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IEC 61499: primer course

Module 0: Motivations and Origins

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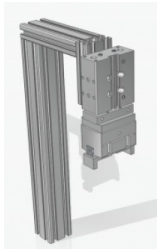
What is IEC 61499?

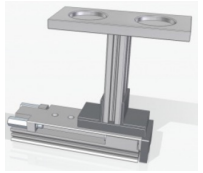
Example: Assembly system model

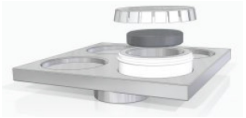
- Mechatronic modularity
- Layout changes during the production process to flexibly accommodate new order
- Wireless comunication
- Totally distributed hardware control architecture

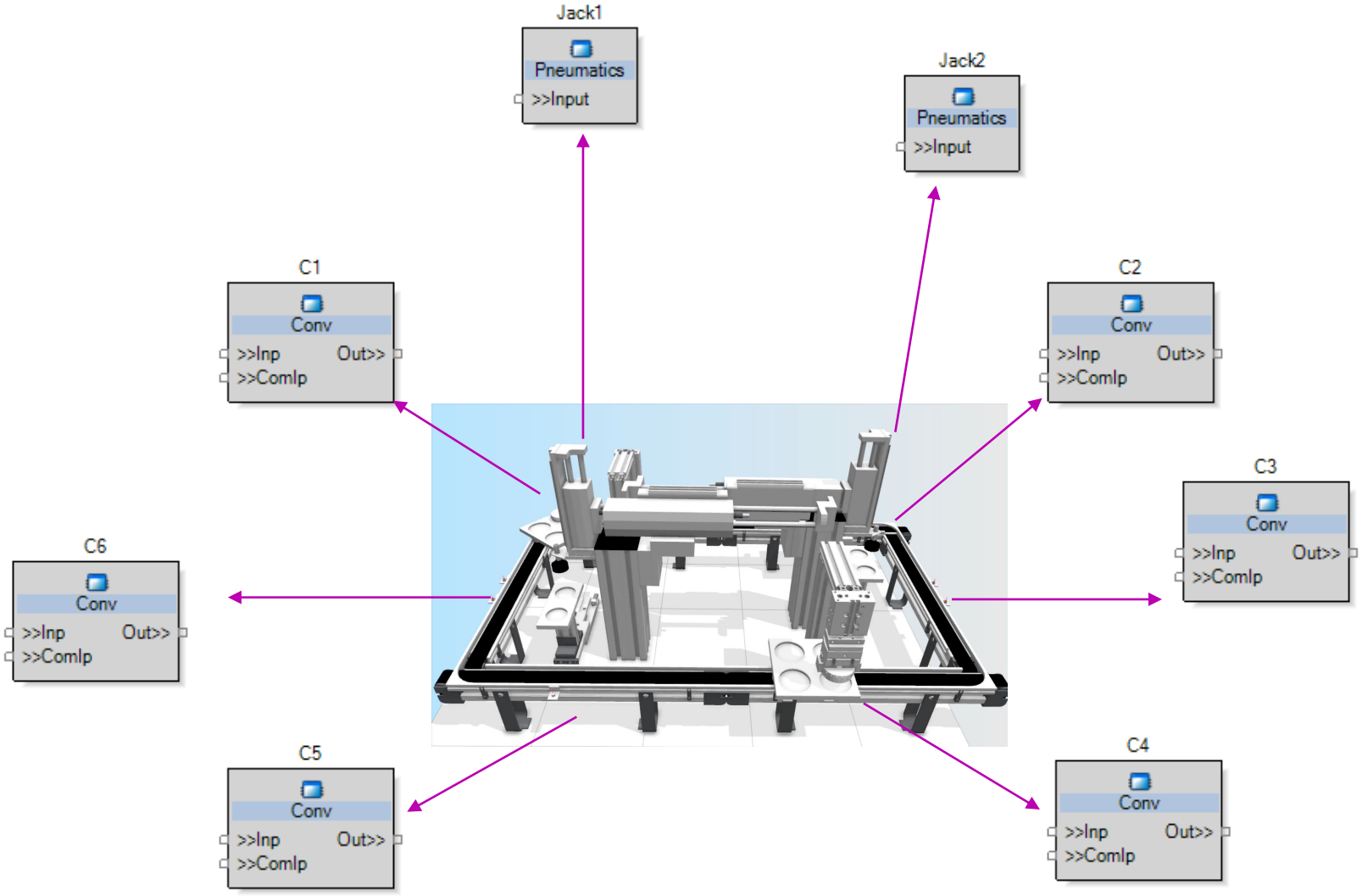
Object-based design

Each function block type corresponds to a mechatronic component type.



