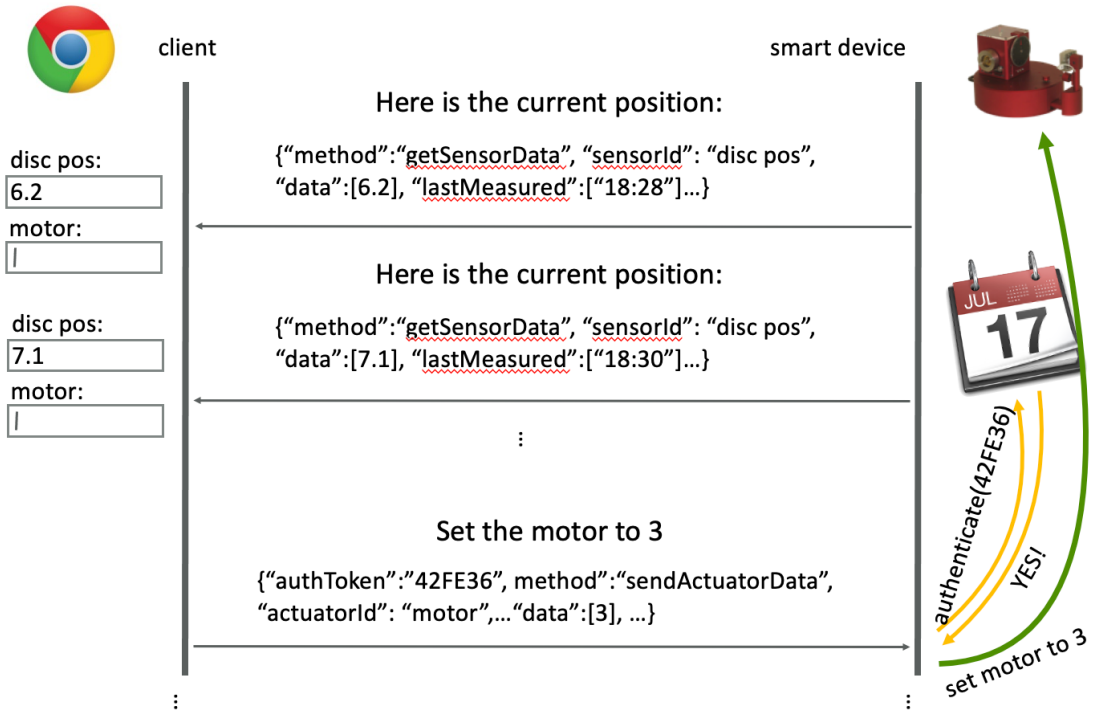
# Example


client
smart device
Hey! What can you do?
http://serverIP/metadata
Here is what I do!
{ name…, “services”: […], …}
services=[…]
Which sensors do you have?
{“method”: “getSensorMetadata”}
These are my sensors:
sensors=[{
id:“disc pos”,
min:0,
max:10}];
{“method”:“getSensorMetadata”, “sensors": [
{ "sensorId": “disc pos”, "values": [
{…"rangeMinimum": 0, "rangeMaximum": 10,…} ],…}

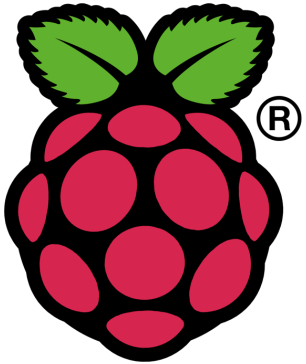
# Example

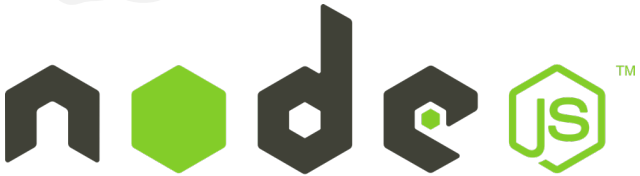

client
smart device
Which actuators do you have?
{“method”: “getActuatorMetadata”}
These are my actuators:
{“method”:“getActuatorMetadata”, “actuators": [
{ ”actuatorId": “motor”, …"values": [
{…"rangeMinimum": -5, "rangeMaximum": 5,…} ]}
actuators=[{
id:“motor”,
min:-5,
max:5}];
Yay! I can
make a UI!
Give me the current disc pos…
{“method”:“getSensorData”, “sensorId”: “disc pos”}
disc pos:
motor:

