complAI

Collaborative Model-Based Process Assessment for trustworthy AI in Robotic Platforms

Funded by FFG via „Ideenlab 4.0“

The FFG-Project complAI: Focus on Robot Interaction

Project Fact Sheet

BOC Asset Management GmbH
https://www.boc-group.com/de/

JOANNEUM RESEARCH ROBOTICS
www.joanneum.at/robotics

UNIVERSITY OF VIENNA – INSTITUTE of PHILOSOPHY
https://philtech.univie.ac.at/

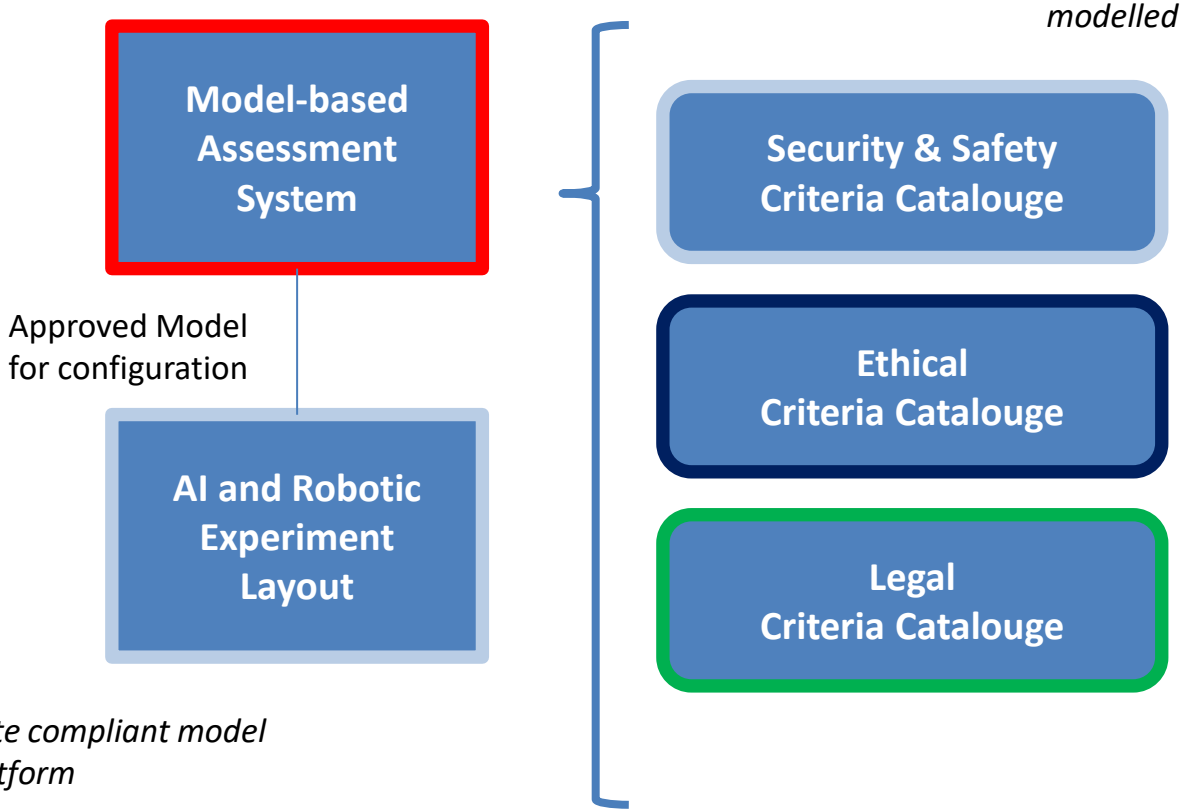
Johannes Kepler University Linz –
Department for Criminal Law
https://www.jku.at/institut-fuer-strafrechtswissenschaften/

Funding: *FFG – Austrian Research Promotion Agency*
Project Type: ***Study***
Start: *01.02.2020*
End: *31.01.2021*
Project Budget: *241.678 EUR*

Project Idea

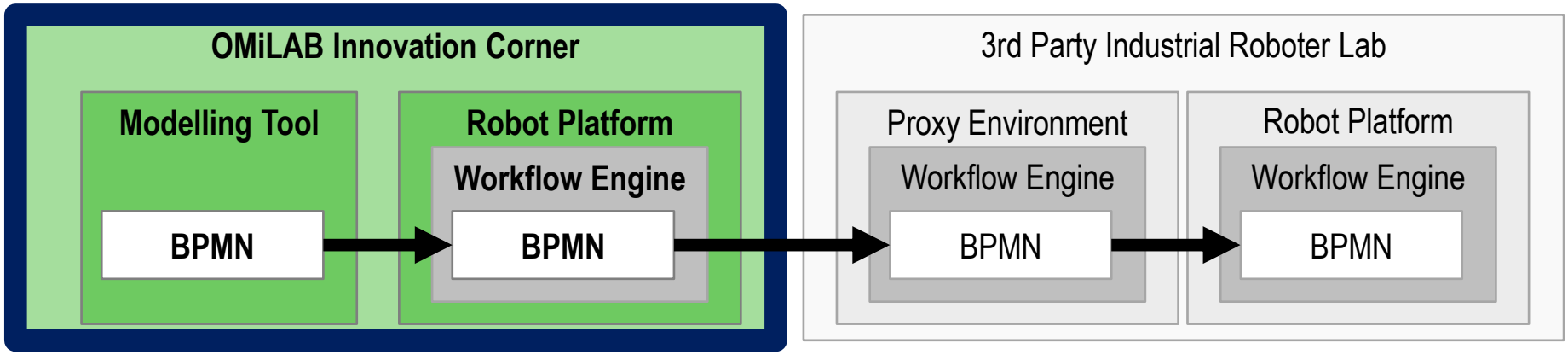
Challenge:
How to model AI, Robotic and assess compliance