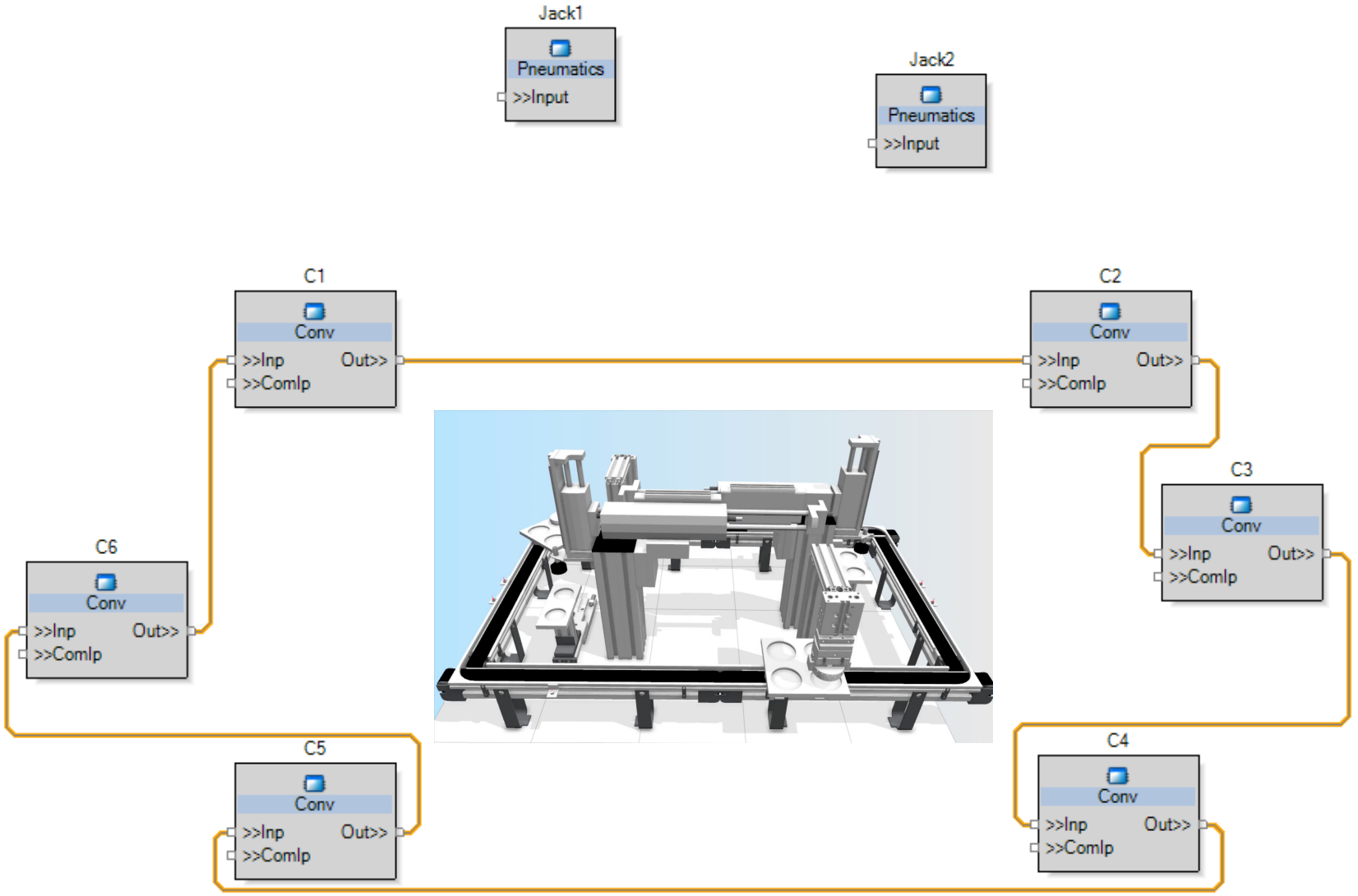




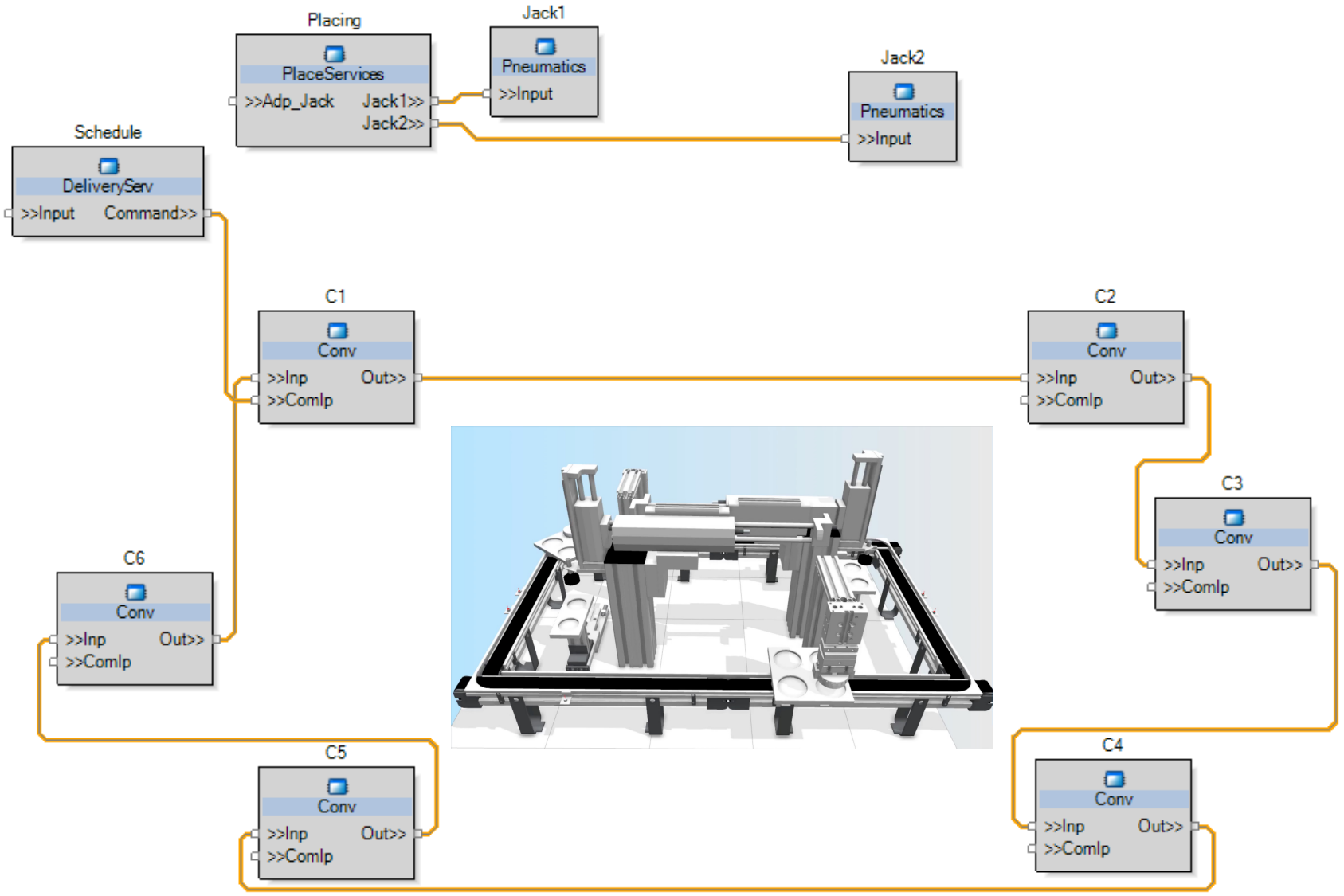


Each function block type implements basic control services for the mechatronic component.

