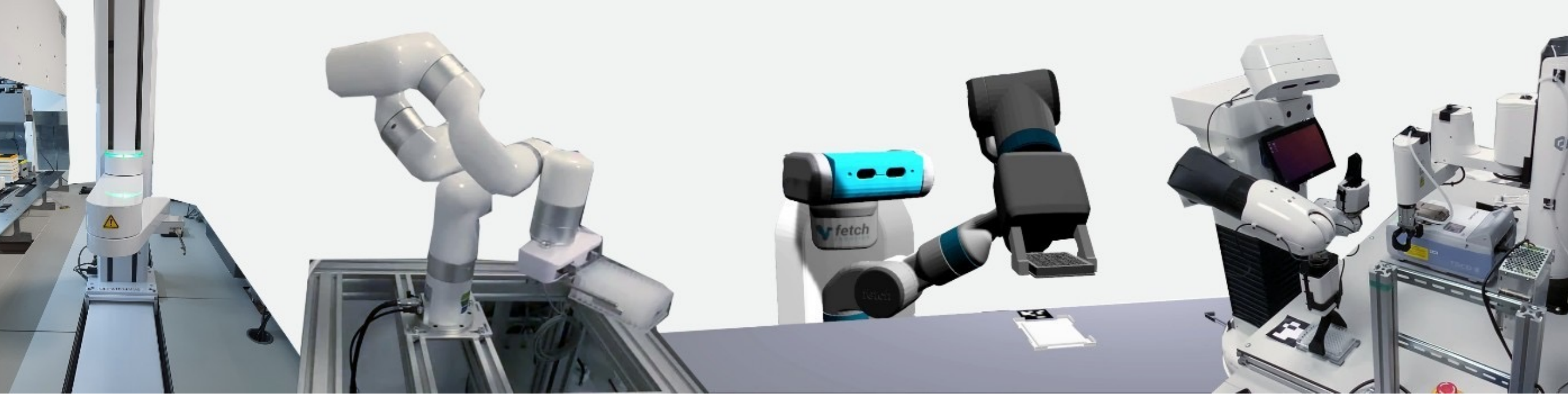

A bioSASH and SiLA journey

Implementing advanced laboratory automation technologies

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Standardization in Laboratory Automation (SiLA) Consortium

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SiLA Rapid Integration

ÓBUDAI EGYETEM
ÓBUDA UNIVERSITY

Future Labs Live, Basel, 27.JUN.2024

Motivation

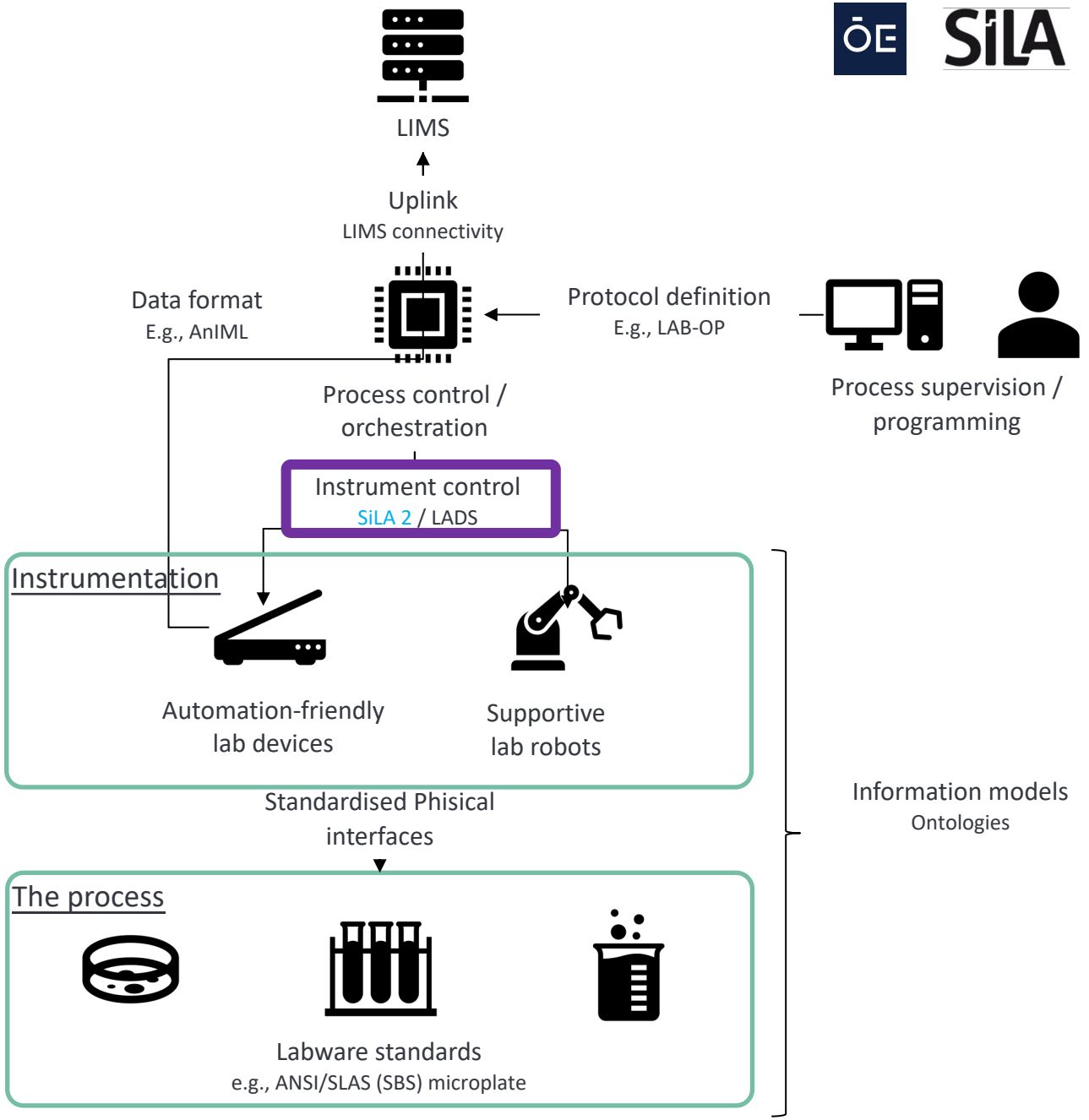
Motivation

Problem statement

- Lab automation systems are becoming increasingly **complex**
- The present-day landscape in terms of system architecture and interoperability is **heterogeneous**
- This poses a **barrier** for implementing **integrated systems**

Vision

- Create a holistic and agnostic reference architecture model for the whole vertical of lab automation systems
- Outline the canonical layers and components in the integrated system
- Standardize the communication between the components
- Create semantic descriptions of capabilities on different granularity levels
- Bind it with a workflow representation framework that enables scalability and transferability between labs
- Create ontologies to represent information in a suitable fashion for advanced control on all levels