Challenge:
How to create criteria catalouges that can be modelled and assessed

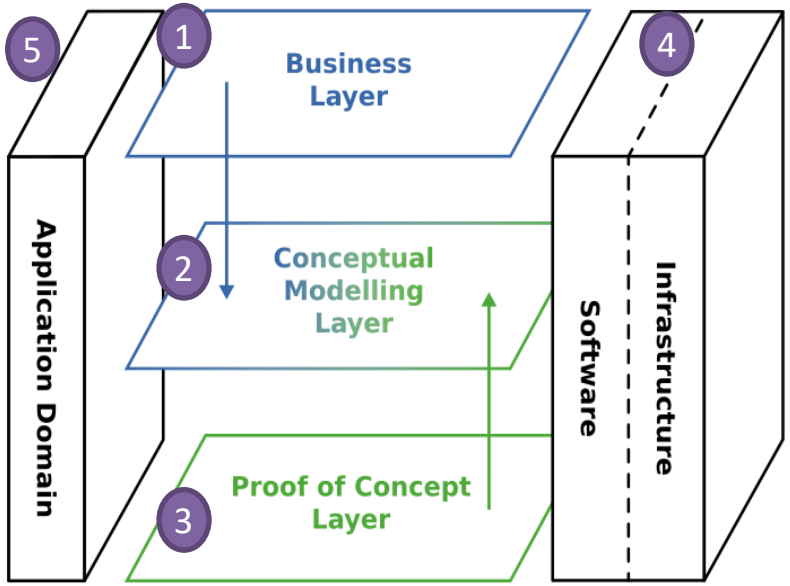


Challenge:
How to operate compliant model on robotic platform

OMiLAB Innovation Corner



Digital Transformation using OMiLAB – Open Innovation Corner

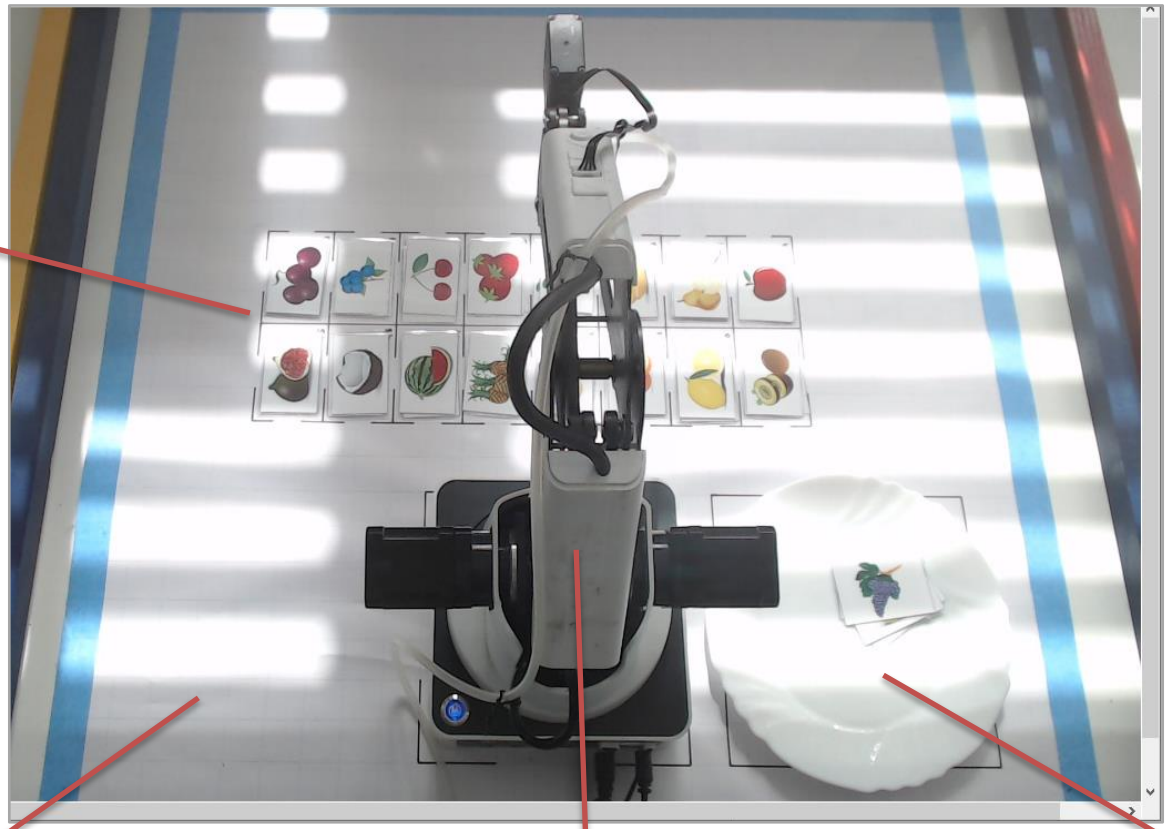


Innovate, Develop and Evaluate Digital Services considering:

1. **Scenario Layer** – using Scene2Model Environment
2. **Conceptual Model Layer** – using the Bee-Up Tool
3. **Run-time Layer** – using Dobot Magician, Makeblock mbot
4. **Software** – using ADOxx, OLIVE, …
5. **Application Domain:** i.e. Factory of the Future

OMiLAB Innovation Corner Setting

Live-Stream to Dobot Magician in BOC-OMiLAB Innovation Corner:
https://lab.boc-group.eu/Dobot_Magician_1_onboard/