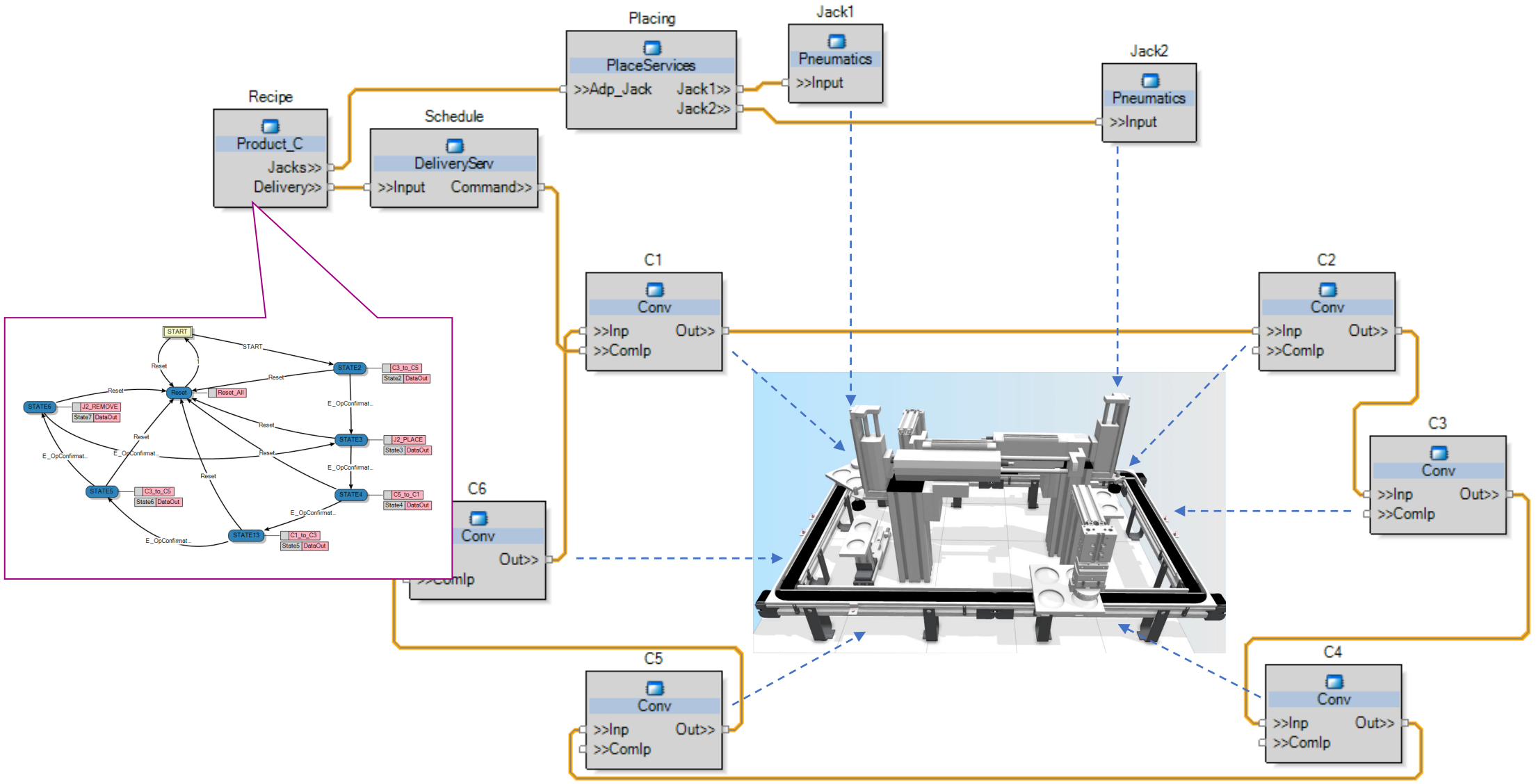
Programming with Function Blocks



Programming with Function Blocks



Programming with Function Blocks

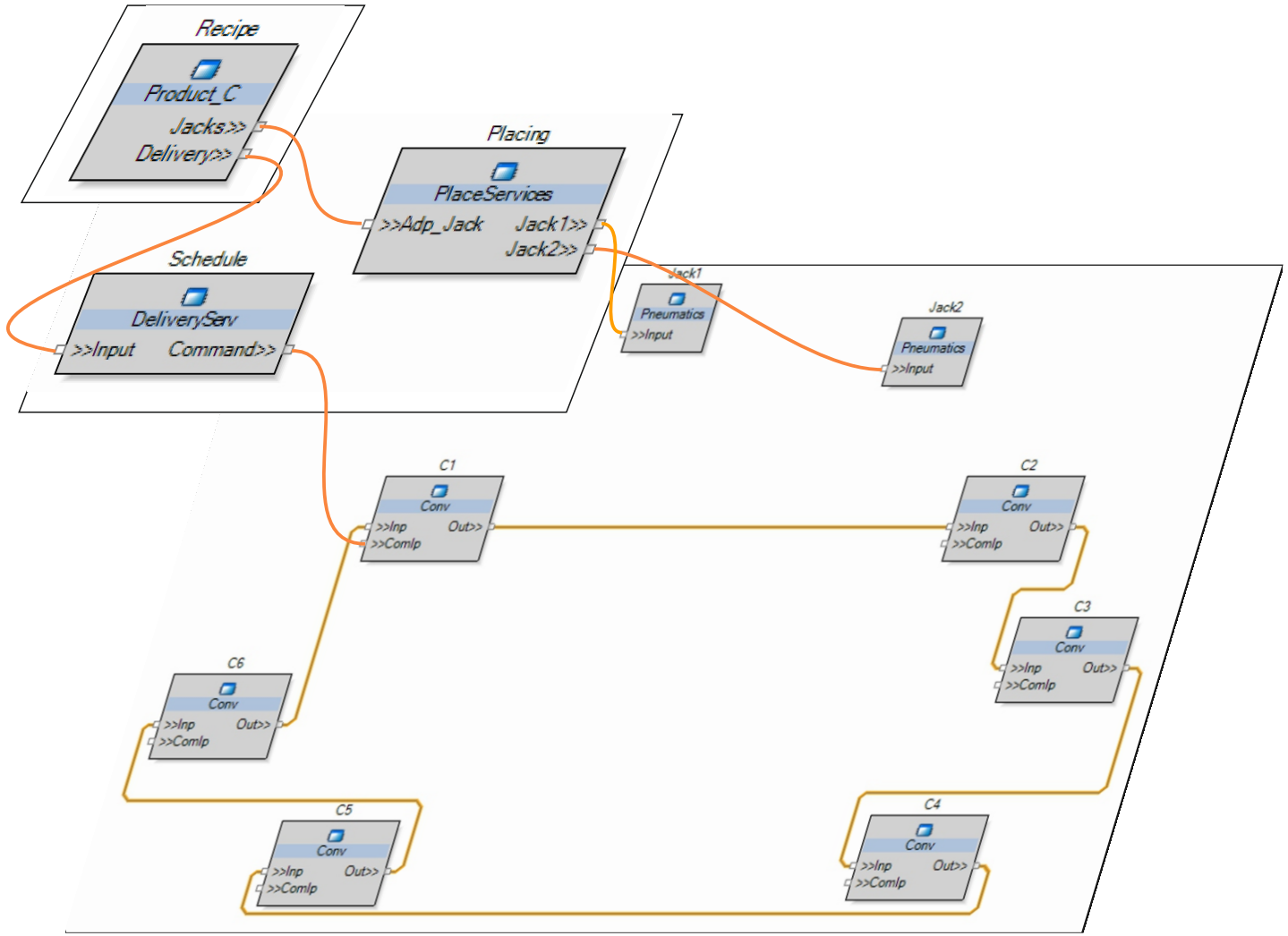


Layered services architecture

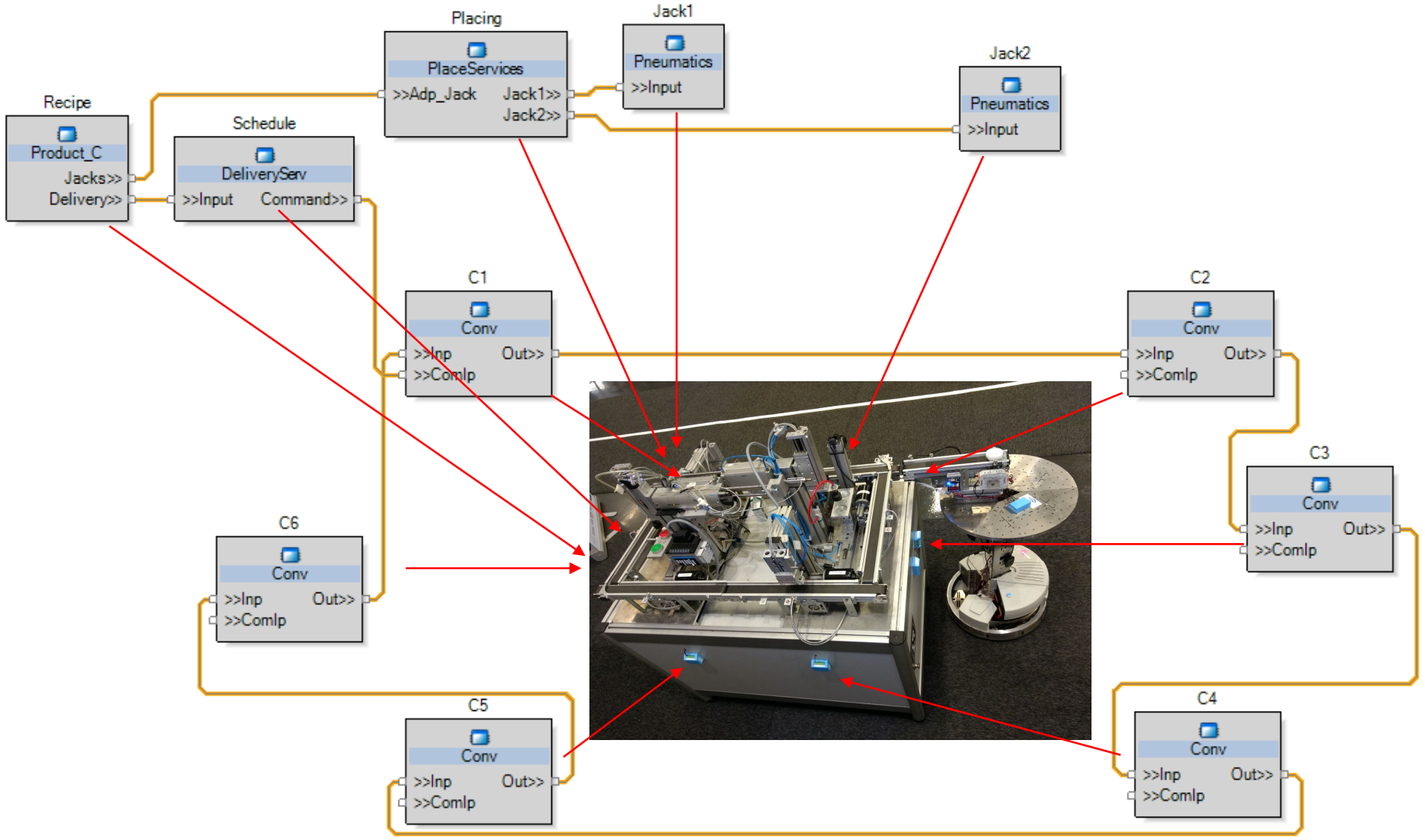
Product description layer

Planning services layer

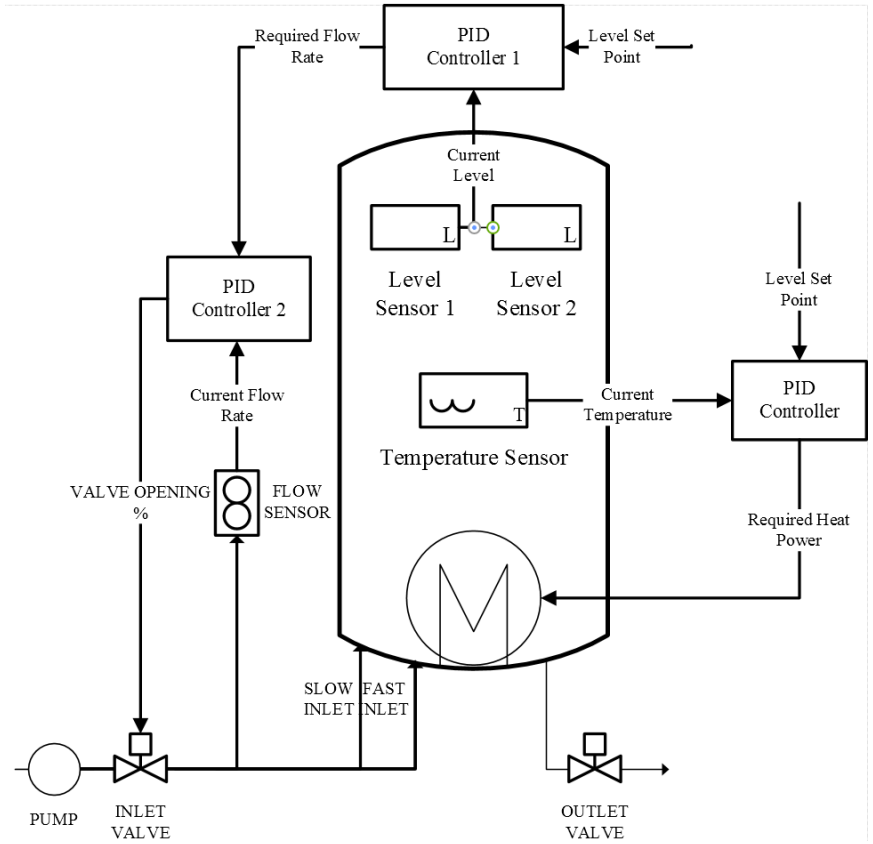
Execution services layer



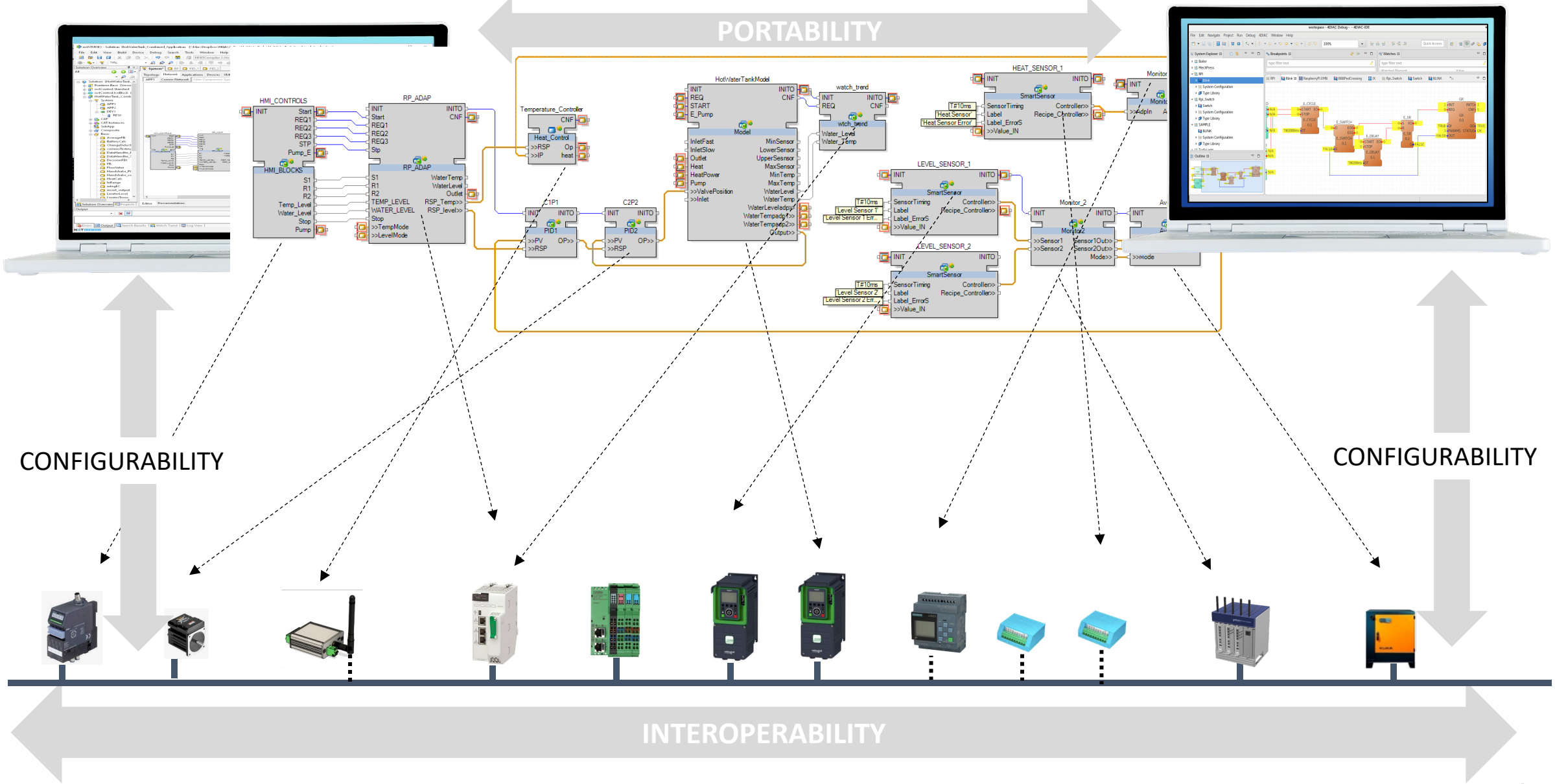
Distributed deployment



What is IEC 61499?



What is IEC 61499?



