SIEMENS

Ingenuity for life

SIEMENS
Global Industry Partner of WorldSkills International

worldskills

University Training Documents for SIMATIC PCS 7

Siemens Automation Cooperates with Education | 02/2020

siemens.com/sce

Learn-/Training Documents PCS 7
Contents

SIEMENS
Ingenuity for life

MODULE 1 + MODULE 2

- P01-01 Process description
- P01-02 and P01-03 Structuring
- P01-04 to P01-08 Basic automation
- P02-01 to P02-03 Higher process control functions

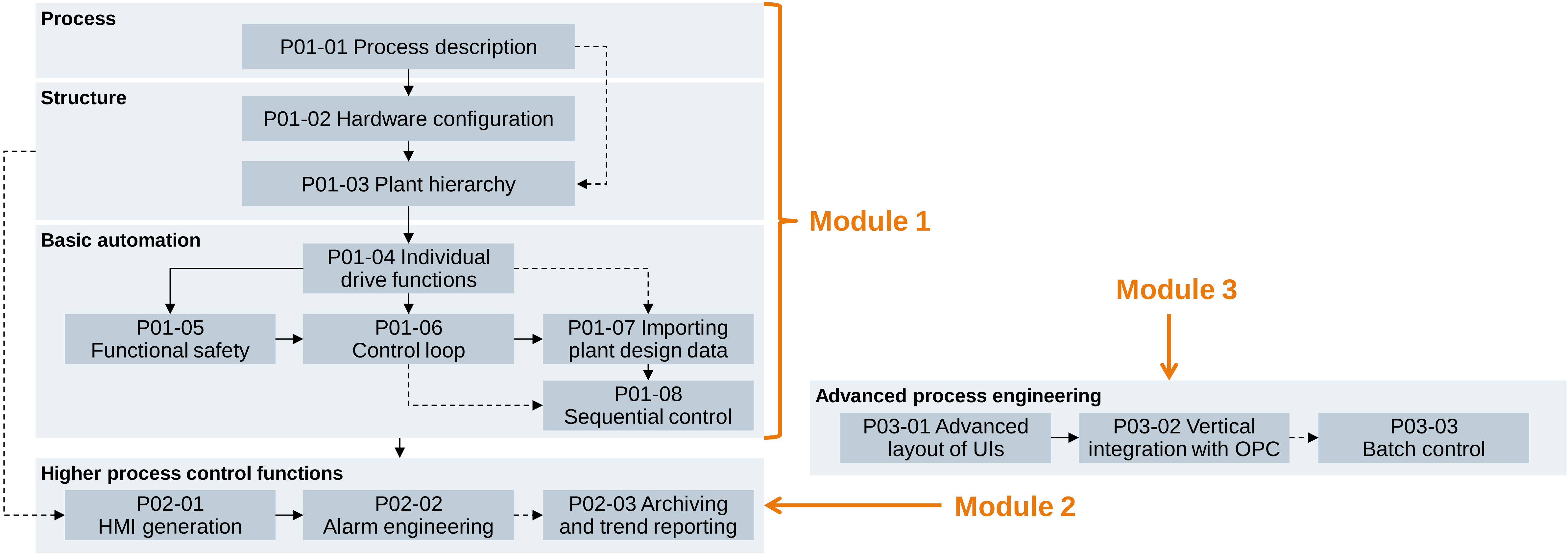
MODULE 3

- P03-01 Advanced layout of user interfaces
- P03-02 Vertical integration with OPC
- P03-03 Batch control with recipes