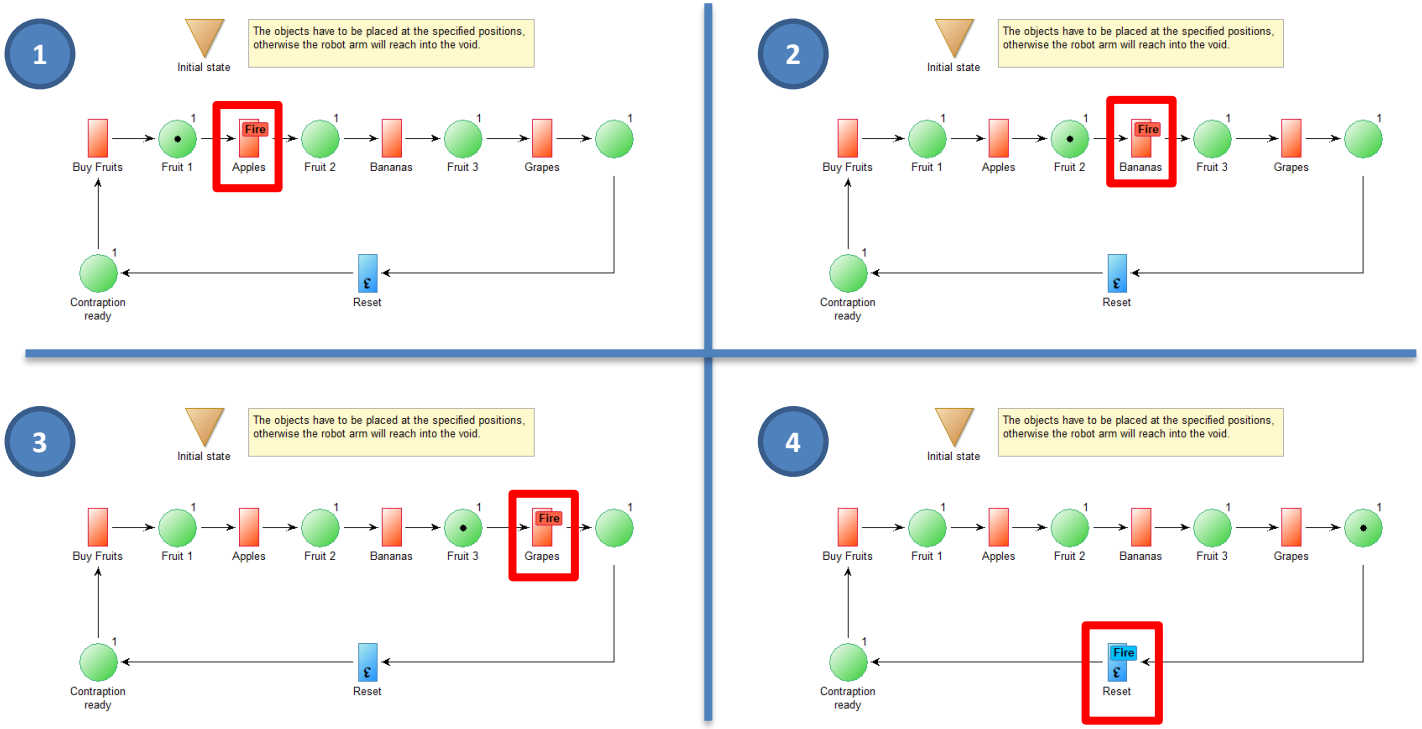
Product Range

Experimentation Environment

Robot Arm „Dobot Magician“

Shopping Basket

„Pick-and-Place“ of Fixed Sequence using Petri-Net

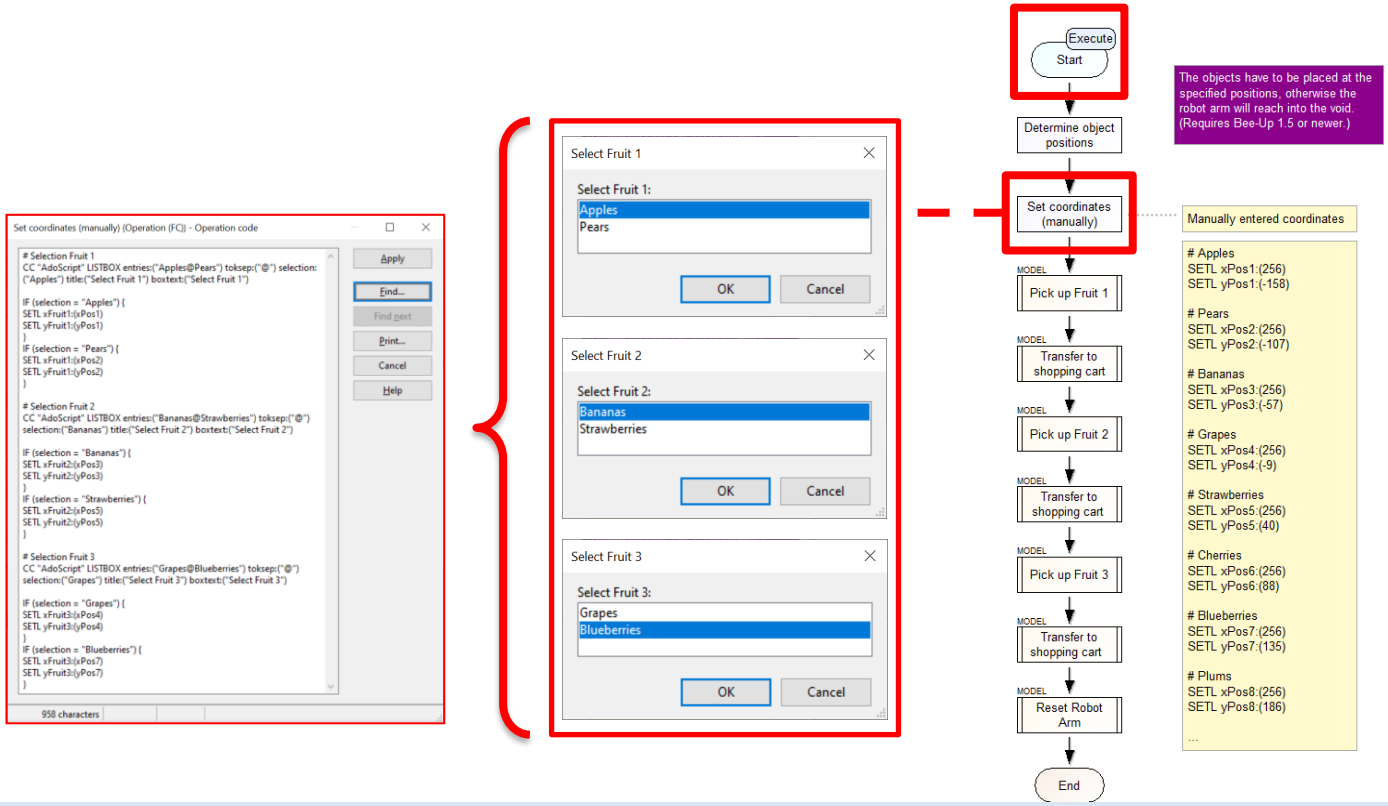


Characteristic:

- Fixed Sequence
- Robot-Arm API interaction is implemented in transistions
- Orchestration is performed by model changes

„Pick-and-Place“ of Fixed Sequence using Petri-Net

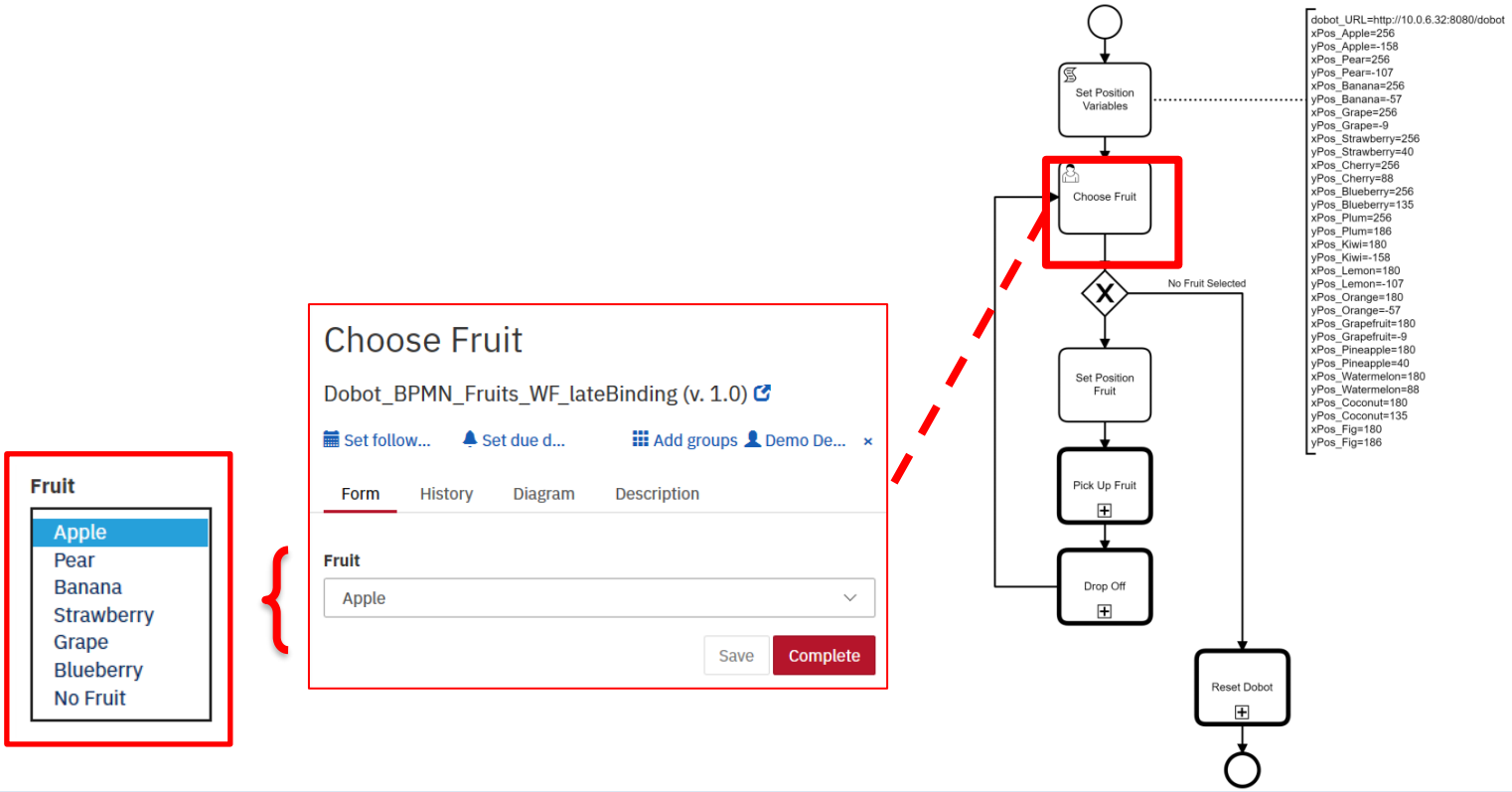
„Pick-and-Place“ of Variable Sequence using Flow Chart