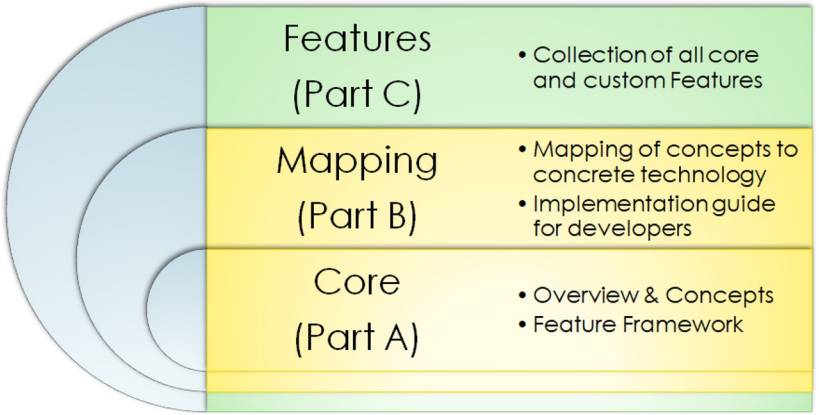


SiLA

SiLA

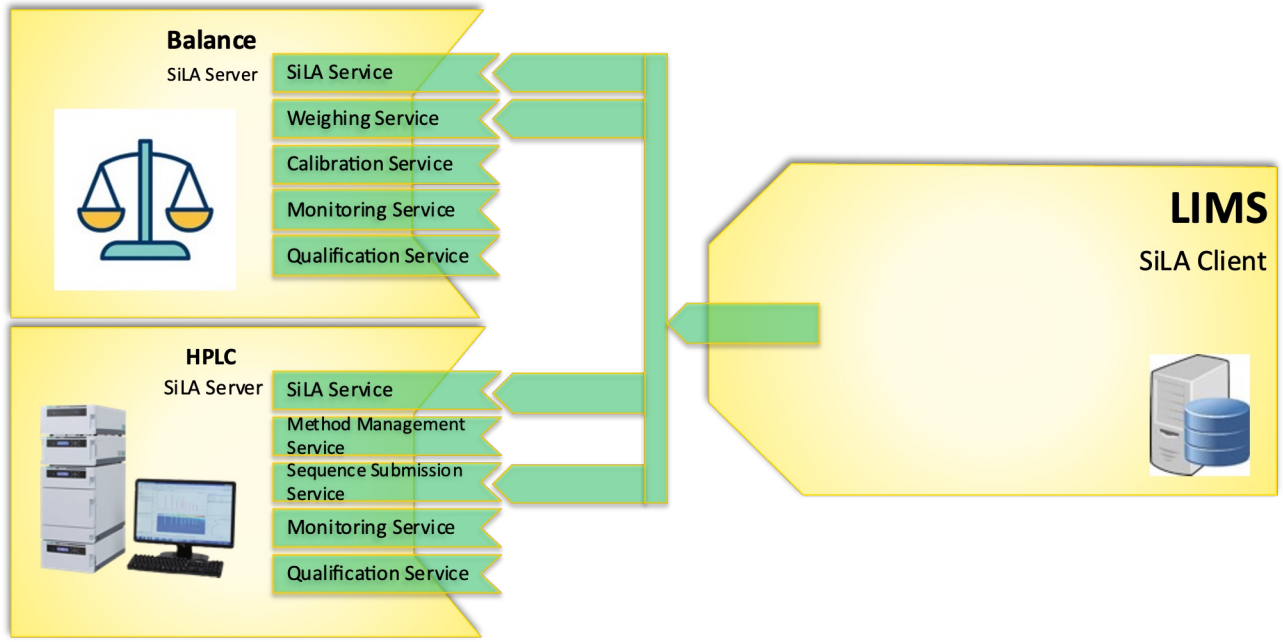
The consortium

- Not-for-profit
- Membership organization: users and solution providers
- Exchange and collaborate
- Working groups
  - Core: to maintain and develop the standard specs and reference implementations
  - Domain-specific WGs (e.g., Robotics): to unify feature definitions and harmonize integration best practices



The standard

- Service-oritented interoperability protocol
- A lab device (or robot) implements a set of features, and acts as a server
- A scheduler controls these devices by triggering commands and supervising their execution, acting as a client
- The featuer definition acts as a semantic description of the features, and serves a contract between the server and the client



The SiLA Robotics Working Group (SRWG)

Vision

- Standardized communication and interoperability for (mobile) robots in automated laboratories
- Plug & play integration
- Vendor-independent solutions

Mission

- Rely on existing technologies
- Unify, scale-up and extend functionality
- Incorporate new concepts
- Extend the SiLA stack
- Facilitate exchange in the lab automation robotics community

Core values

- Community effort
- Open-source implementations
- Open access publications

Operating model

- Hackathons
  - BioSASH
- Regular meetings
  - Monthly
- Focus groups
  - Use case oriented
  - Technology oriented

Work packages

- Feature unification
  - LabwareTransfer
  - Extended framework
- Reference implementations
  - SiLA-ROS bridge
  - LabwareTransfer for stationary robots
  - LabwareTransfer for mobile manipulators (in progress)
- Ontologies
  - Labware (in progress)
  - Devices (planned)