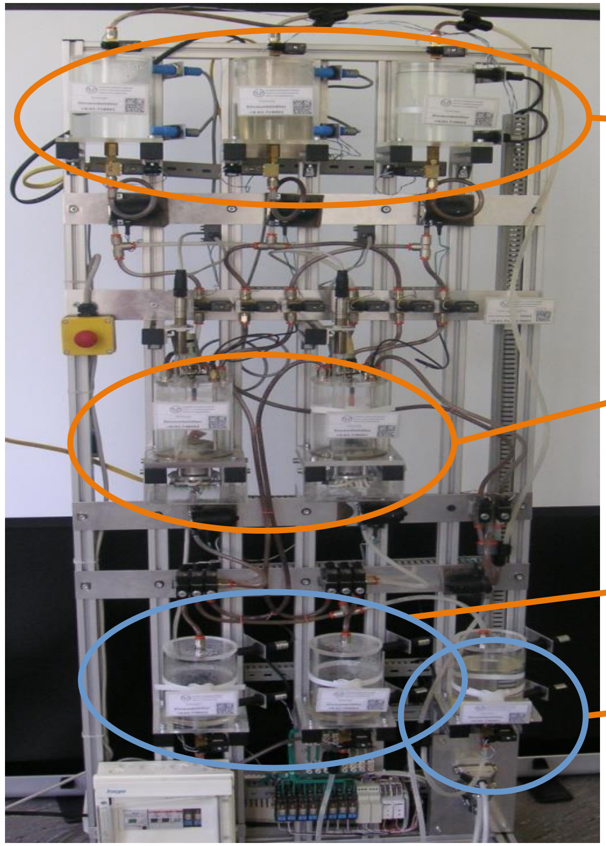
Learn-/Training Documents PCS 7
Module overview