Characteristic:

- Fixed Sequence with variable „Picks“
- Robot-Arm API interaction is implemented in sub-processes
- Resource Allocation is performed by external service

„Pick-and-Place“ Adaptive Sequence with BPMN

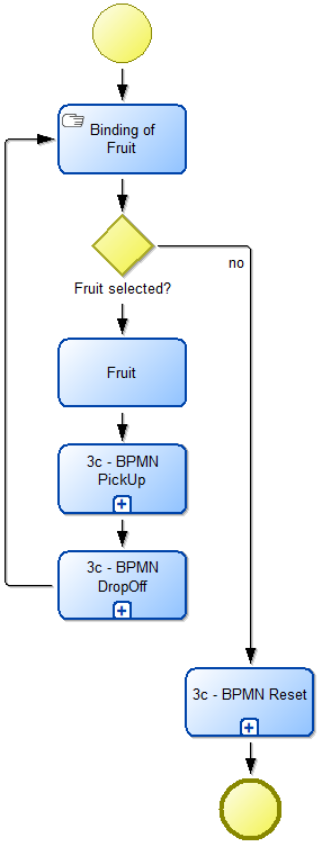


Characteristic:

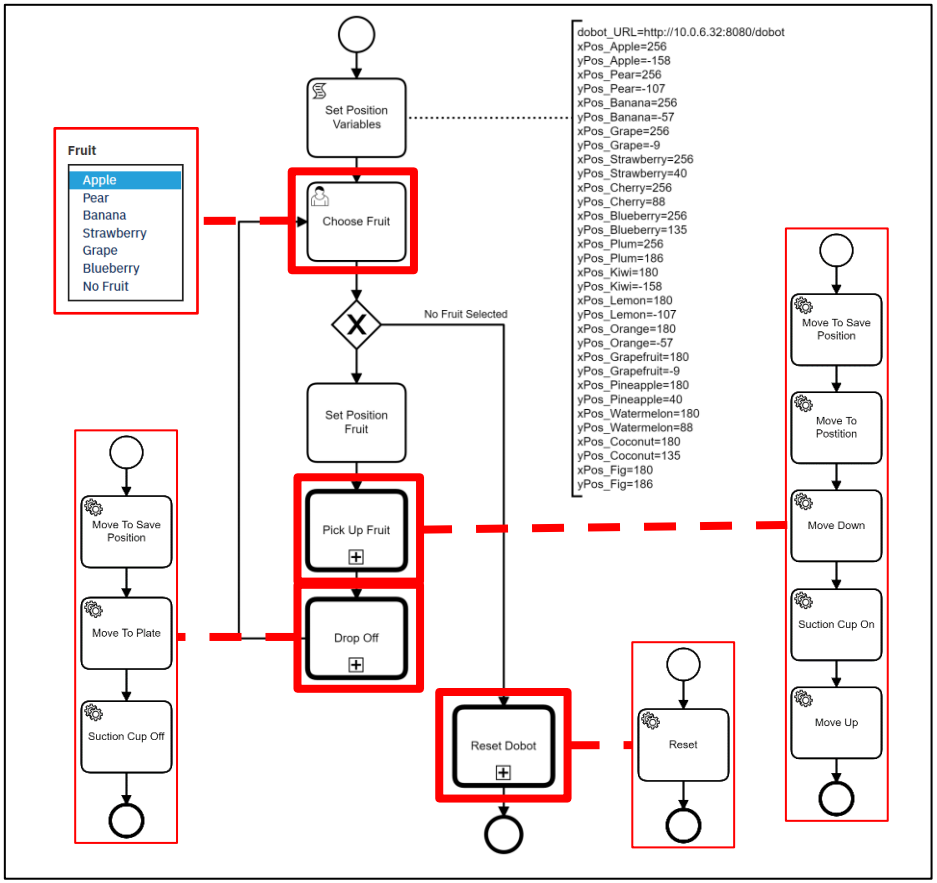
- Adaptive Sequence with variable „Picks“
- Robot-Arm API interaction is implemented in sub-processes
- Orchestration is performed by Workflow Engine using external services