Motivation

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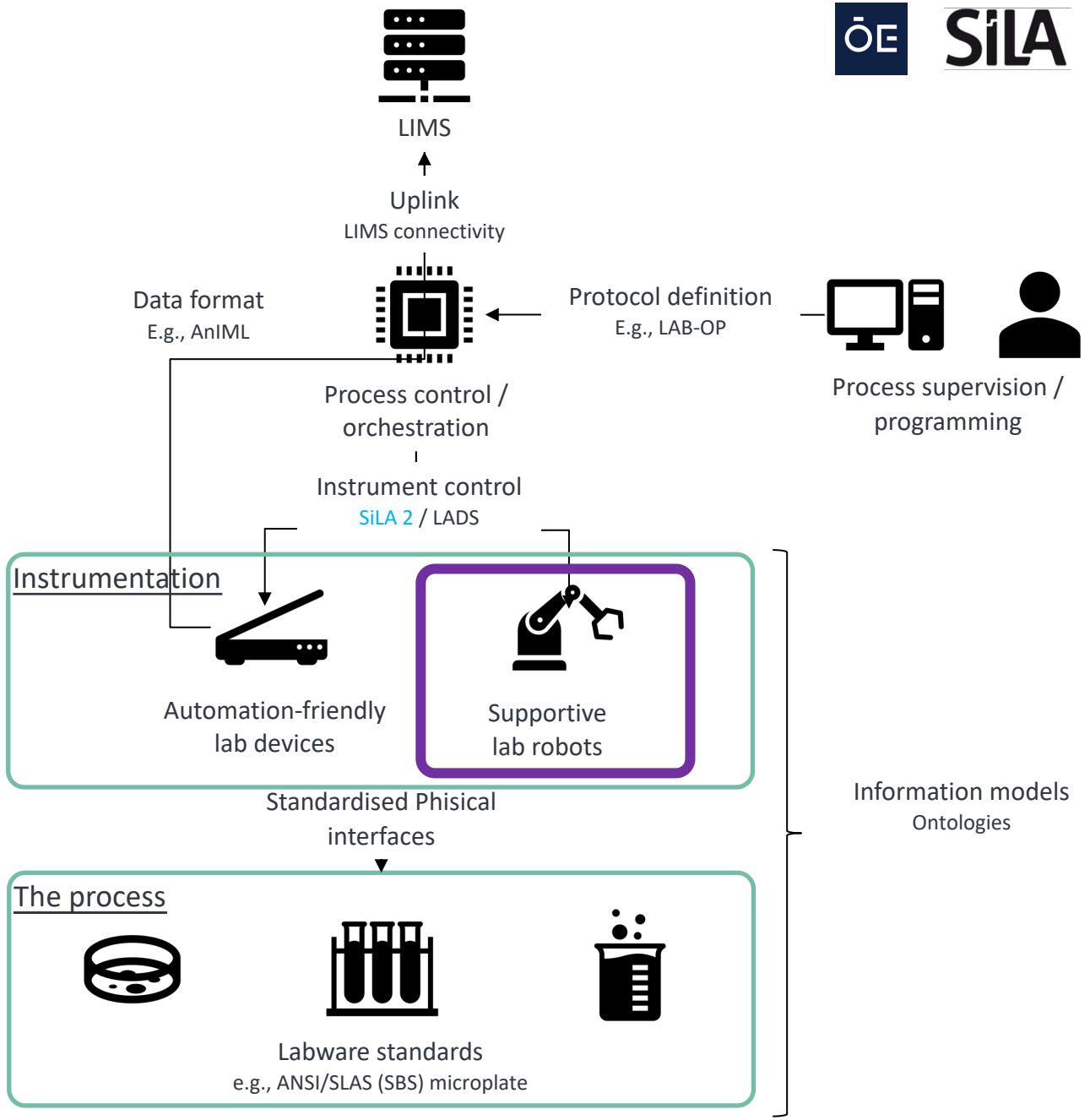
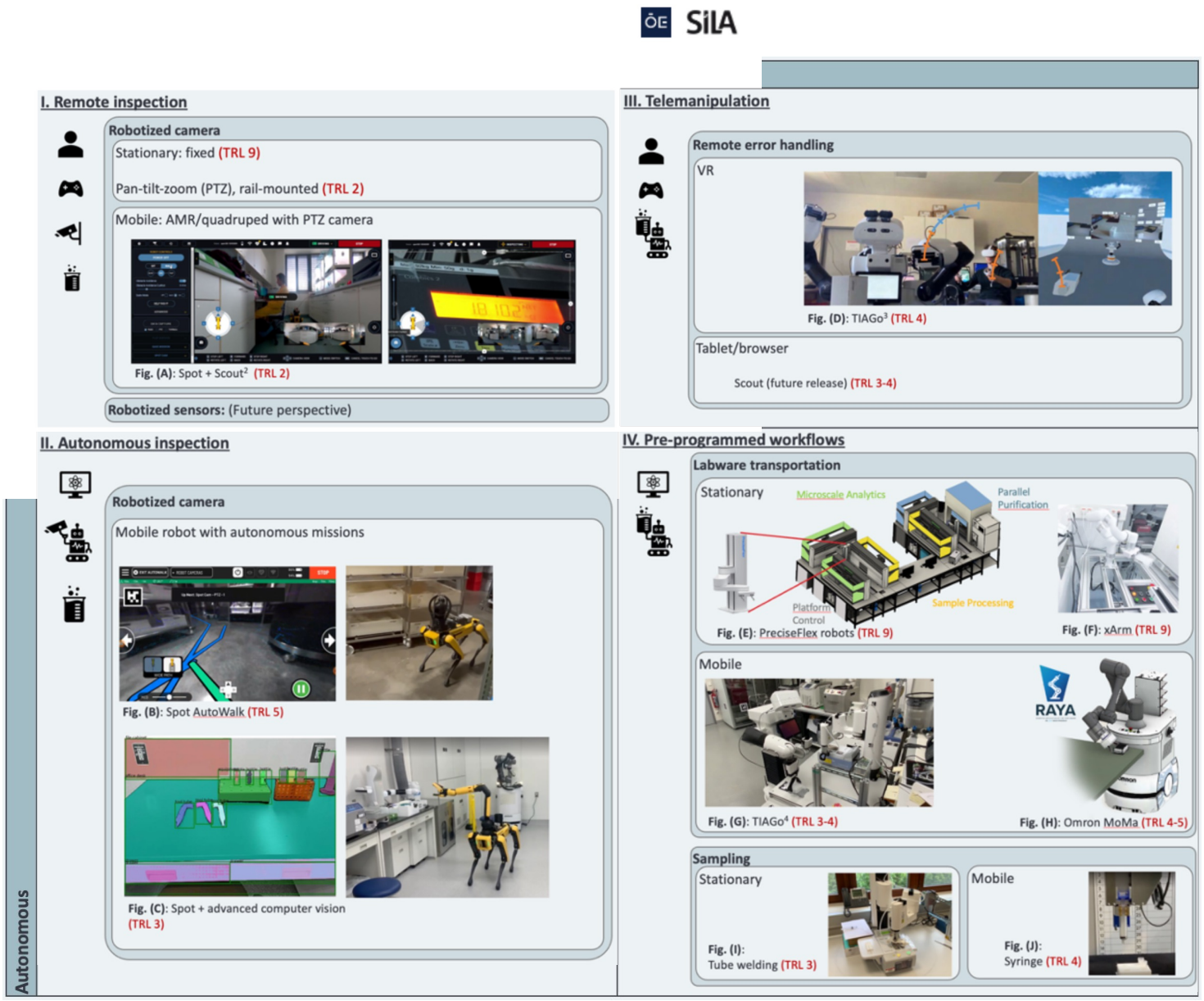


Supportive robotics in lab automation

The lab robotics matrix



I. Remote inspection

Robotized camera

Stationary: fixed (TRL 9)

Pan-tilt-zoom (PTZ), rail-mounted (TRL 2)

