

PLC Based Automation at European XFEL

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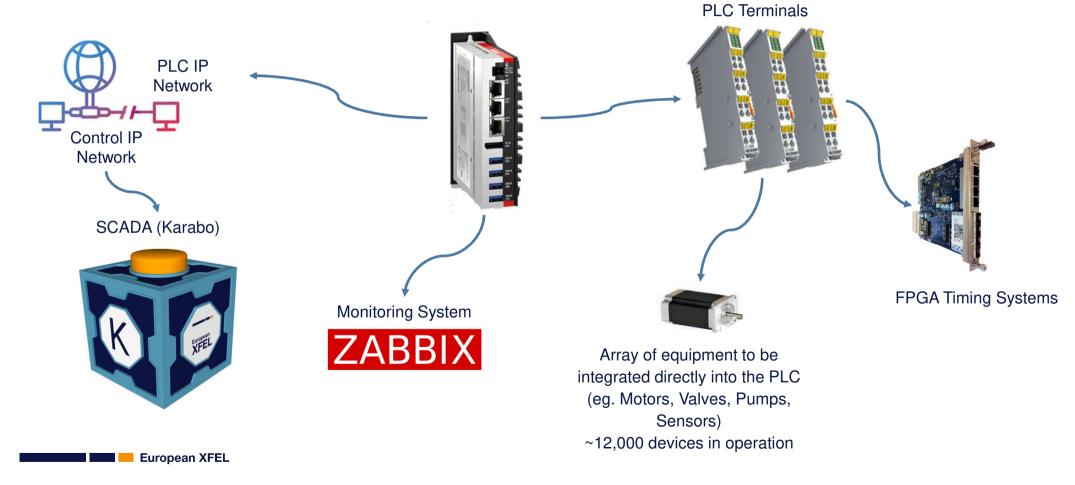
European XFEL February 6th 2025

Outline

- Engineering Systems surrounding the Programmable Logic Controllers (PLC)
- Soliciting Requirements and Processes
- Transition Towards Sustainable Tooling
- Extraction of Information for the Automation of System Integration
- Customisation of PLC Configurations and Hardware Behaviours
- Future Developments and Questions



Engineering Systems interfacing into Programmable Logic Controllers (PLC): An Overview



Soliciting Requirements and Processes: A Bottom Up Approach

E Equipment Request	
Equipment Details	
Equipment Name *	
Mass Flow Controller	
Manufacturer 📀	
Bronkhorst	
Manufacturer Part/Model Number 📀	
FG-201CV-TGD-33-V-DA-000	
This is the model number of the equipment to be integrated. If equipment has a sub module / controller built-in and you have number, add the other part number(s) separated by a comma.	
Built-in Controller? 📀	

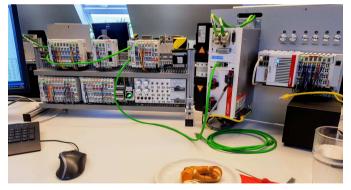
An EIR (Equipment Integration Request) web form is completed

- Details of the specific hardware
- Feasibility of integration
- Expected functionality
- Mixture of both high and low level detail

A ticket for tracking the integration process

A cross-functionality team of device integrators is formed to commence integration.

This includes the review and development of the wiring, device functionality, SCADA integration and concludes with a final test with the requestor where possible.



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Soliciting Requirements and Processes: Challenges

This process is rather lengthy and involves a lot of discussion across teams during the review and implementation phase, especially where information is lacking, incorrect or unclear.