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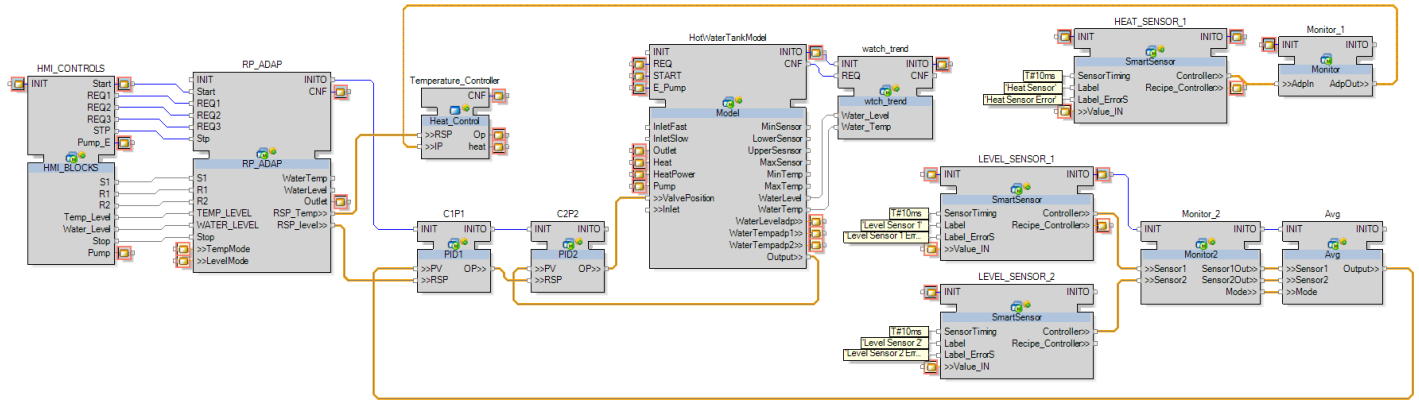
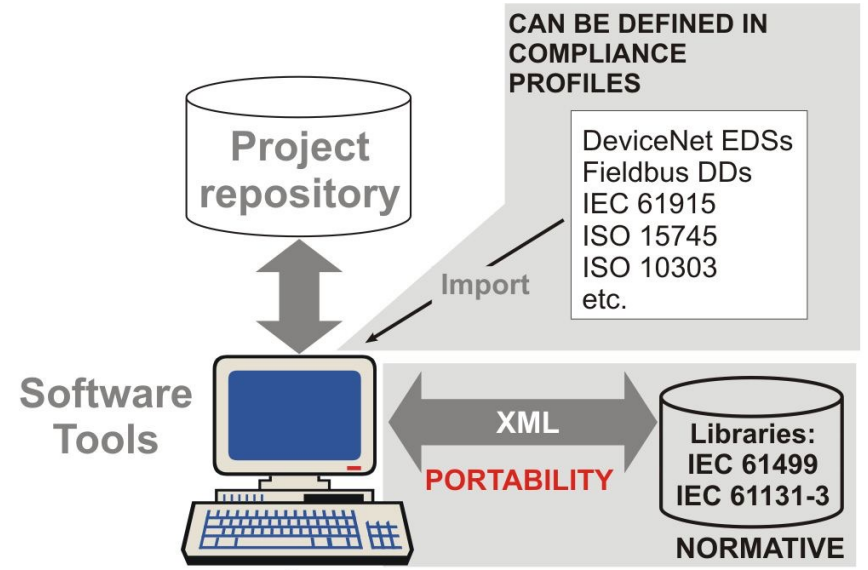
How does IEC61499 address the needs?

Open Distributed Automation Architecture

Extends IEC 61131 PLC programming with a component design language for distributed automation systems





Standard management protocols (XML)==>**CONFIGURABILITY**

Standard data transfer protocol ==>ASN.1 **INTEROPERABILITY**

Distributed Intelligent Devices and Controllers

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IEC 61499 International Standard

International Electrotechnical Commission IEC TC 65B/ WG7/ MT15

A **component-based**, **open reference architecture** for

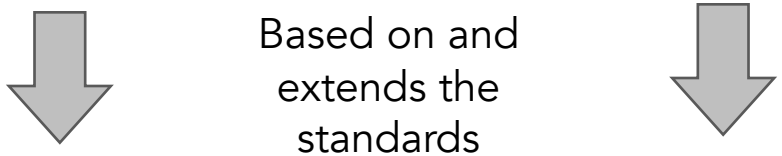
Distributed **Industrial - Process Measurement & Control Systems** (IPMCS)

which can meet both current and future requirements for intelligent automation

1992 – project started

2005 – first edition

2011 – second edition



PLC Function Blocks (IEC 61131-3)

DCS Function Blocks (IEC 61804 project)

IEC61499 ingredients

- Extends PLC programming languages of IEC 61131-3 to dustributed systems design
- Uses visual block-diagram representation for component-based design
- Uses state-machines for defining components' logic
- Components communicate via message passing

- All these features are common in engineering of automation and embedded systems, in IEC 61499 they are brought making powerful engineering framework for modern automation needs

Origins

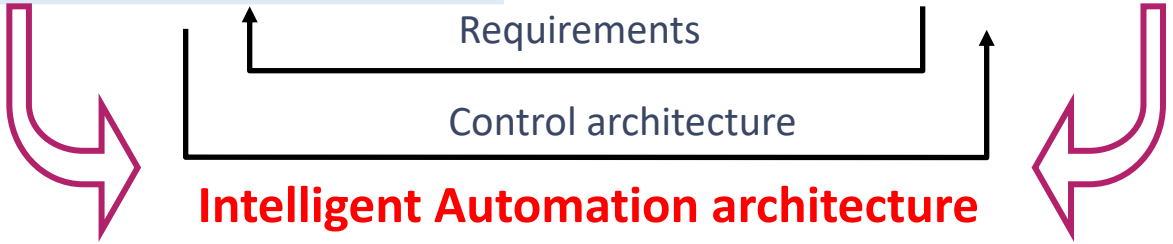
Architectural Co-Evolution

IEC 61499

- **Parent organization**: IEC
- **Working group**: TC65/WG6
- **Goal**: Standard model (function blocks) for control encapsulation & distribution
- **Started**: 10/90
- **Active development**: 3/92
- **Trial period**: 2001-03
- **Completion**: 2005

Holonic Manufacturing Systems (HMS)

- **Parent organization**: IMS
- **Working group**: HMS Consortium
- **Goal**: Intelligent manufacturing through holonic (autonomous, cooperative) modules
- **Feasibility study**: 3/93-6/94
- **First phase**: 2/96 - 6/00
- **Second phase**: 6/00-6/03