Mobile: AMR/quadruped with PTZ camera

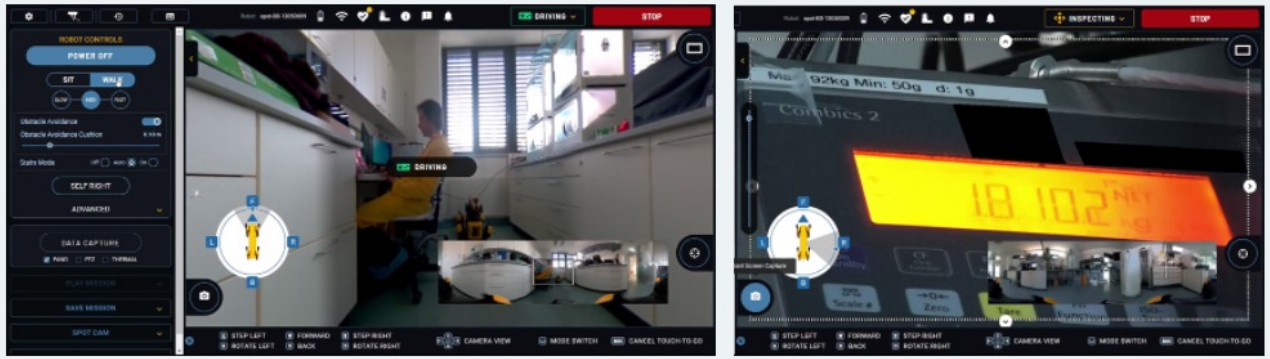


Fig. (A): Spot + Scout[2] (TRL 2)

Robotized sensors: (Future perspective)

II. Autonomous inspection

Robotized camera

Mobile robot with autonomous missions

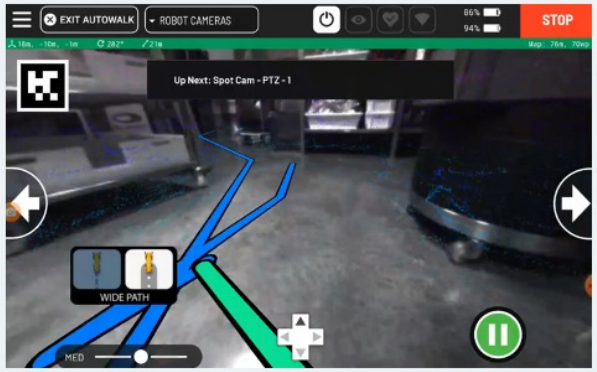


Fig. (B): Spot AutoWalk (TRL 5)

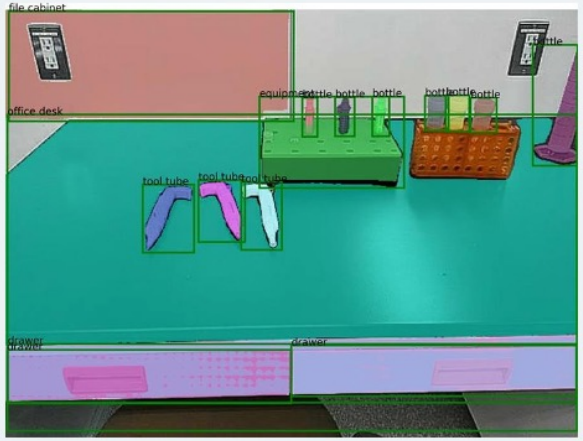


Fig. (C): Spot + advanced computer vision (TRL 3)

III. Telemanipulation

Remote error handling

VR

Fig. (D): TIAGo^3 (TRL 4)

Tablet/browser

Scout (future release) (TRL 3-4)

IV. Pre-programmed workflows

Labware transportation

Stationary

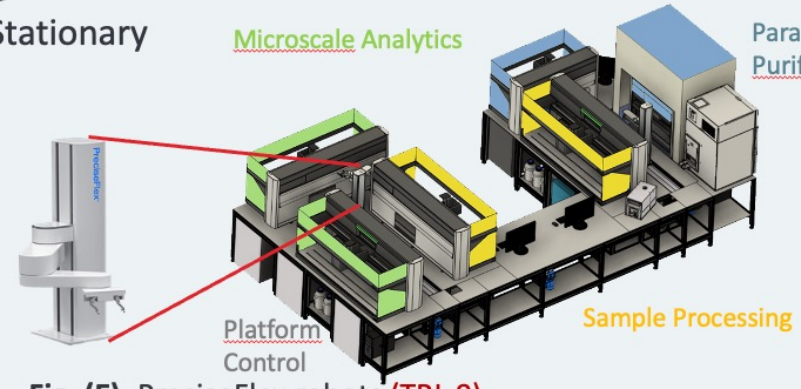


Fig. (E): PreciseFlex robots (TRL 9)

Fig. (F): xArm (TRL 9)

Mobile

Fig. (G): TIAGo[4] (TRL 3-4)

Fig. (H): Omron MoMa (TRL 4-5)

Sampling

Stationary

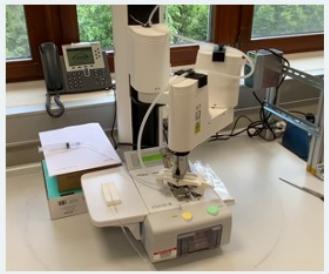


Fig. (I):
Tube welding (TRL 3)

Mobile

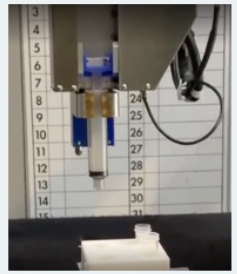
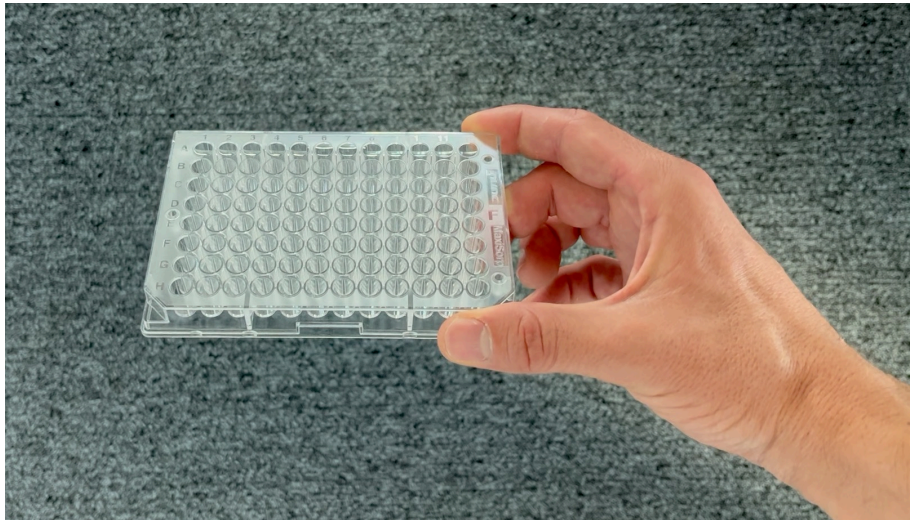