# Example


client
smart device
Here is the current position:
{“method”:“getSensorData”, “sensorId”: “disc pos”,
“data”:[6.2], “lastMeasured”:[“18:28”]…}
disc pos:
6.2
motor:
Here is the current position:
{“method”:“getSensorData”, “sensorId”: “disc pos”,
“data”:[7.1], “lastMeasured”:[“18:30”]…}
disc pos:
7.1
motor:
Set the motor to 3
{“authToken”:”42FE36”, method”:“sendActuatorData”,
“actuatorId”: “motor”,…“data”:[3], …}
JUL
17
authenticate(42FE36)
YES!
set motor to 3

# Implementation





https://github.com/go-lab/smart-device

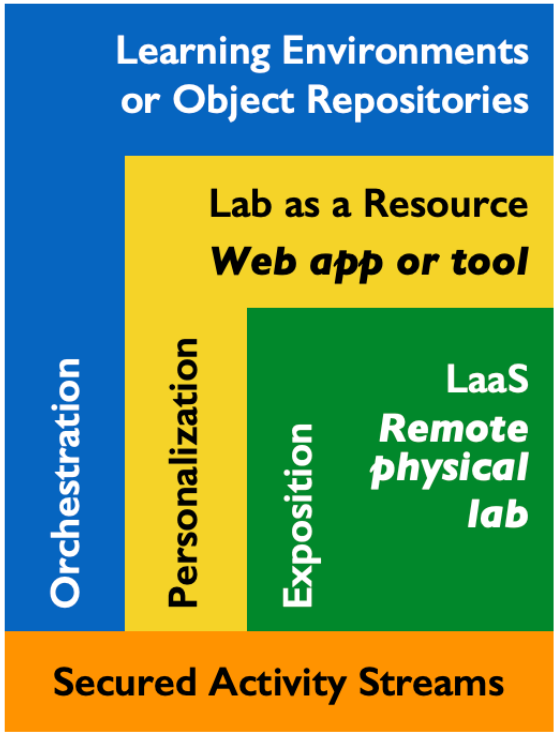
# Other Layers

## Abstraction levels

- Lab as a Service (LaaS), typically using an embedded computer
- Lab as a Resource (LaaR)
  Web app, LTI module, or ILS

## European Contributions

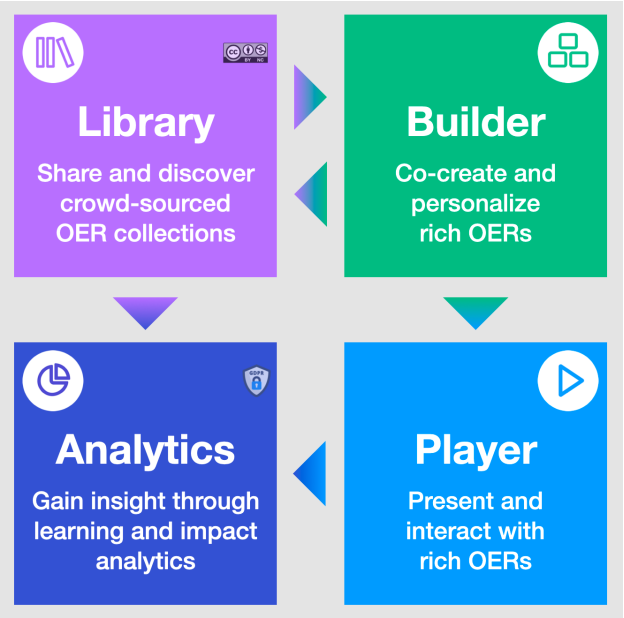
- Metadata, services, protocols
- WebSockets to communicate with sensors and actuators
- Automatic client generator
- Learning analytics support



# Digital Education Platform

## Graasp.org

- Open source and open access
- Supporting the full life-cycle of rich and interactive Open Educational Resources (OERs), including online labs




## Supported by

- FP7 and H2020 European innovation actions
- Swiss initiatives for digital skills


- D. Gillet, I. Vonèche-Cardia, J. C. Farah, K. L. P. Hoang and M. J. Rodríguez-Triana, "Integrated Model for Comprehensive Digital Education Platforms," 2022 IEEE Global Engineering Education Conference (EDUCON), 2022, pp. 1587-1593, doi: 10.1109/EDUCON52537.2022.9766795.

# Conclusions

- The Smart Device specification decouples client-server through well-defined services & metadata, enabling:
  - interoperability between clients and other Smart Devices
  - a machine readable specification that allows the generation of simple client UIs
- Platform agnostic & implementations are available
- C. Salzmann, S. Govaerts, W. Halimi and D. Gillet, "The Smart Device specification for remote labs," Proceedings of 2015 12th International Conference on Remote Engineering and Virtual Instrumentation (REV), 2015, pp. 199-208, doi: 10.1109/REV.2015.7087292