„Pick-and-Place“ Adaptive Sequence with – whole BPMN Stack

BPMN

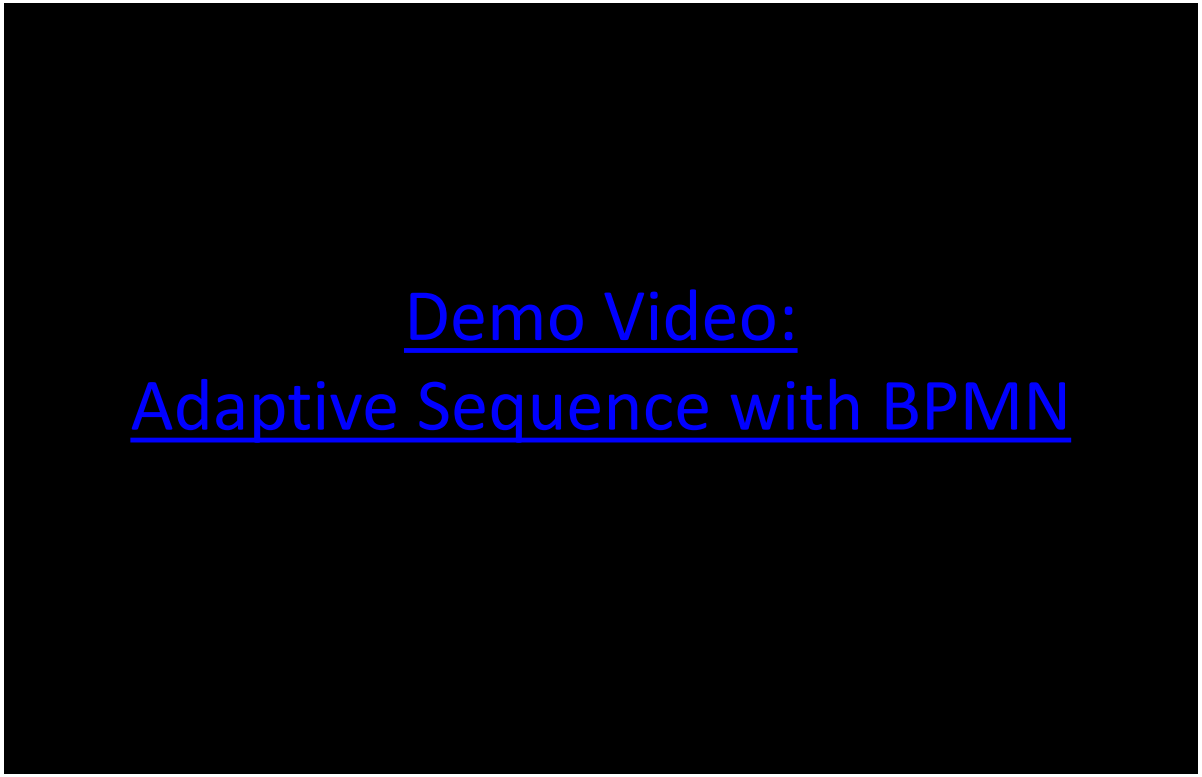


BPMN for Workflow Engine

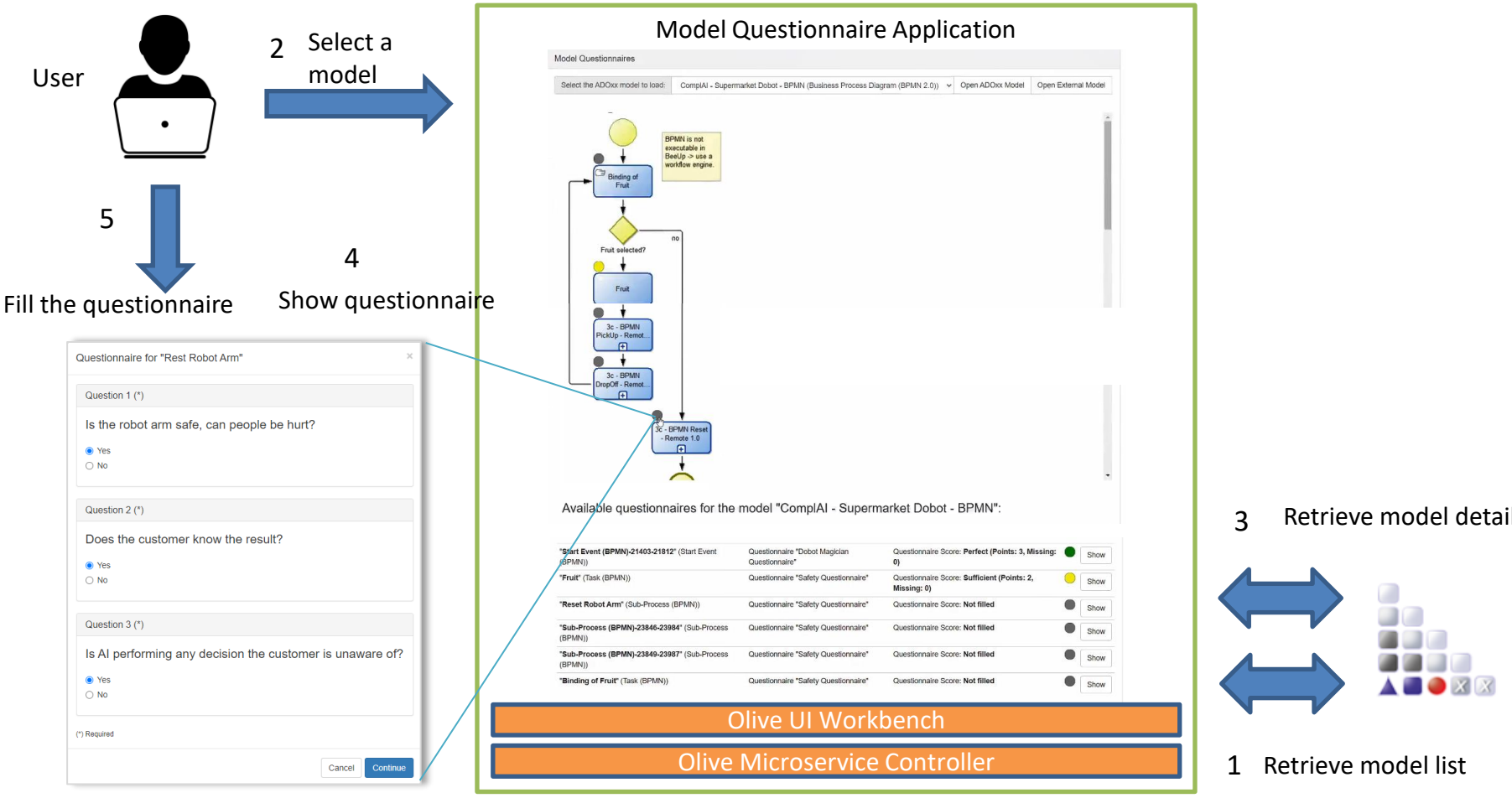


Robot Arm

„Pick-and-Place“ Adaptive Sequence with BPMN



Legal, Ethical and Security Assessment of the Workflow using Questionnairs



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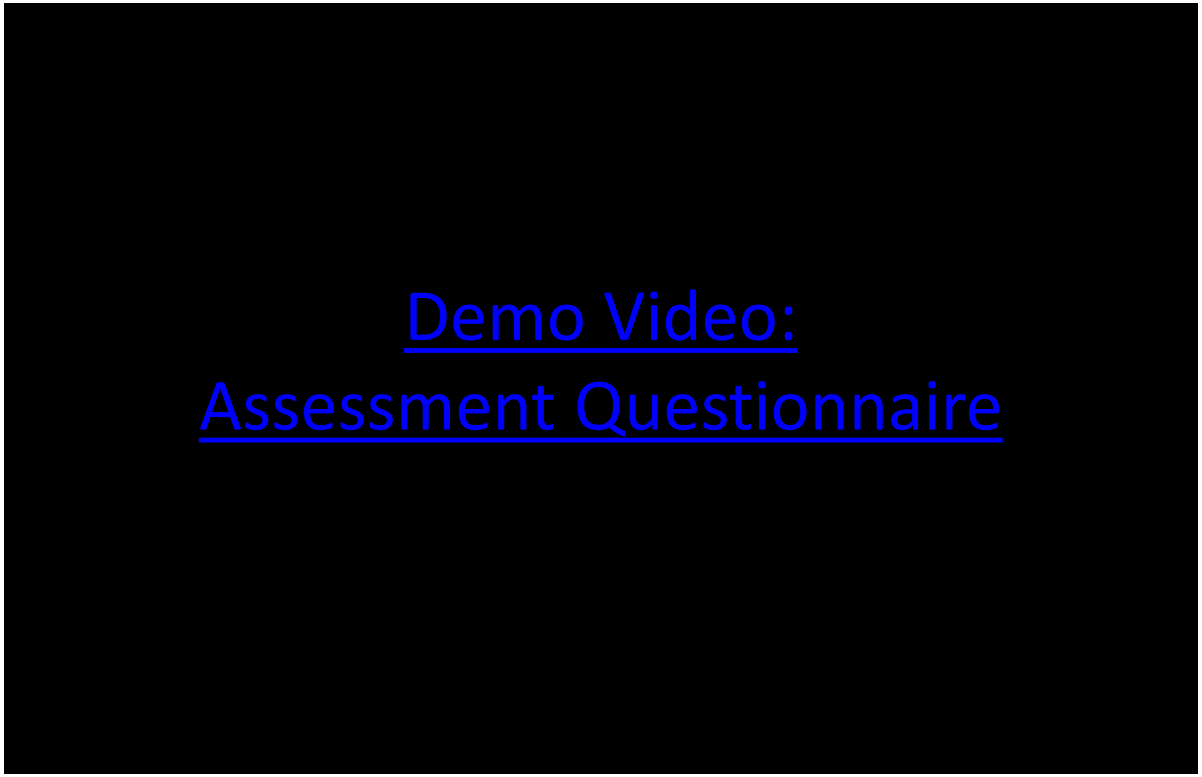