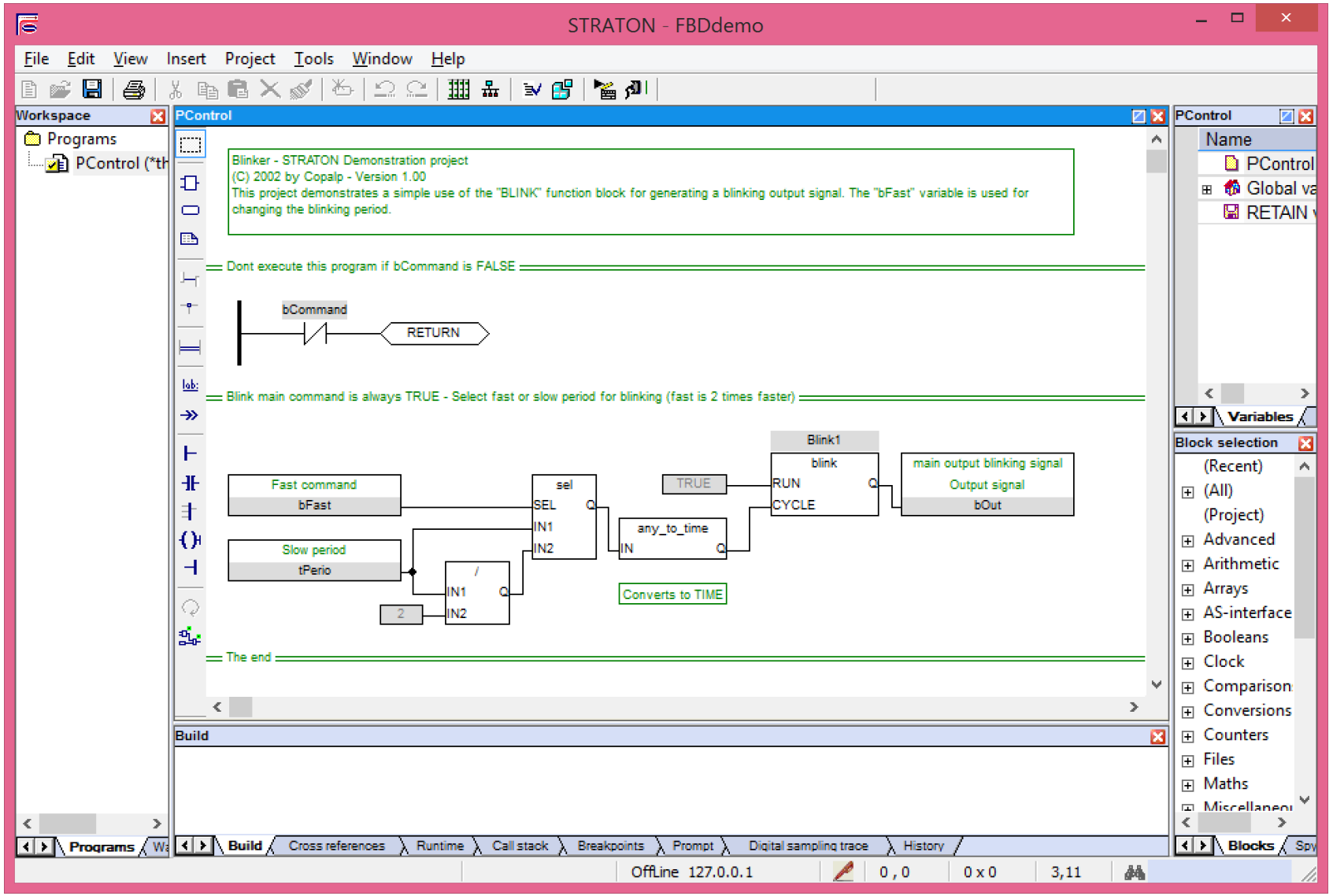
Intelligent Automation architecture

Origins/block diagram programming

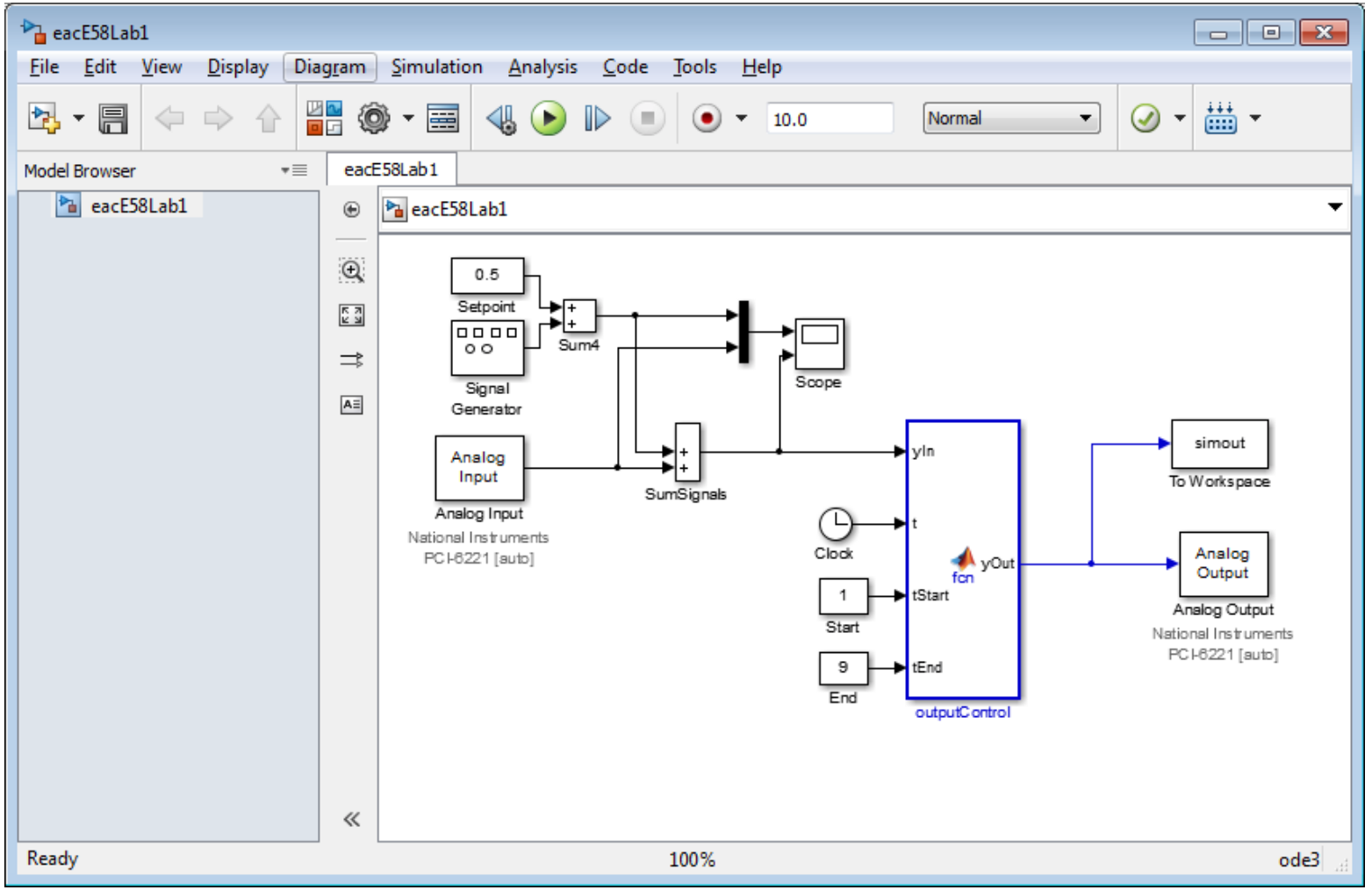
Block diagrams as a programming language

- Block diagrams is a convenient abstraction for representing component-based engineering
- It is used widely in Industrial Automation, Embedded systems, Cyber-Physical Systems, including automotive and aerospace

Block Diagram Programming in Automation

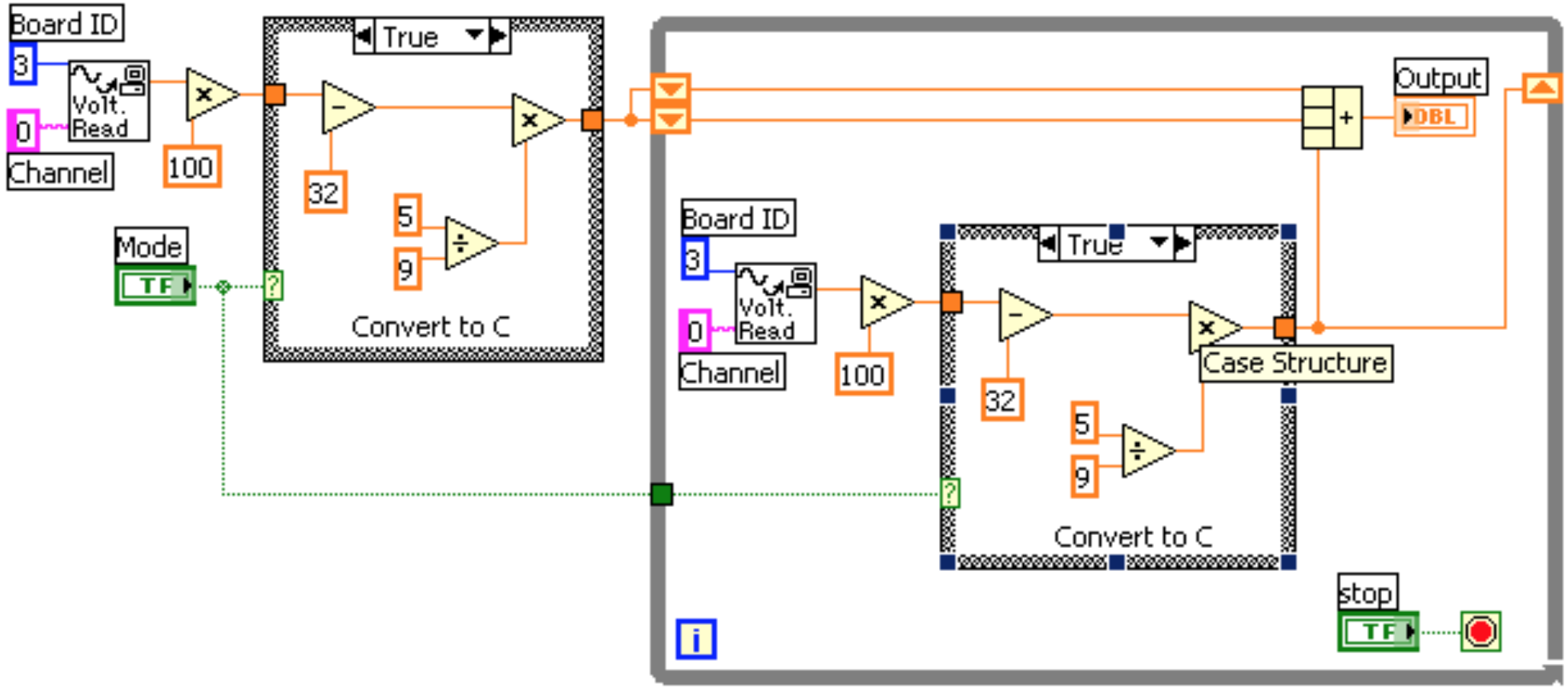


Matlab / Simulink

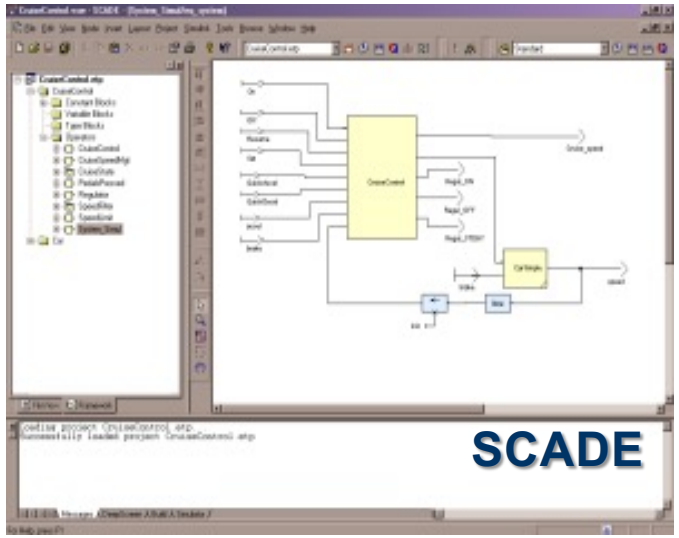


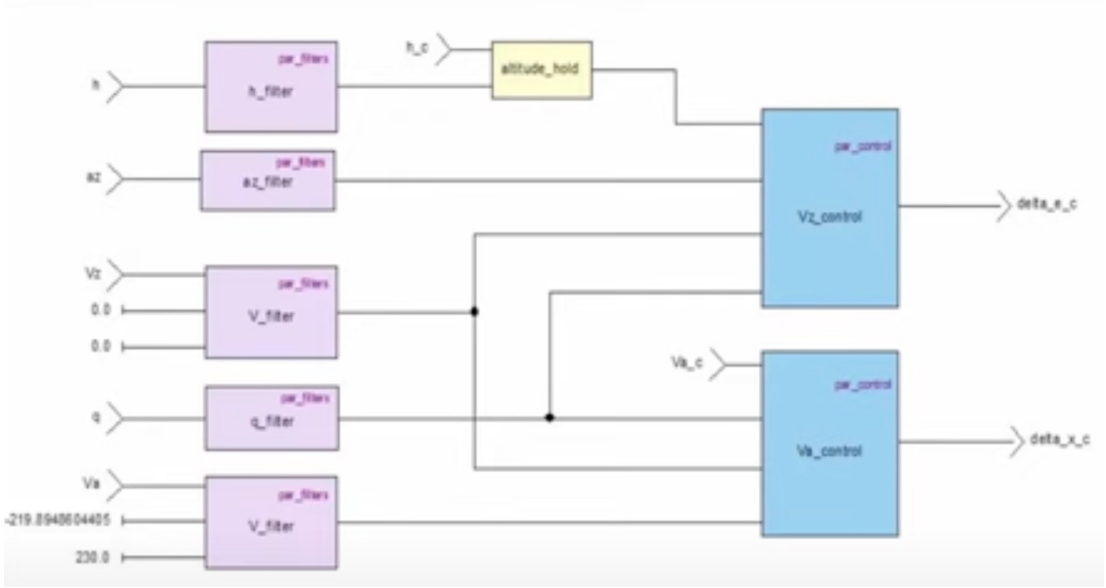
- Block diagrams is a convenient way of defining systems' functionality.
- It is quite standard in control systems engineering and in modelling.

