

Reconfigurable Digital Twins for an Industrial Internet of Things Platform

Eliseu Pereira (eliseu@fe.up.pt)

Maria Arieiro (up201606469@fe.up.pt)

Gil Gonçalves (gil@fe.up.pt)

Agenda

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 - Industry 4.0
 - IEC 61499
- **Implementation**
 - Architecture
 - GUI
- **Experiments & Results**
 - 3D Printed Gripper Control
 - Monitoring & Energy Optimization
- **Conclusions & Future Work**
 - Contributions
 - Future Work

Introduction

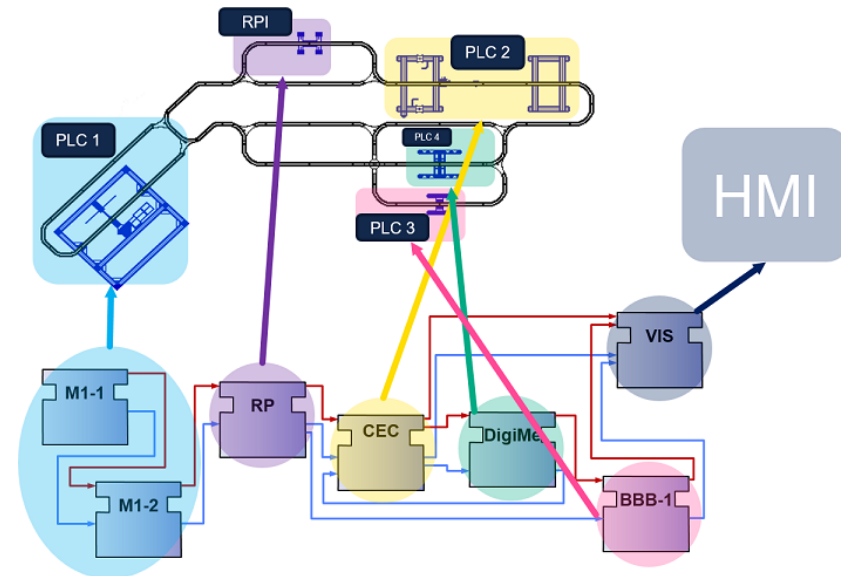


Industry
4.0

IEC61499

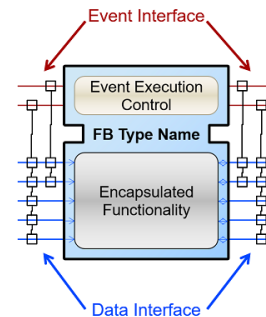
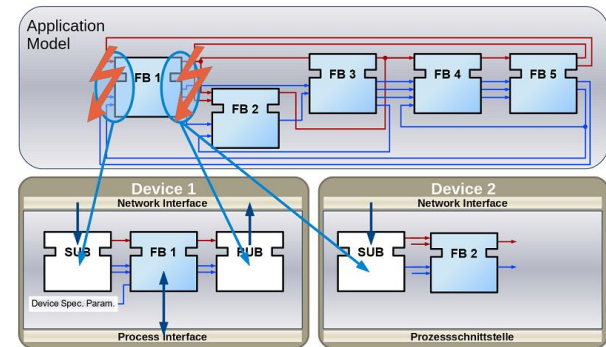
Industry 4.0

- Digitalization of industrial equipment (sensors, machines)
- **Reconfiguration of large** Cyber-Physical Production Systems, enabling:
 - Quick modification of requirements (products).
- Existent reconfiguration **tools** or **programming languages**:
- **IEC 61499**: industrial standard to design distributed CPPS;



IEC 61499

- Industrial Standard;
- Distributed Orchestration;
- Encapsulation of software in Function Blocks (FBs);
- **Development Environment (IDE):**
 - Orchestrate, Map, and Deploy.
- **Runtime Environment (RTE):**
 - Execute FBs according to its Execution Model.

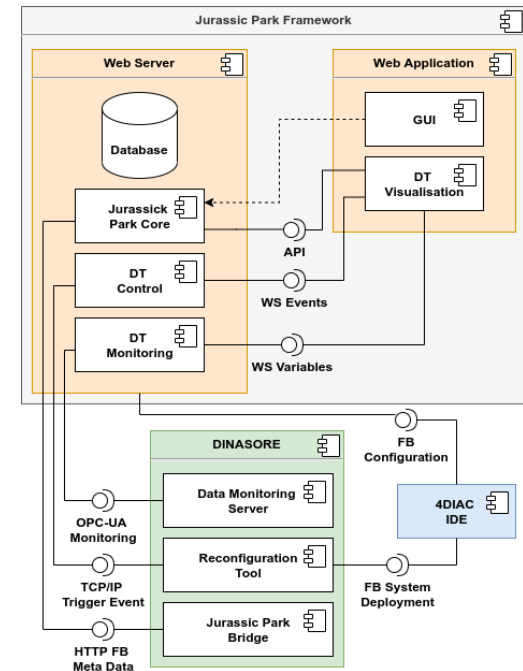


Implementation








DT Platform Architecture












- **DT visualization:** allows the interaction between the DT platform and the user.
- **DT monitoring:** intends to serve as a processing tool of the information that arrives from the physical entity to the digital one.
- **DT control:** permits to trigger functionalities over the physical entities connected to the platform.