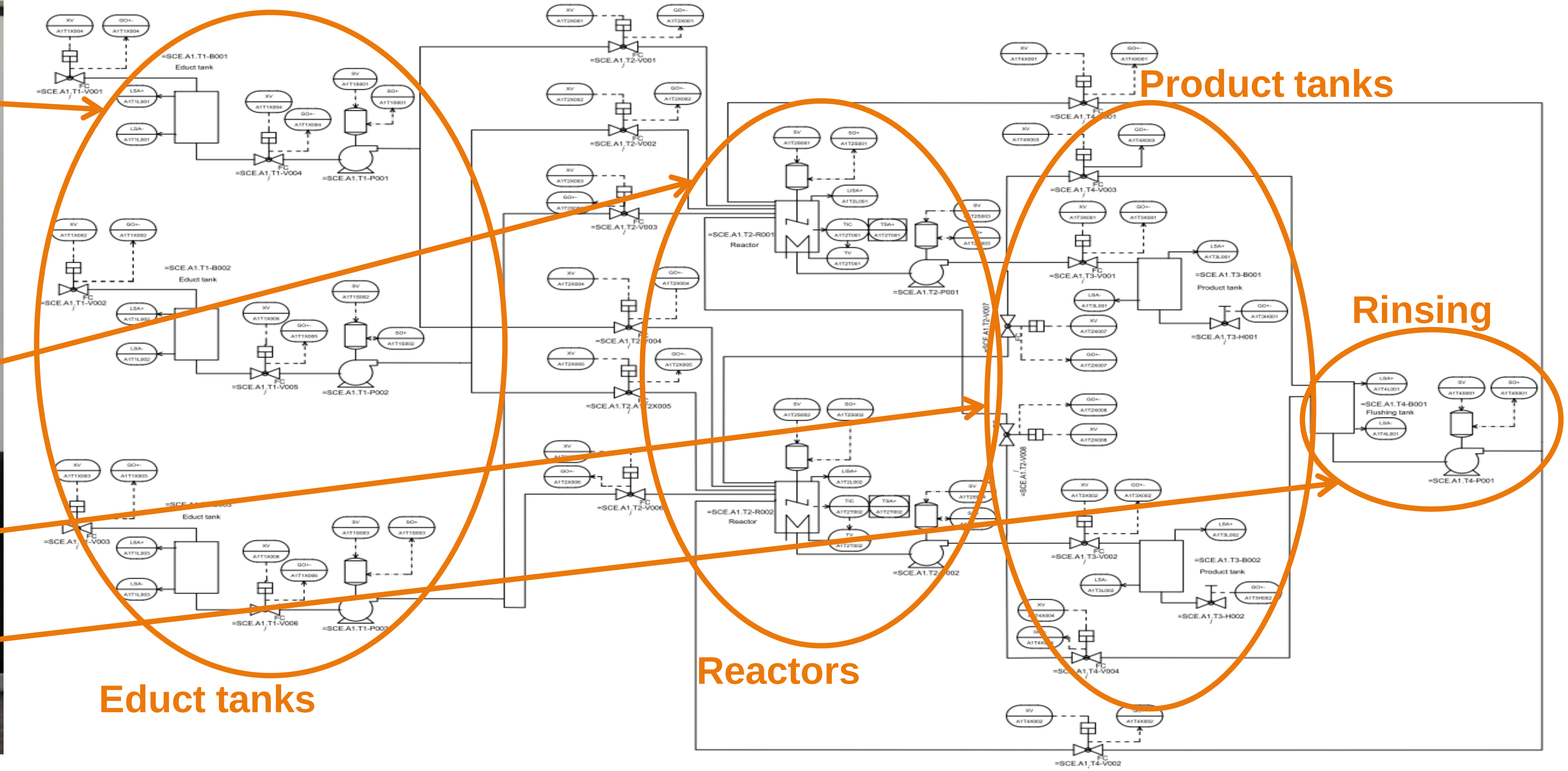
SIEMENS
Ingenuity for life

Module overview



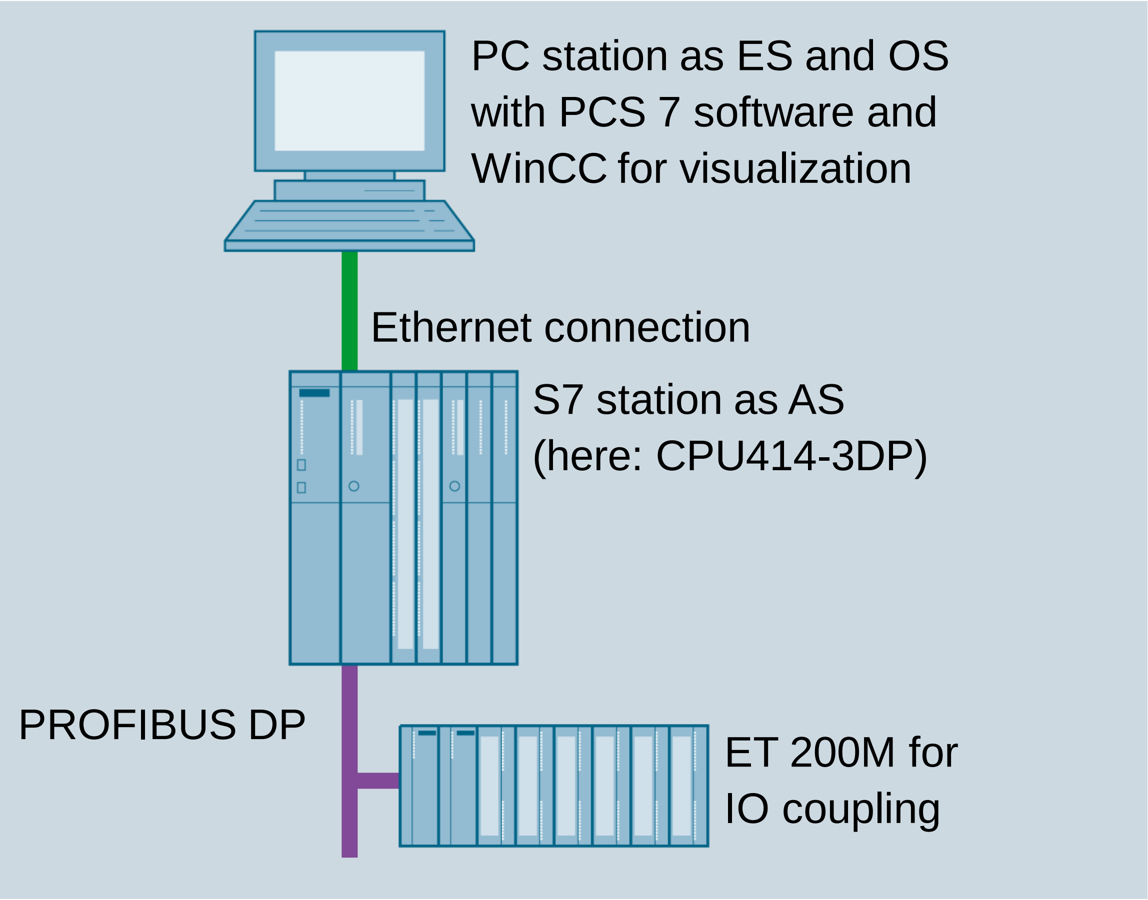
P&ID of the laboratory plant





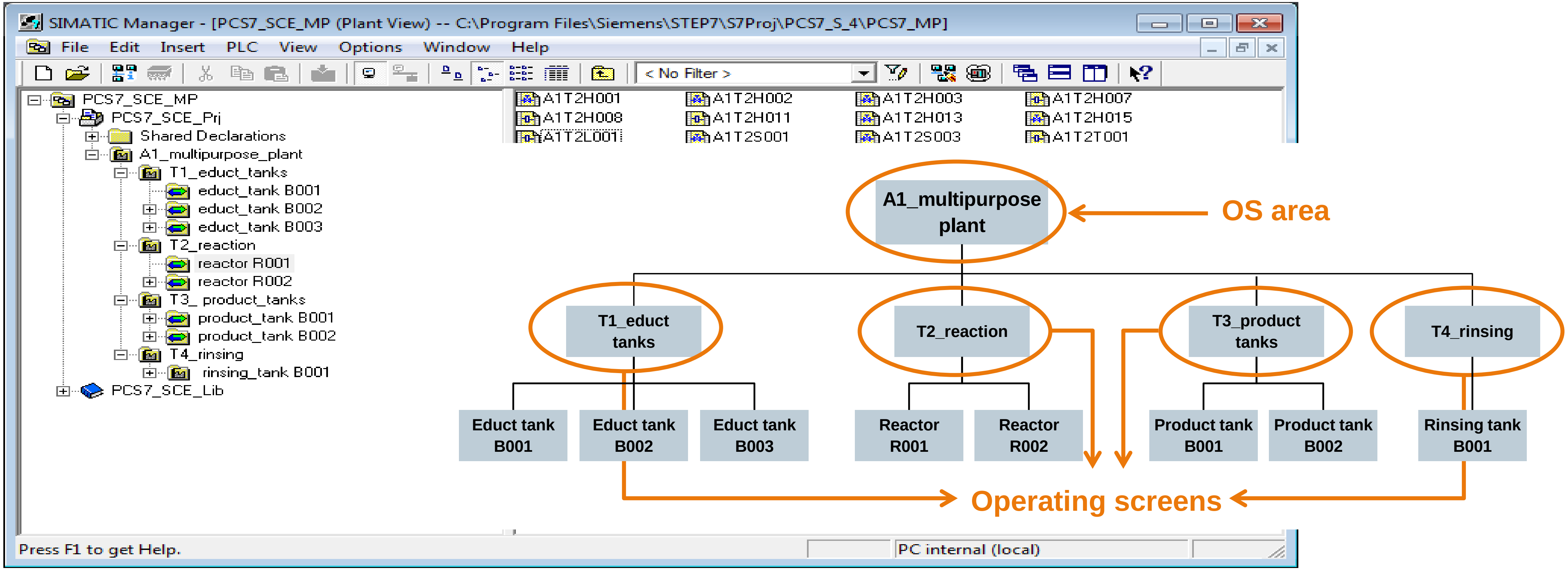
Hardware configuration of the laboratory plant

- AS
  - PS
  - CPU (with PROFIBUS)
    - ET 200M (with PROFIBUS)
      - 7x DI
      - 3x DO
      - 1x AI
      - 1x AO
    - CP (with Ethernet)
- ES/OS
  - PC (with Ethernet)