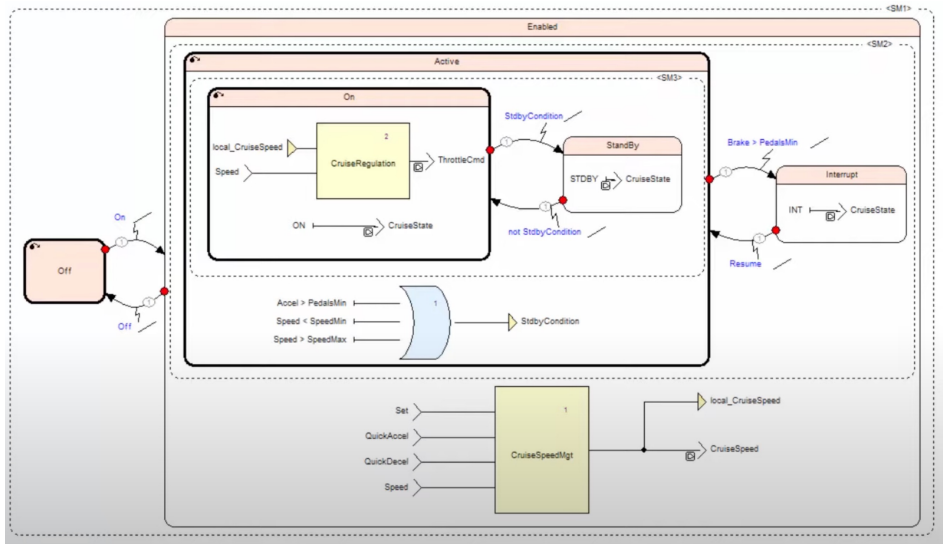
LabView



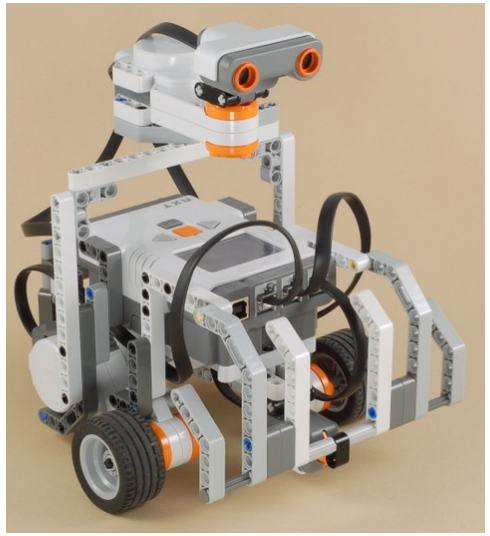
Ansys Scade

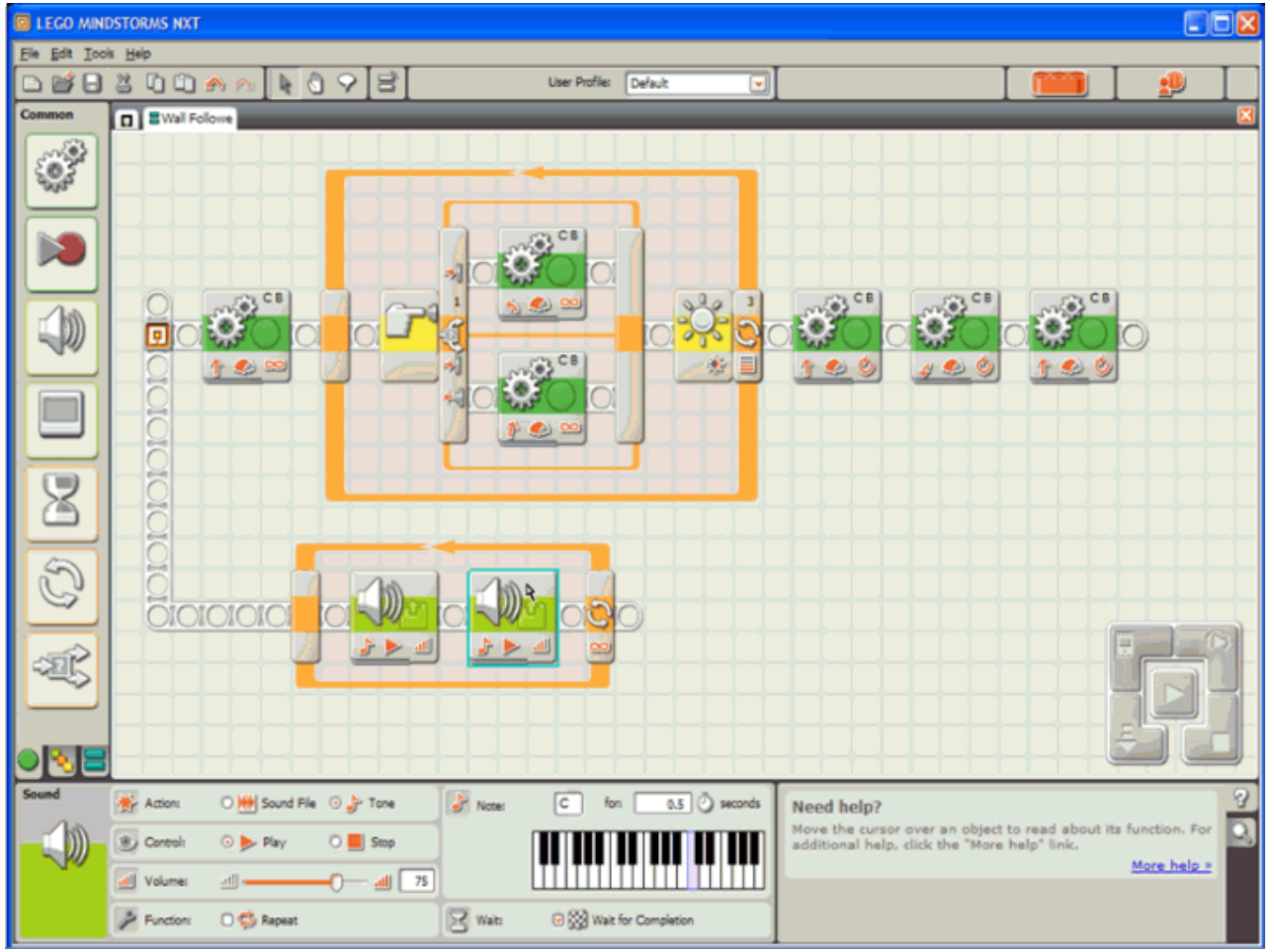




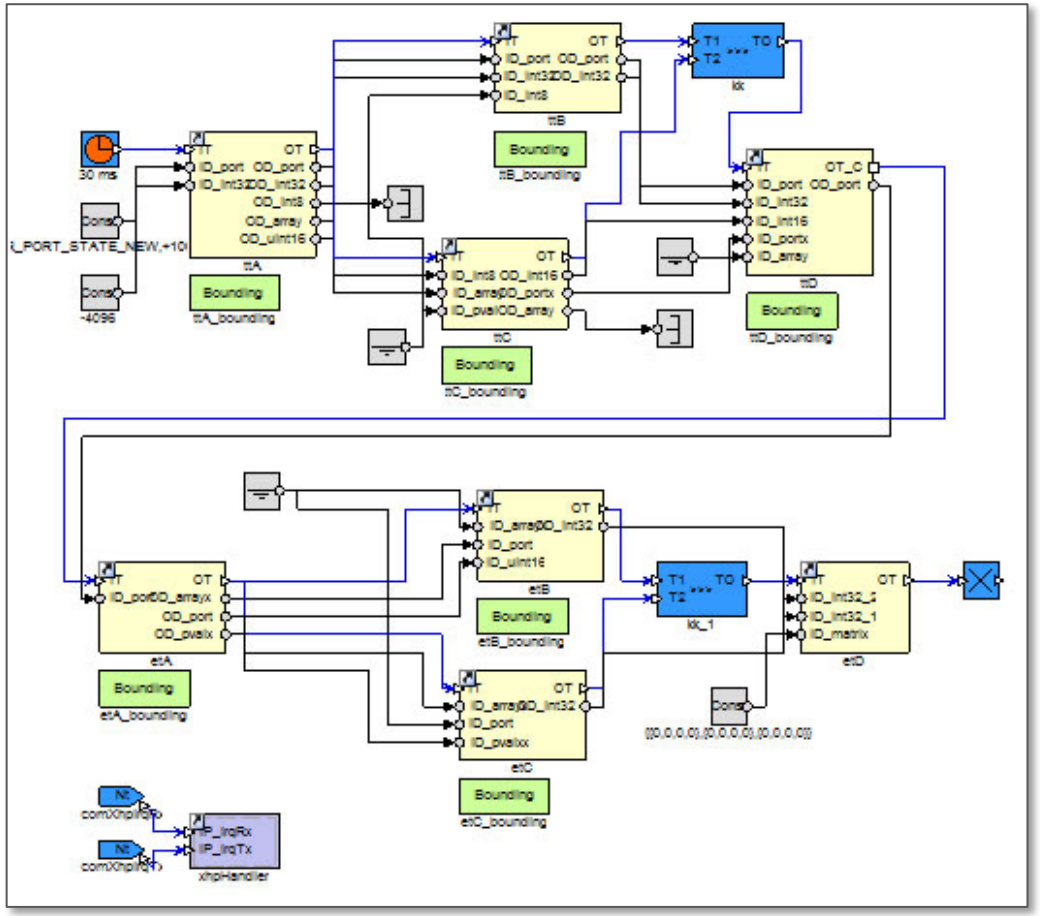


Lego MindStorm

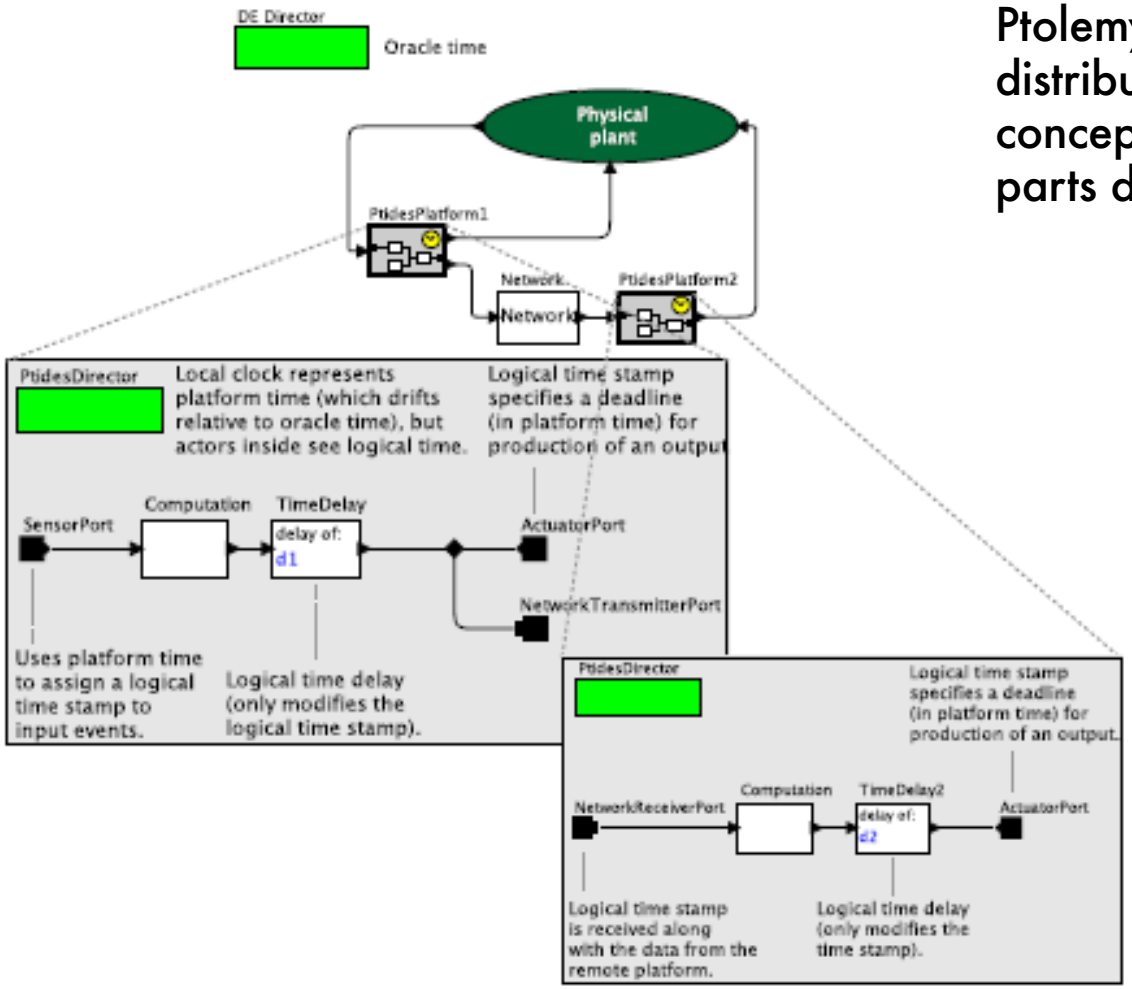




Rubus: embedded systems programming



Ptolemy II