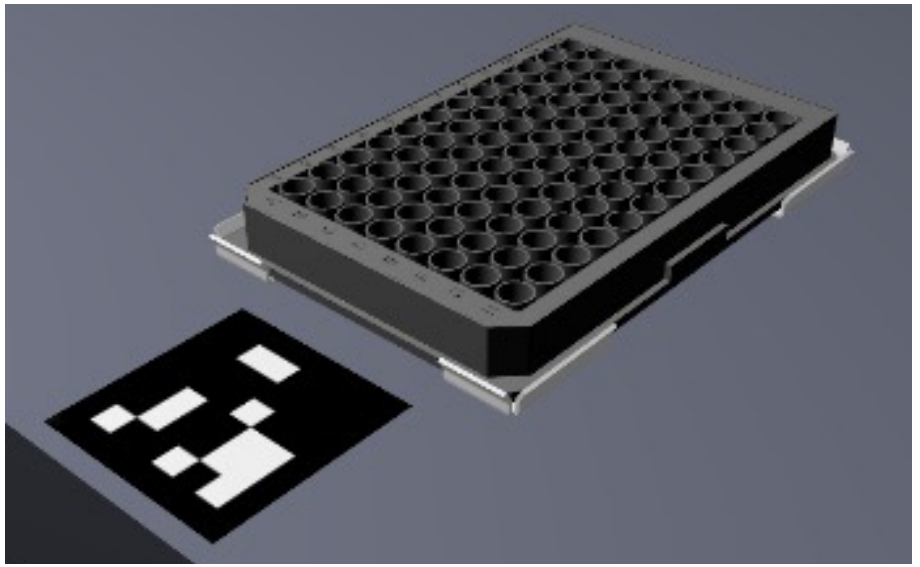
Fig. (J):
Syringe (TRL 4)

The sample transportation use case

Pick-and-place transportation of standardized labware

- ANSI/SLAS-conform (aka. SBS) microplate[1]
- Fixed hand-over positions (aka. sites) within lab devices
- Fixtures (aka. nests) that allow < 1mm tolerance
- Landmarks (aka. fiducial markers) for position detection
- Pick-up (source) and drop-off (destination) positions selected via command parameter
- Source and destination can be located across the room
- Secondary scope: different rooms/floors → elevator access





[1] Meets the Standards ANSI/SLAS 1-2004 through ANSI/SLAS 4-2004.

Prototype implementations

Interoperability for laboratory MoMas

Standardization in Laboratory Automation (SiLA) Consortium

SiLA Robotics Working Group (SRWG)

- Open community, monthly exchange meetings
- Feature definition unification workstream
- Ontologies workstream (more details later)
- Hackathons: BioSASH, a BioLAGO-SiLA Project

Industrial-Academical projects

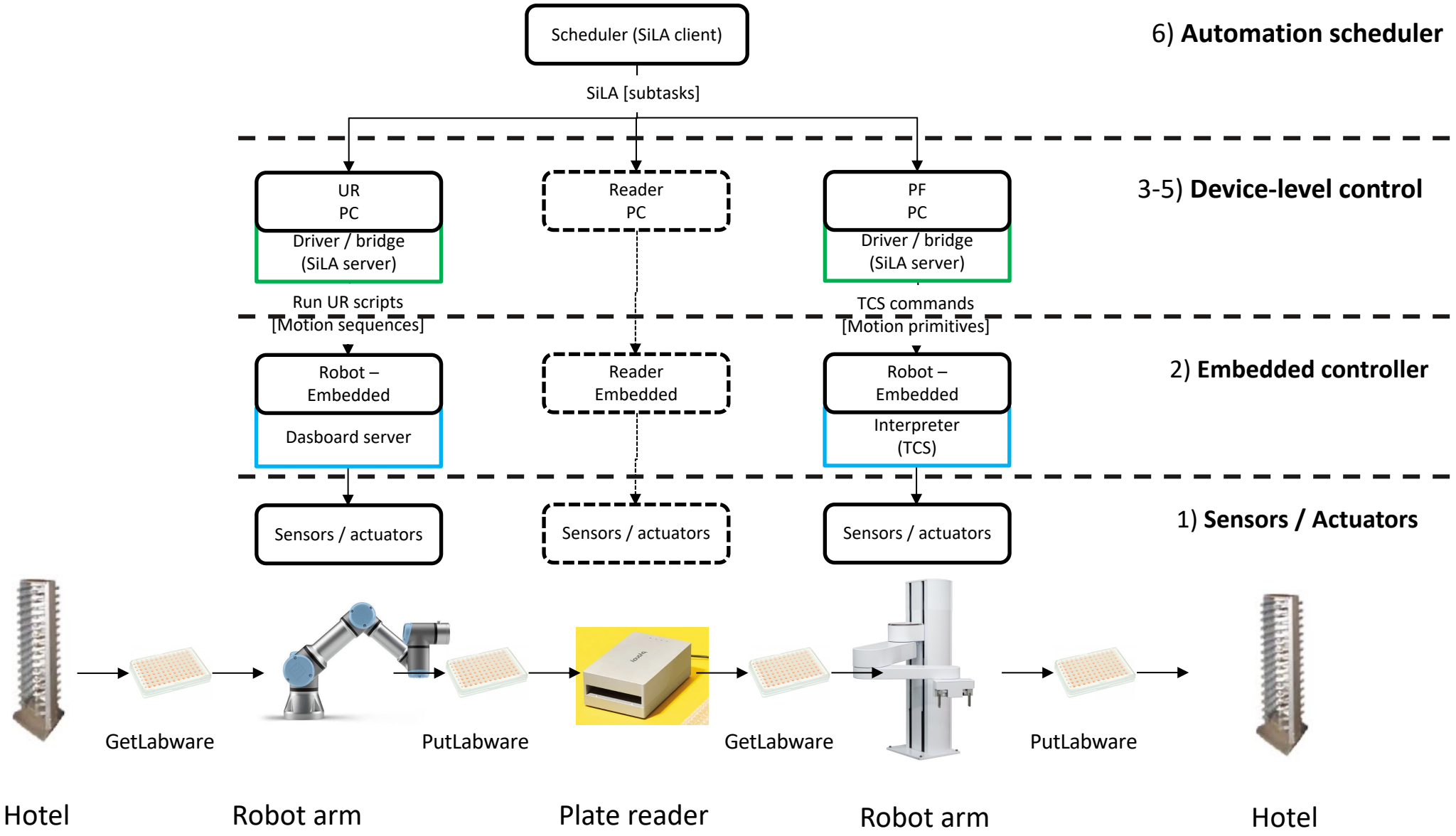
- Óbuda University
- Industrial pilot project