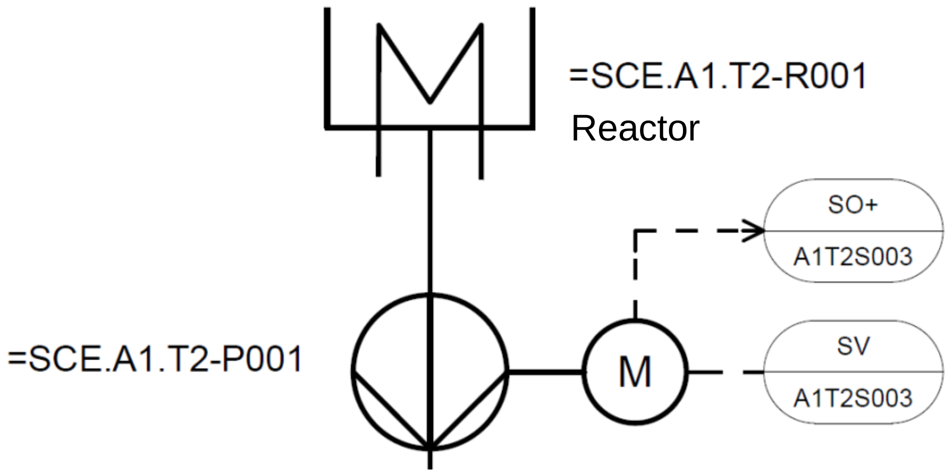
SIEMENS
Ingenuity for life

Plant hierarchy and the effect on visualization



Implementation of a pump of the laboratory plant

- Pump SCE.A1.T2-P001 for draining the reactor content
- Pump is driven by a motor
- Motor has the following signals
  - Signal for control
  - Signal for running feedback
- Template from PCS 7 AP library
  - MotorLean



Symbol	Address	Data type	Symbol comment
A1.T2.A1T2S003.SO+.O+	I 1.3	BOOL	pump outlet reactor R001 feedback running on
A1.T2.A1T2S003.SV.C	Q 3.4	BOOL	pump outlet reactor R001 actuating signal

SIEMENS
Ingenuity for life

Design of the interlock for the pump of the laboratory plant

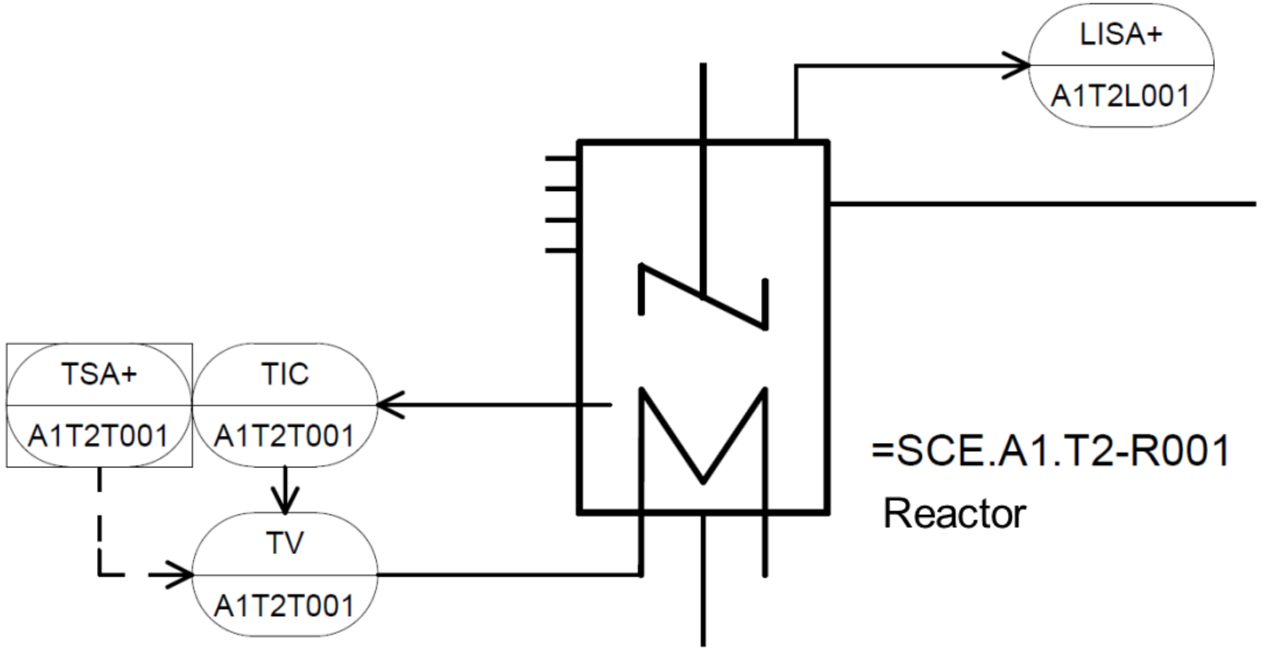
- The pump may only be turned on when the main switch of the plant is switched on and the Emergency Off switch is unlocked
- The pump must not take in air, which means the level of the reactor has to be at least 50 ml
- The pump must not work against closed valves, which means at least one valve has to be open