Delays are often encountered

Obtaining updated manuals from the manufacturer

- Encountering bugs in the hardware
- Lack of prioritisation
- Testing
 - Test set-up are not always available
 - End-to-end testing



Toolings – a First Attempt PLCMS DB EPLAN Export Project Data File Interlock Definitions $\langle \rangle$ PLAN Reads in data from all sources Data integrity checks and generates the PLC Project File • XML File, with a selected framework version XML PLC Projec File Configuration and Initialization values Beckhoff XAE – C# • Project Builder Creates a TwinCAT PLC Project BECKHOFF • Ready for deployment Twin**CAT**® PLC Projec

Transition Towards Sustainable Tooling: A Step Back, and a Review

- Work with your development environment
- Cohesion

- Ease of Maintenance
- Lower the entry hurdle



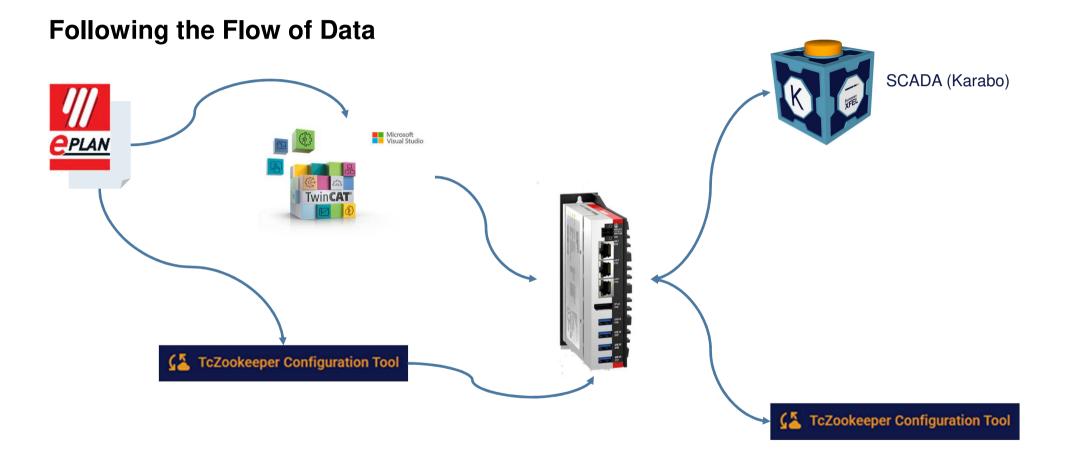
Extraction of Information for the Automatic Integration of Systems:

- What information is essential for the PLC?
- Which aspects would benefit the most from automation?
- How could that be achieved?

Narrowed down our focus to three main systems:

- Electrical wiring
- SCADA Interface
- PLC Interface itself
 Focus on ease of development and configuration

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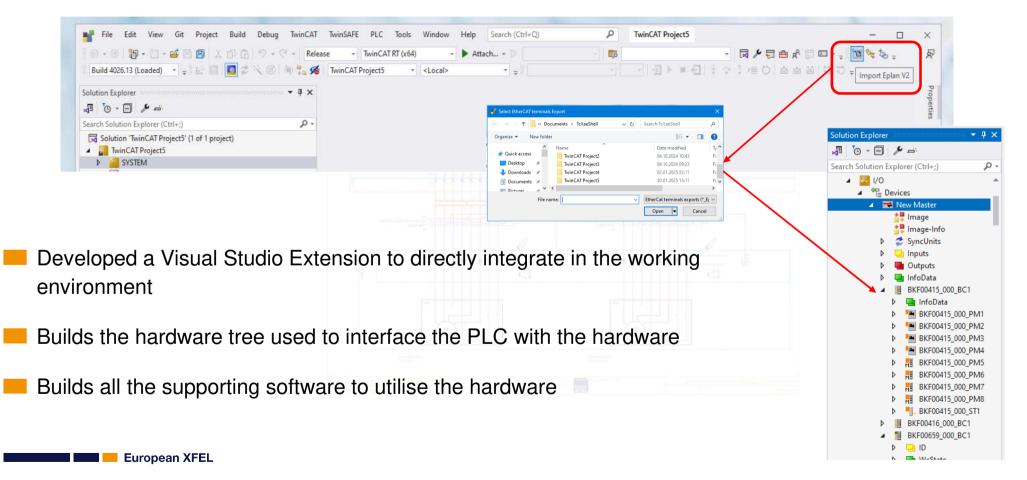
PLC – ECAT Integration: EPLAN Exports – A Tale of Two Wires.