biolago.org

uni-obuda.hu

Reference implementation for stationary robots

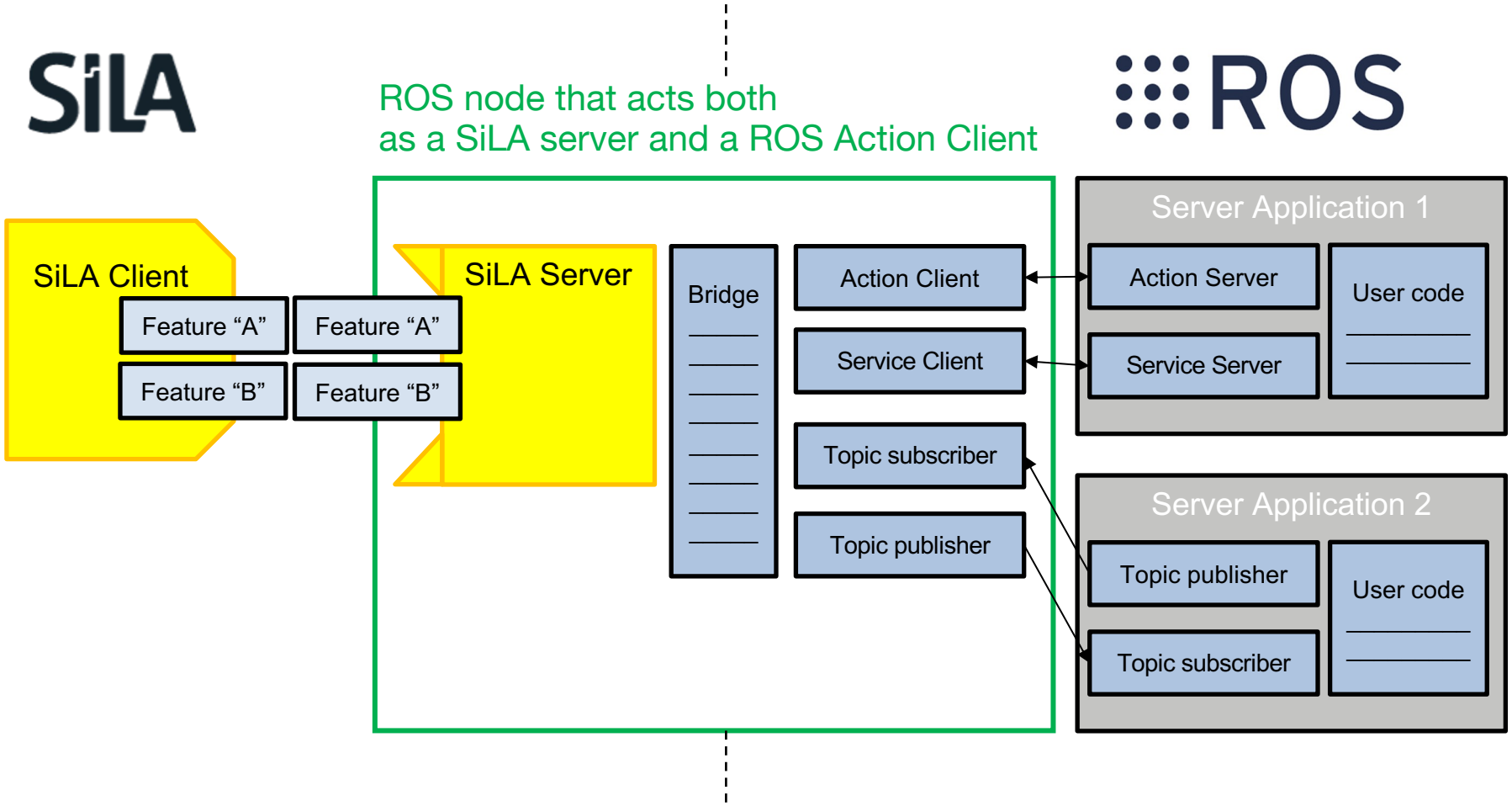
BioSASH #4



The SiLA-ROS bridge

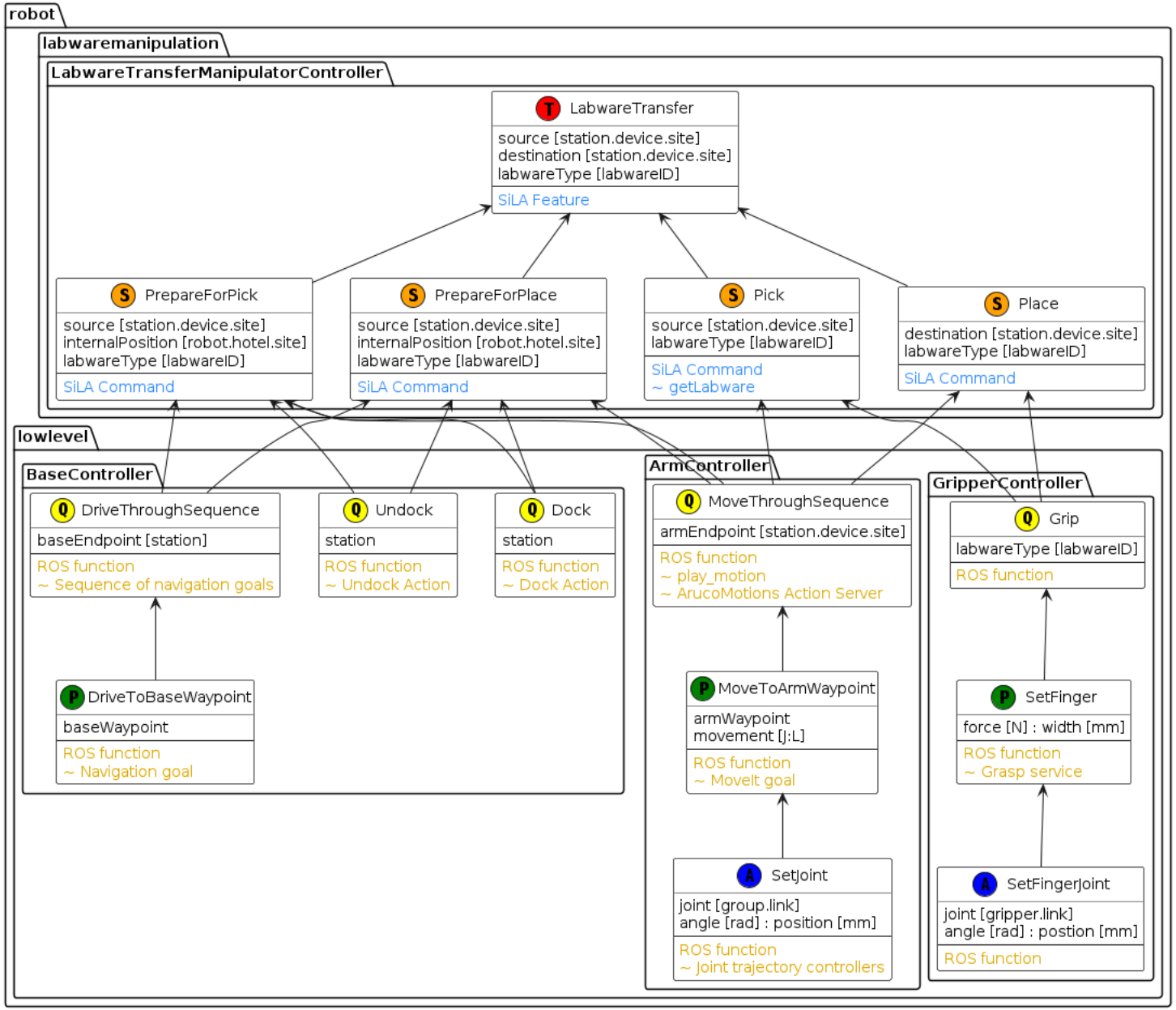
BioSASH #3

- Reference implementation
- Bridging the lab automation ecosystem with the robotics ecosystem
- SiLA for high-level control
- ROS for low-level control