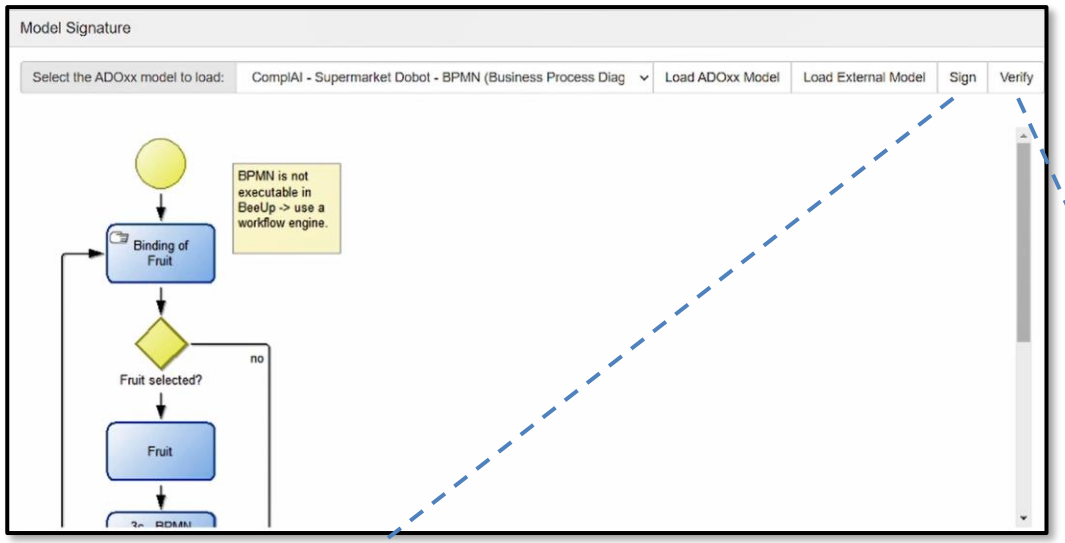
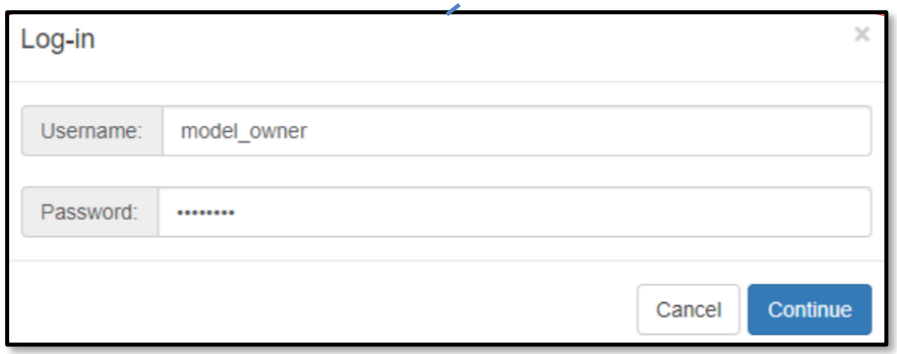


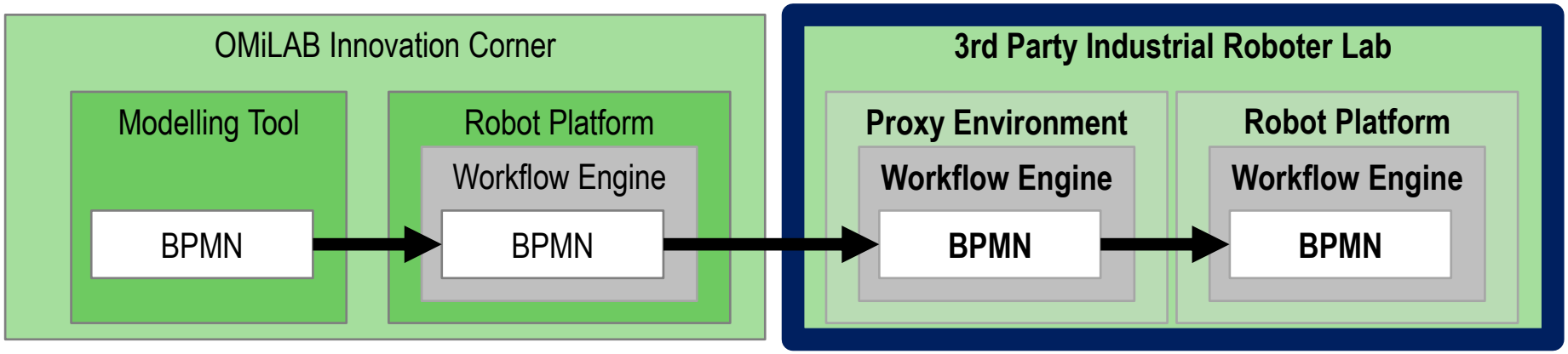
Legal, Ethical and Security Approval of the Workflow using Digital Signature





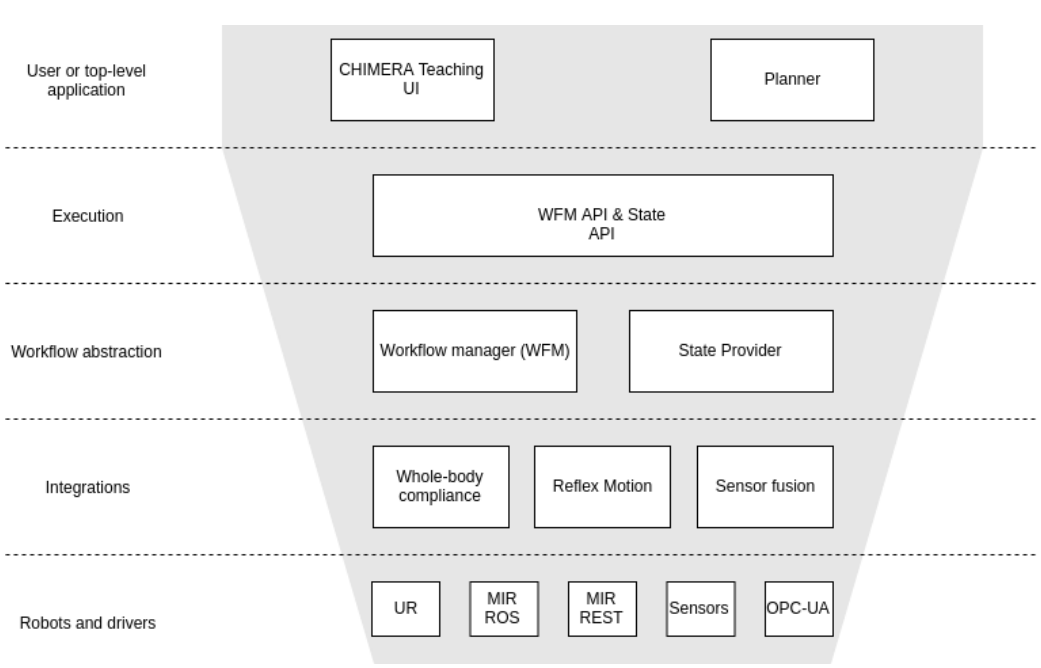
Legal, Ethical and Security Approval of the Workflow using Digital Signature