GUI: DT Monitoring Page

Digital Twin Monitoring
Jurassic Park Marketplace 

-  Function Blocks
-  Function Blocks Categories
-  Smart Components
-  Digital Twin Platform
- + New Function Block
- + New Digital Twin

Functionality ▲	Digital Twin	Details	Add Details	Edit	Delete
Gripper	DT_Gripper_test				
Optimization_test	DT_test_optimization				
Sensorization_test	DT_test_sensorization				


New Functionality





Digital Twin



▼

ADD FUNCTIONALITY



GUI: DT Details Page



Digital Twin Monitoring
Jurassic Park Marketplace 

-  Function Blocks
-  Function Blocks Categories
-  Smart Components
-  Digital Twin Platform

-  New Function Block
-  New Digital Twin

Optimization_test

Variable	Function Block	Smart Component	Current Value	Delete
COST	ENERGY_COSTS_1	dinasore3	1269.8766074325235	
TEMPERATURE	OPTIMIZE_ENERGY	dinasore3	1	

Event	Function Block	Smart Component	Trigger Event	Delete
READ	ENERGY_COSTS	dinasore3		

Test Case Scenarios



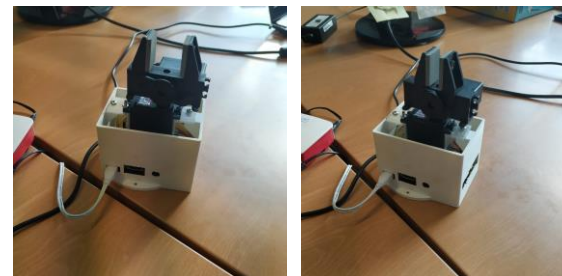
3D Printed
Gripper
Control



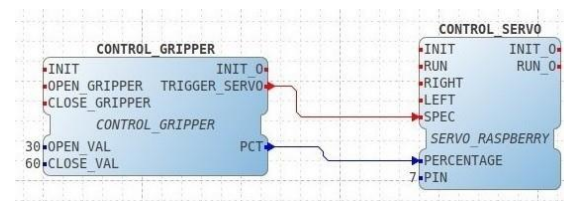
Monitoring
& Energy
Optimization

DT for 3D Printed Gripper Control

- CPS to control a gripper allowing the user to open and close it.
- **Control pipeline:** workflow that selects the corresponding percentage to move the servo motor, and then updates the general-purpose input/output (GPIO) that controls the servo motor with the corresponding value.



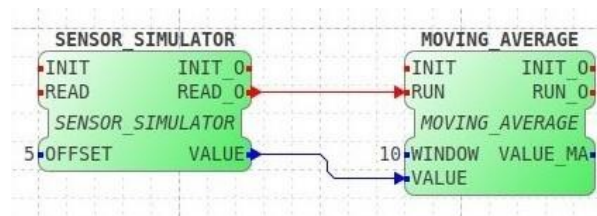
Open and closed gripper.



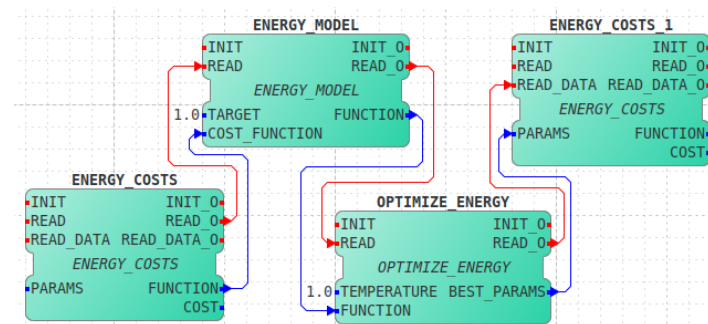
FB pipeline for gripper control.

Monitoring & Energy Optimization

- CPS composed by 2 raspberry pi's: 1) for sensing purposes and 2) for energy optimization.
- **Sensing pipeline:** workflow that generates random data and calculates the average of the last N values.
- **Optimization pipeline:** workflow that specifies the function for energy costs and then optimizes it.



FB pipeline for sensor simulation.



FB pipeline for energy optimization.

Conclusions & Future Work



Conclusions

Future
Work

Conclusions & Future Work

- The platform implements a flexible and reconfigurable DT solution capable of increasing the monitoring capacity and enable the remote control of a CPS.
- The main contributions were the platform flexibility and configurability, allowing to be easily integrated in the industrial sector and support the IEC-61499 standard.
- The future work will focus on the storage of data generated by the DT variables, allowing the implementation of predictive algorithms to forecast and optimize the behavior of DTs.



Thanks for your attention!

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