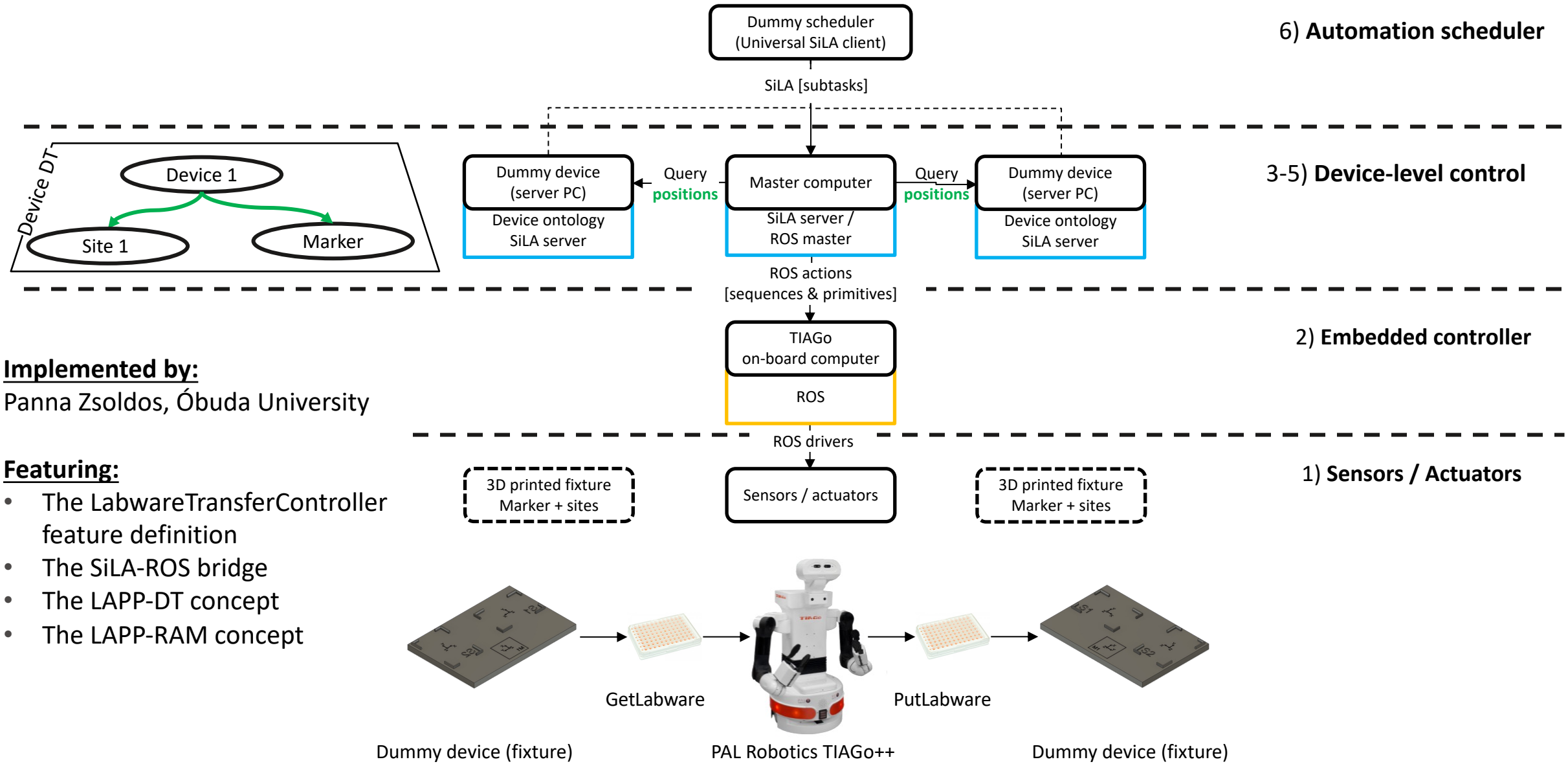


Mapping SiLA and ROS concepts to the LAPP-RARs

- The hierarchical decomposition of lab workflows with the LAPP robotic activity representations (RARs)
- SiLA commands implementing Subtasks
- ROS implementing motion sequences, motion primitives and actuator primitives



Prototype implementation for a MoMa



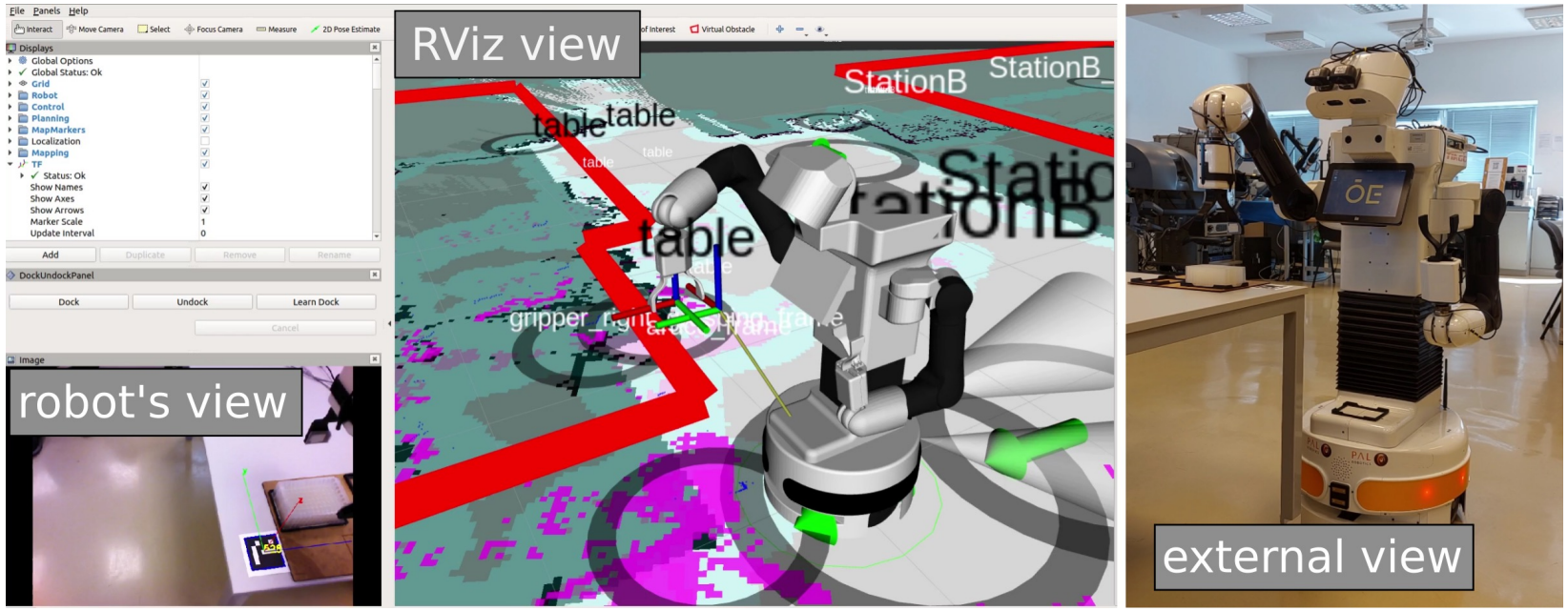
Implemented by:
Panna Zsoldos, Óbuda University