Industrial Roboter LAB



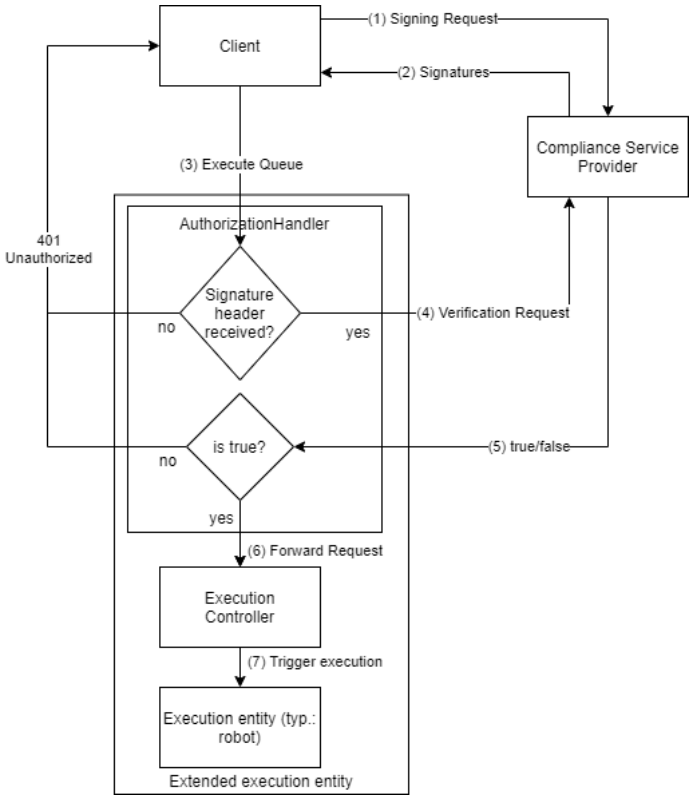
JR ROBOTICS Software Stack

- Layered approach for executing workflows on a robotic platform



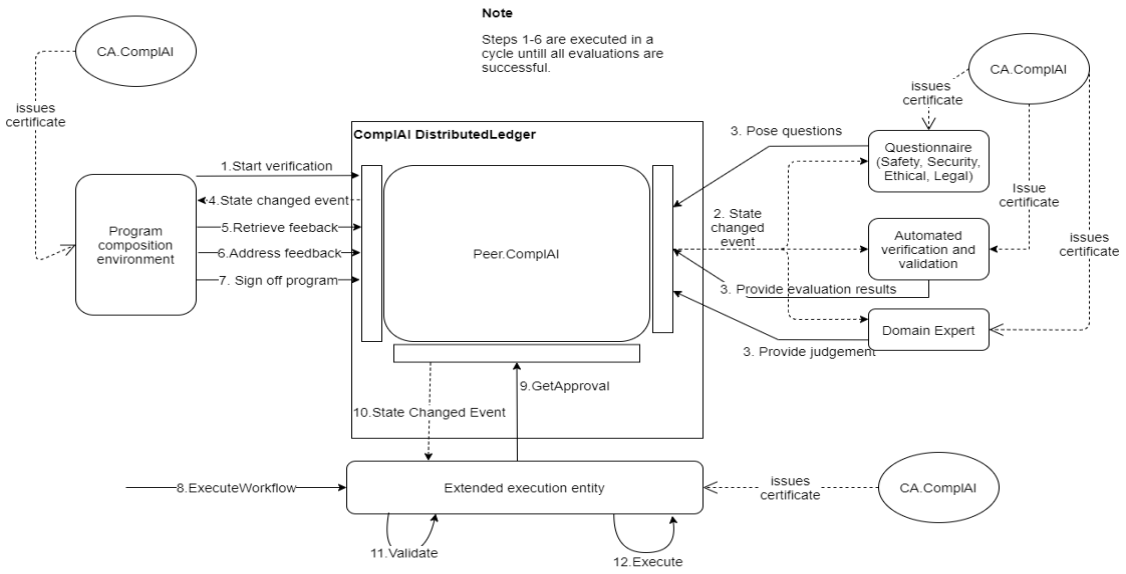
Workflow Engine Extension

1. Workflow engine receives a queue of workflows including a signature
2. Workflow engine sends a verification request to the Compliance Service Provider
3. If the verification fails the engine aborts and sends back an error message
4. If the verification succeeds the workflow queue is executed on the robot



Verification Process - Concept

- Distributed Ledger maintains workflow verification procedure
- Operations are signed by the corresponding entity and stored in a blockchain
- Workflows are executed only if they are verified and signed by the verification authority



Reflection and Project Results

Project: Recap

Challenge:
How to model AI, Robotic and assess compliance

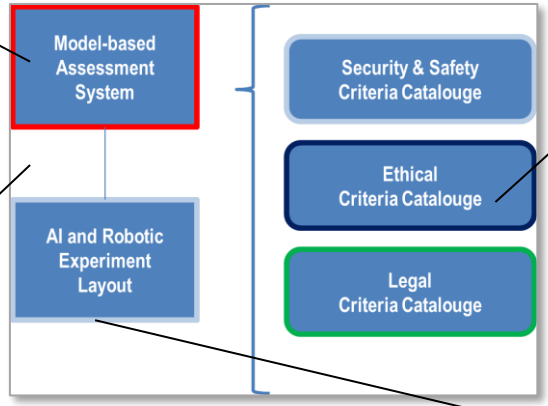
Business Domain Model
- *BPMN-Business Processes*

Technical Robot Model
- *Petri-Net*
- *Flow Chart*
- *BPMN Workflows*

Artificial Intelligence
- *DMN-Rules*
- *CNN for image recognition*

Challenge:
How to create criteria catalouges that can be modelled and assessed

- *Questionnaire and Threshold Model*



Approved Model for configuration:

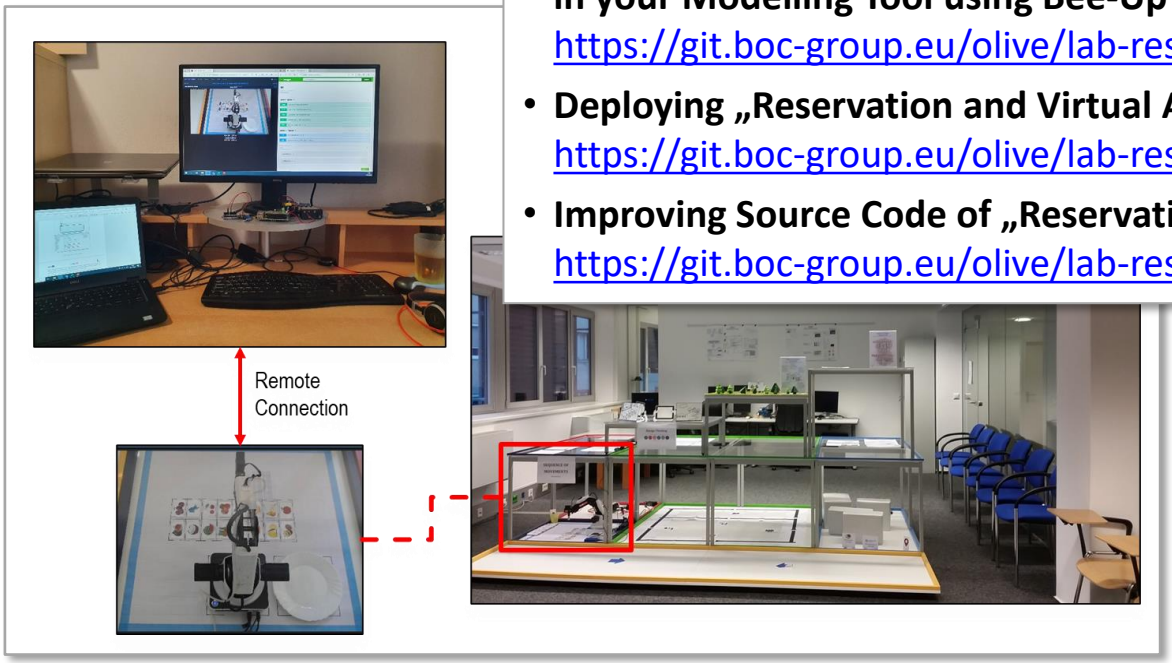
Questionnaire Model
- *Associating Questionnaire Model with Technical Robot Model*
- *Signing the Model*