Ptolemy and pTides is a semantic framework for distributed CPS that uses a uniform time concept for both physical and computational parts developed at UCLA Berkeley.

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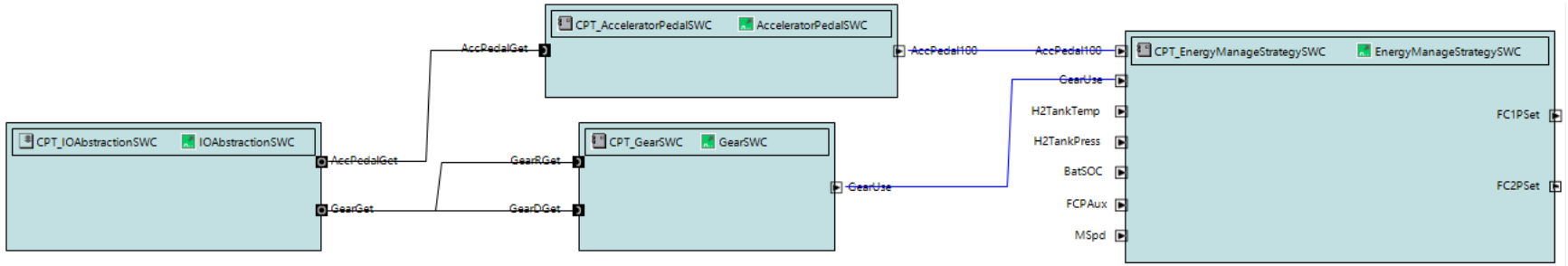

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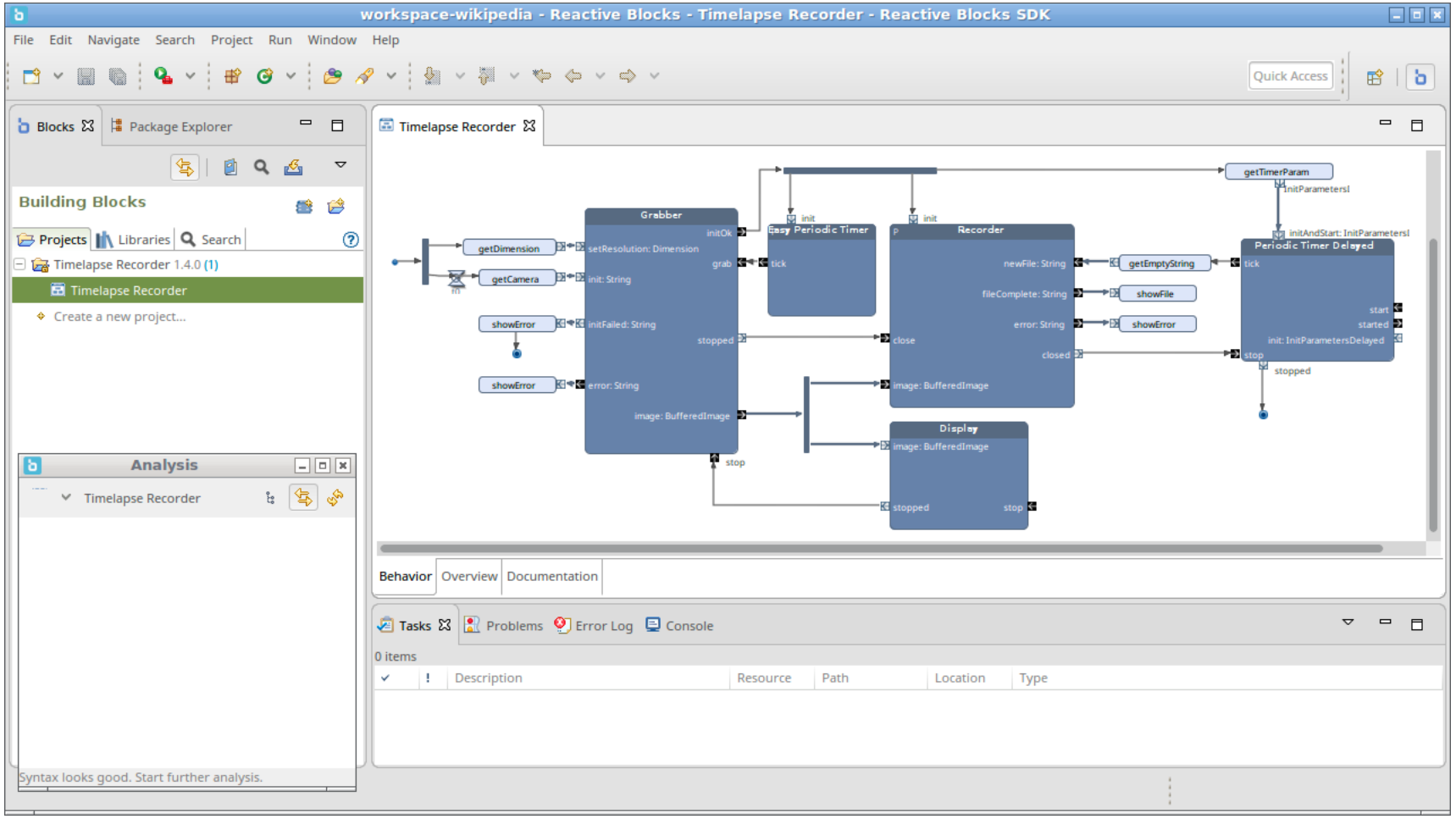
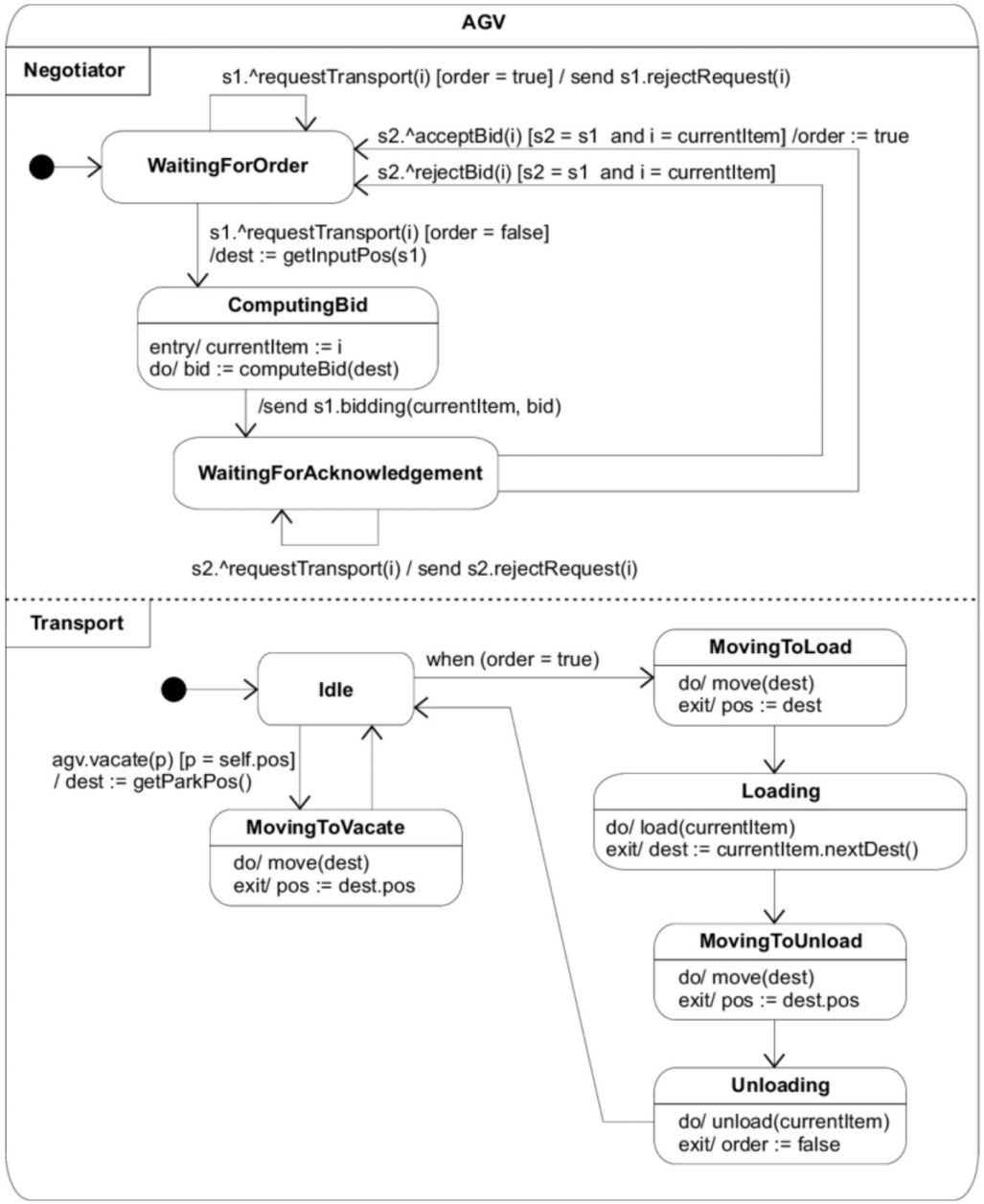
ReactiveBlocks