Featuring:

- The LabwareTransferController feature definition
- The SiLA-ROS bridge
- The LAPP-DT concept
- The LAPP-RAM concept

Testing of the ArUco based arm motions and the microplate picking

- RViz view of the simulated robot state
  - Dark grey areas framed by red lines are restricted areas
  - Light grey areas show where the robot is allowed to navigate
  - Green arrows are the POIs placed on the map
  - Magenta dots are the real-time obstacle data detected by the LIDAR
  - grey circles mark the virtual objects on the map which can be modified by dragging and moving them
- Robot's head camera view
- External view



Pilot implementation

Highlights of our industrial pilot project

Jul 2023

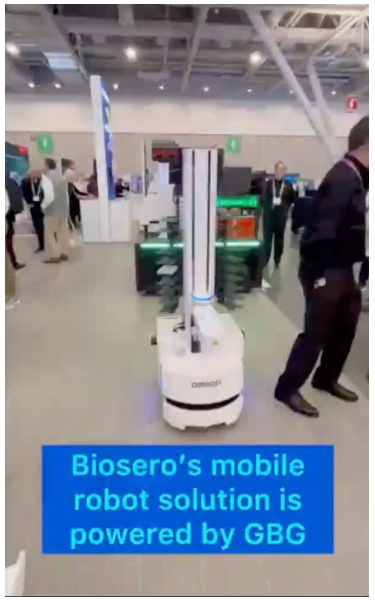
Labware transfer SAT demo Vienna

Oct 2023

Our project won the ISPE Robotics Application of the Year Award (RAYA) In the Logistics category

Feb 2024

At SLAS, Biosero and EngRoTec showcased their strategic collaboration to offer mobERT with GBG, alongside (or - in the future - instead of) Biosero's own robot, Rosie



Mar 2024

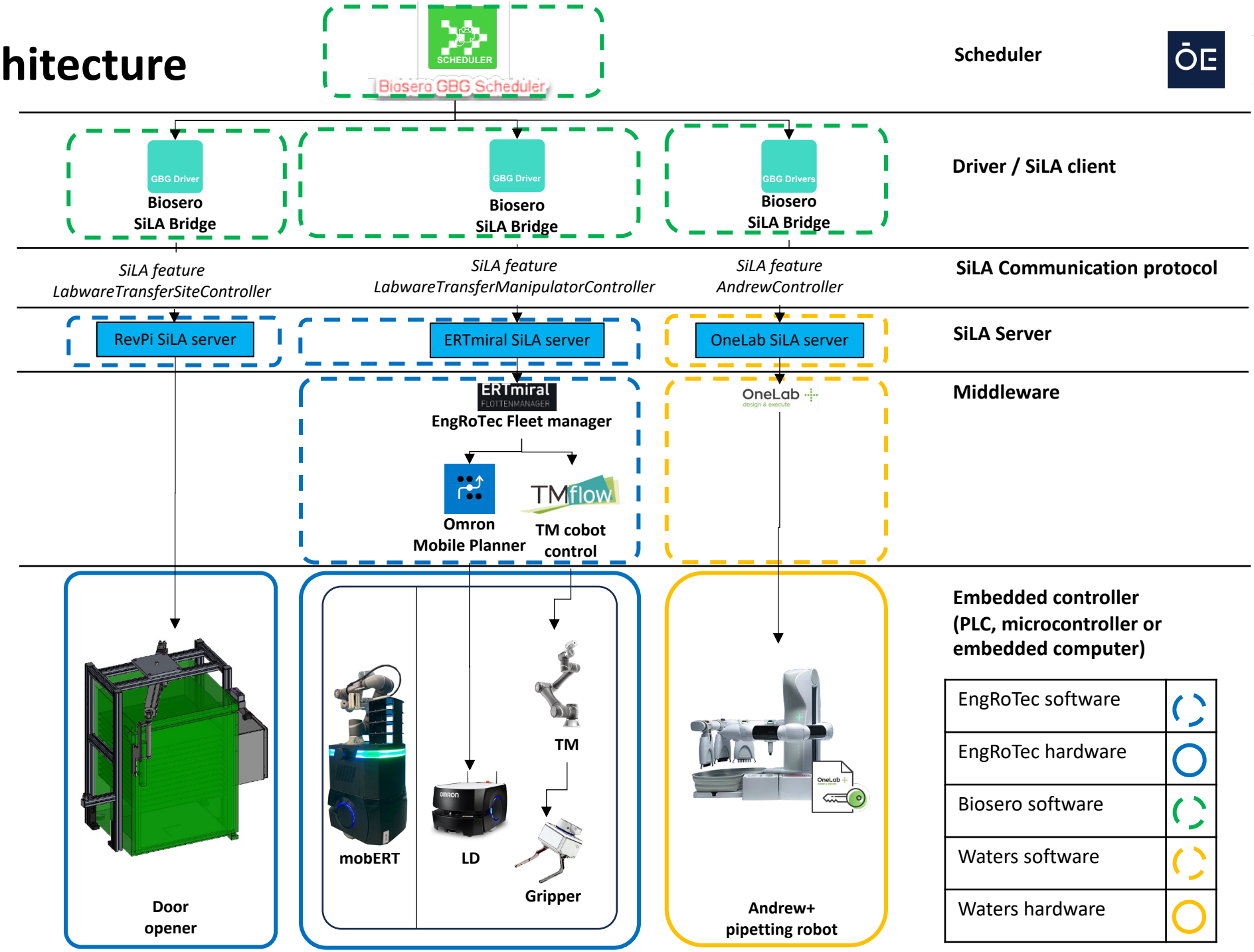
Commissioning of extensions in Vienna:

Door opener, tool changer

Demo workflow: Plate from fridge to Andrew

SiLA interface prepared

System architecture



Acknowledgements

PhD Supervisors

Péter Galambos

Károly Széll

DigiLab, Takeda

Patricia Wildberger

Brian Parkinson

Project TIAGo

Panna Zsoldos

SiLA

Stefan Koch

Mark Dörr

Lukas Bromig

Georg Hinkel

SiLA Robotics Working Group

SiLA Board

BioLAGO

Jamin Bouras

EngRoTec

Omron

Biosero

PAL Robotics

Public LAPP project website

https://wlfdm.github.io/LAPP/