Challenge:
How to operate compliant model on robotic platform

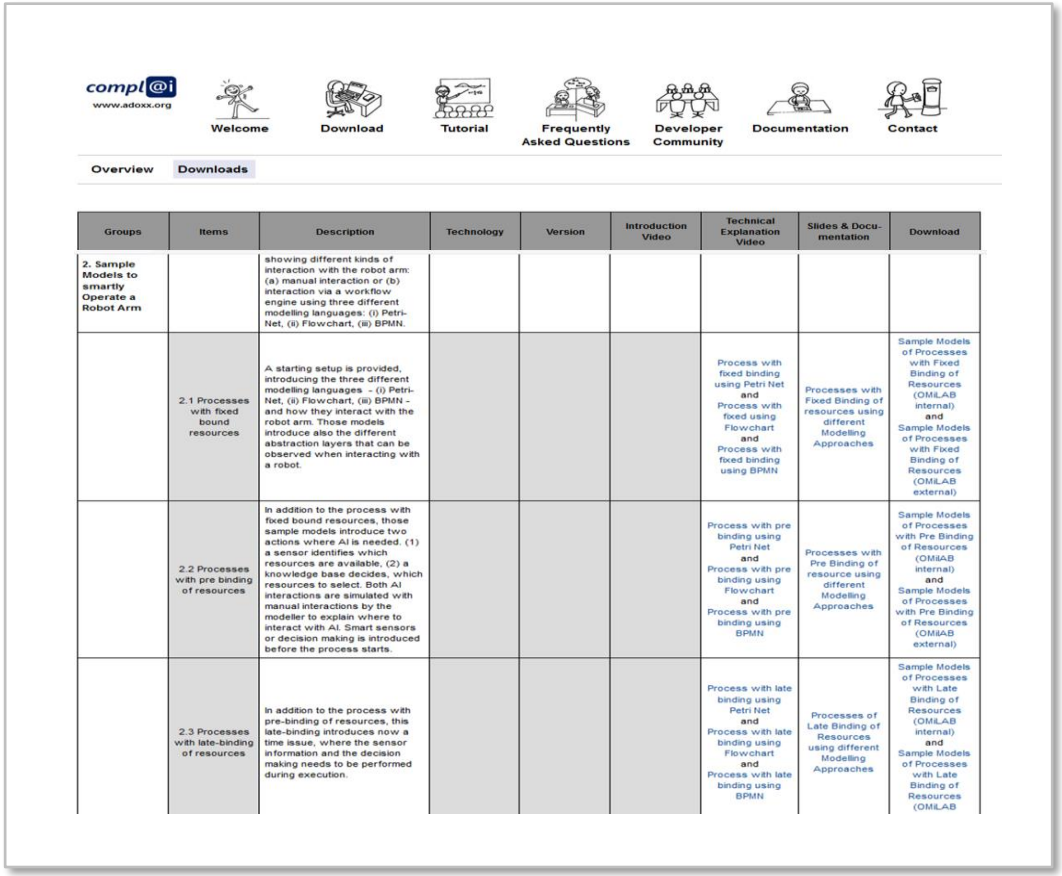
Workflow Engine
- *„Verified“ BPMN Processes*

Accessing Experiment in OMiLAB Innovaition Corner

- **BOC OMiLAB-Innovation Corner:** http://olive.innovation-laboratory.org/lab-reservation-service/
- **Deploying „Reservation and Virtual Access Service“ for local testing:** https://git.boc-group.eu/olive/lab-reservation-fast-deployment-package/-/releases
- **Integration „Reservation and Virtual Access Service“ in your Modelling Tool using Bee-Up as sample:** https://git.boc-group.eu/olive/lab-reservation-beeup-integration
- **Deploying „Reservation and Virtual Access Service“ for Production:** https://git.boc-group.eu/olive/lab-reservation-service
- **Improving Source Code of „Reservation and Virtual Access Service“:** https://git.boc-group.eu/olive/lab-reservation-service-docker



Access to Results



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Overview | Downloads

Groups	Items	Description	Technology	Version	Introduction Video	Technical Explanation Video	Slides & Documentation	Download
2. Sample Models to smartly Operate a Robot Arm		showing different kinds of interaction with the robot arm: (a) manual interaction or (b) interaction via a workflow engine using three different modelling languages: (i) Petri-Net, (ii) Flowchart, (iii) BPMN.						
	2.1 Processes with fixed bound resources	A starting setup is provided, introducing the three different modelling languages – (i) Petri-Net, (ii) Flowchart, (iii) BPMN - and how they interact with the robot arm. Those models introduce also the different abstraction layers that can be observed when interacting with a robot.				Process with fixed binding using Petri Net and Process with fixed using Flowchart and Process with fixed binding using BPMN	Processes with Fixed Binding of resources using different Modelling Approaches	Sample Models of Processes with Fixed Binding of Resources (OMiLAB internal) and Sample Models of Processes with Fixed Binding of Resources (OMiLAB external)
	2.2 Processes with pre binding of resources	In addition to the process with fixed bound resources, those sample models introduce two actions where AI is needed. (1) a sensor identifies which resources are available, (2) a knowledge base decides, which resources to select. Both AI interactions are simulated with manual interactions by the modeller to explain where to interact with AI. Smart sensors or decision making is introduced before the process starts.				Process with pre binding using Petri Net and Process with pre binding using Flowchart and Process with pre binding using BPMN	Processes with Pre Binding of resource using different Modelling Approaches	Sample Models of Processes with Pre Binding of Resources (OMiLAB internal) and Sample Models of Processes with Pre Binding of Resources (OMiLAB external)
	2.3 Processes with late-binding of resources	In addition to the process with pre-binding of resources, this late-binding introduces now a time issue, where the sensor information and the decision making needs to be performed during execution.				Process with late binding using Petri Net and Process with late binding using Flowchart and Process with late binding using BPMN	Processes of Late Binding of Resources using different Modelling Approaches	Sample Models of Processes with Late Binding of Resources (OMiLAB internal) and Sample Models of Processes with Late Binding of Resources (OMiLAB

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Webpage

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