Compiled to Java



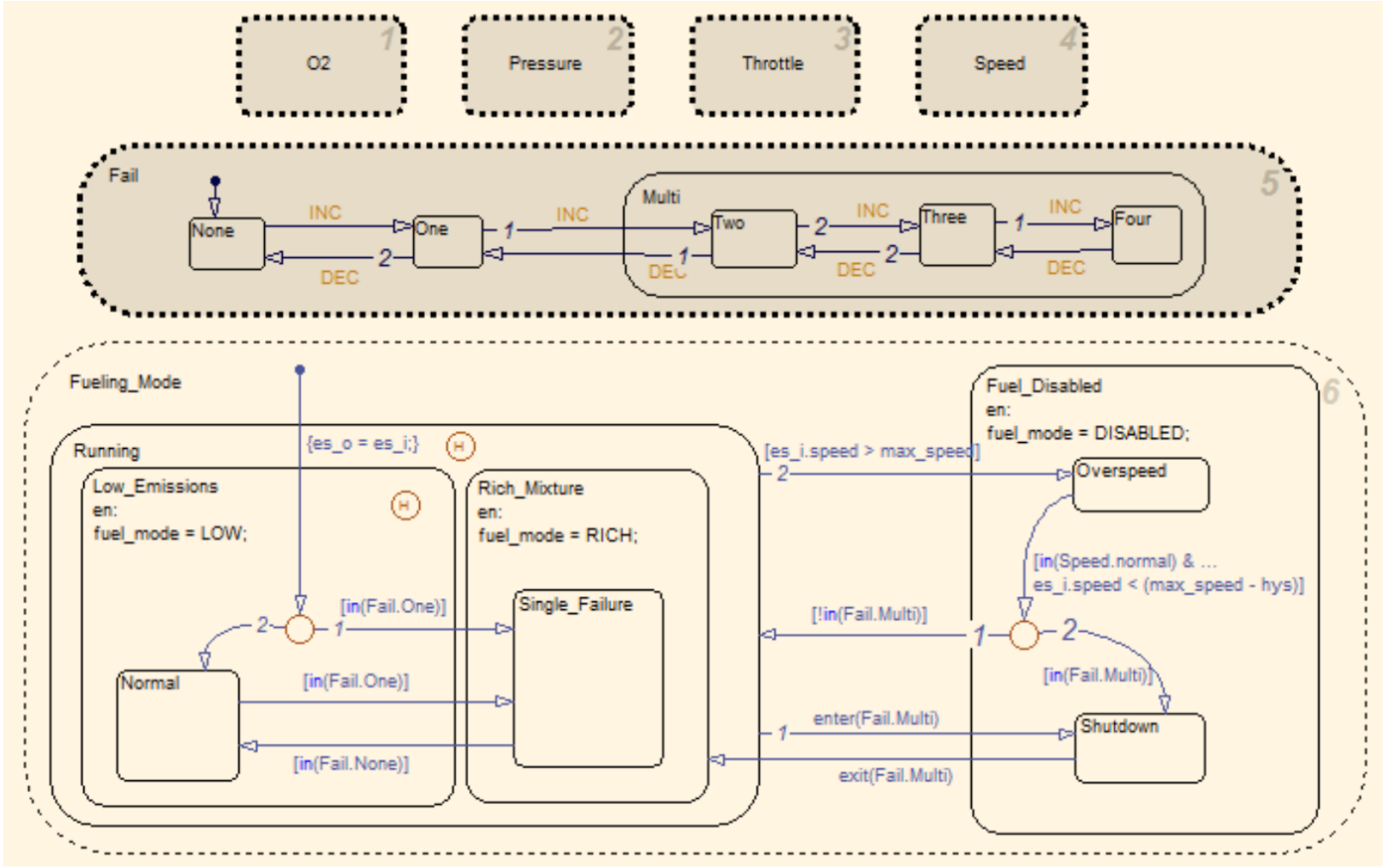
State machines

UML State Charts

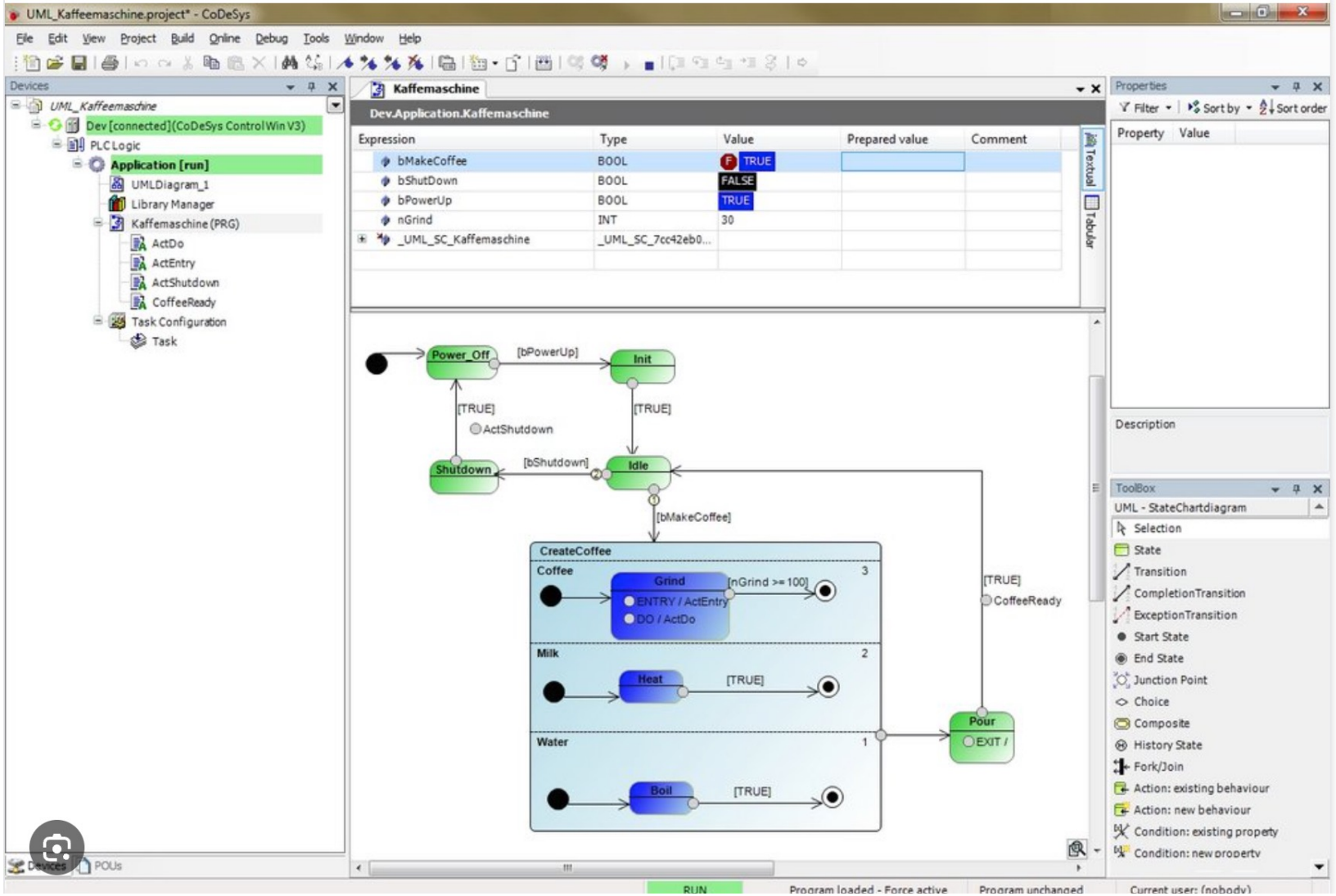


- An important supporting tool for Model-Based Engineering in software and embedded systems engineering.

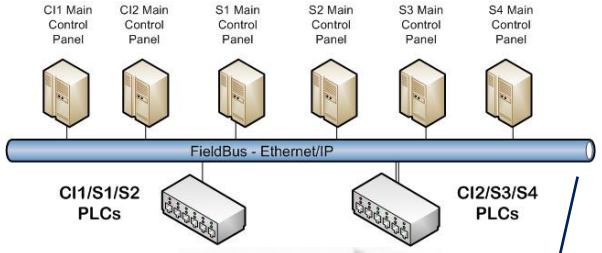
Matlab/Symulink StateFlow

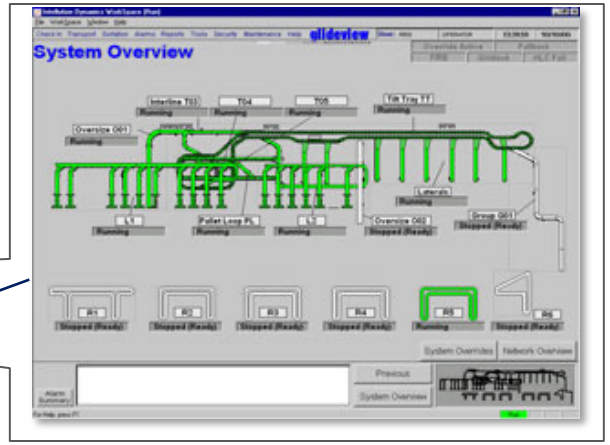


CoDeSys State Charts



Structure of the course





Evolution of Automation | IEC 61499 standard | State based control | System -level design | Design Rules and Patterns | HMI and SCADA | Communication | Alarms and Events Handling | Continuous control | Deployment on hardware | Project

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