The wiring diagram holds crucial information regarding how one piece of hardware connects with another.

EPLAN Export to capture the data in a useable format for the PLC

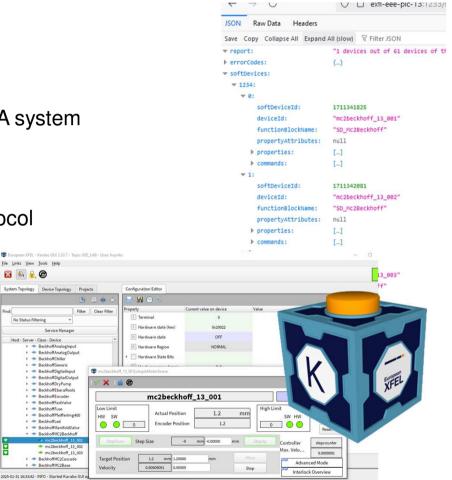
Develop a parser which:
Extracts relevant information
Machine readable but also Human readable
Acts as a Linter

PLC – ECAT Integration: PLC Project Build Tool



PLC – SCADA Integration: SCADA – A User Interface

- PLCs are mostly useful when paired as part of a SCADA system
- PLC code built with modularity with abstraction
- Single communication layer to cater to the SCADA protocol
- Enables complex functionality to remain in the PLC
- Passes only information needed for the user



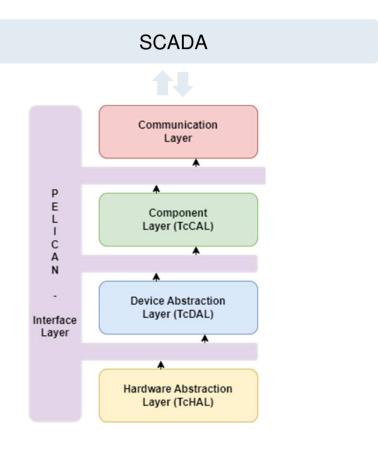
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The PLC Interface

- PLC architecture relies on a layered abstraction approach
 - Enables a clear division of scope
 - Simplifies:

Testing

- Debugging
- Developing
- Configuration



Customisation of PLC Configurations and Hardware Behaviours:

- Each PLC interfaces into several hundred devices
- To configure these devices a Configuration Tool was developed
- Simplifies the interface to the SCADA System
- Hardware settings and device functionality is obfuscated from the user

CZookeeper Configuration Tool	h.	TcZooke Europea XFE
Q Search Sort by Type	> Wrapped Interface Properties for Karabo	
> DI_Channel	AI_Temperature_1_Ch_1	Q Search
> DO_Channel	Name	Value
AI_Temperature_1_Ch_1 EEE18.EEE18_PLC HAL.Term_BC1_EL3202_AF	Hardwa CoeEnableUserScale CoePresentation	re False
AI_Temperature_1_Ch_2 EEE18.EEE18.PLC.HAL.Term_BC1_EL3202_AI	CoeEnableFilter CoeEnableLimit_1	False False
AI_VoltageChannel	CoeEnableLimit_2 CoeEnableAutomaticCalibration	False
-	CoeEnableUserCalibration	False
AI_Voltage_Ch_1 EEE18.EEE18 PLC.HAL.Term BC1 EL3164 AI:	CoeEnableVendorCalibration	False
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	CoeUserScaleGain	0

Future and Ongoing Developments

- Complete Hardware layer to support additional EtherCAT based fieldbus devices
- Improve testing methods
 - Test Driven Development (TDD)
 - Integration tests
- Maintenance plan to adapt to upgrades
 - EPLAN version updates
 - TwinCAT updates
 - VisualStudio (Extensions) updates



Image credit to : https://www.xfel.eu

Thank you for your attention, - the PLC team.