Symbol	Address	Data type	Symbol comment
A1.A1H001.HS+-.START	I 0.0	BOOL	Switch on main power switch
A1.A1H002.HS+-.OFF	I 0.1	BOOL	Activate EMERGENCY OFF
A1.T2.A1T2L001.LISA+.M	IW 72	WORD	Actual value level reactor R001
A1.T2.A1T2X007.GO+-.O+	I 66.3	BOOL	Open/Closed valve … feedback signal
A1.T3.A1T3X001.GO+-.O+	I 67.4	BOOL	Open/Closed valve … feedback signal
A1.T4.A1T4X003.GO+-.O+	I 68.2	BOOL	Open/Closed valve … feedback signal

SIEMENS
Ingenuity for life

Temperature control of the laboratory plant

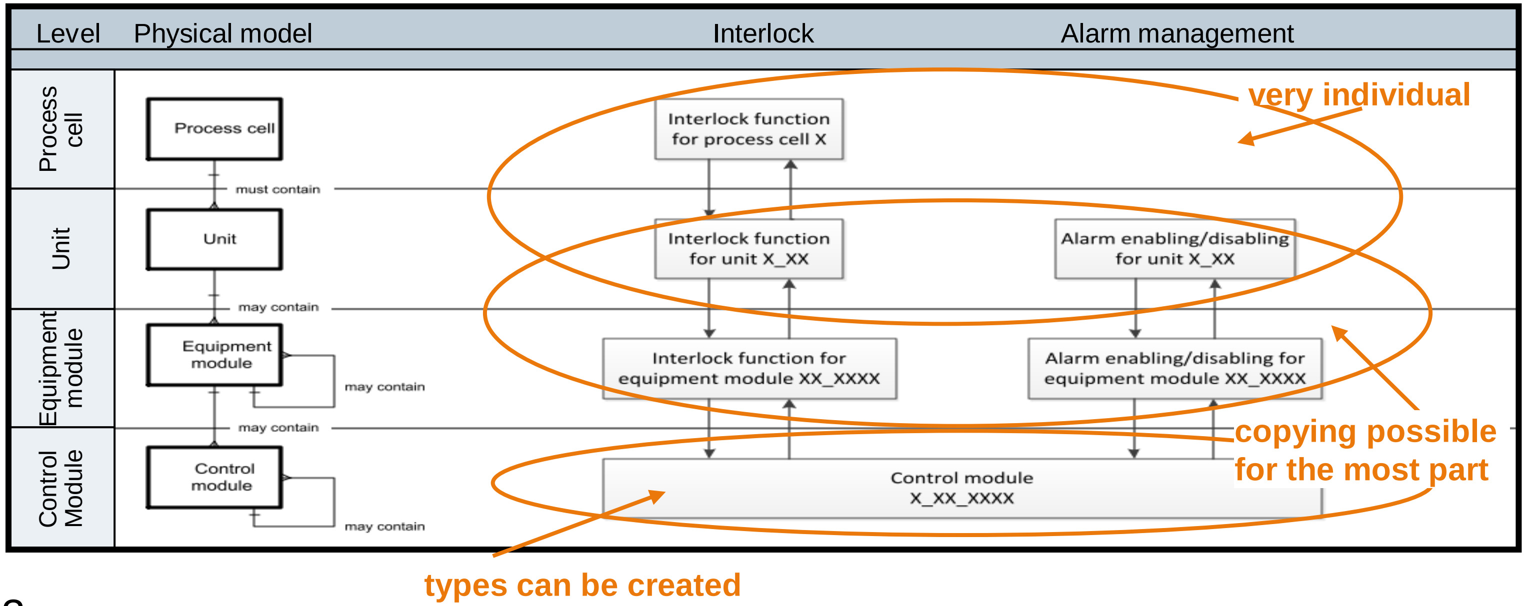
- Control loop
  - Process variable/controlled variable is A1.T2.A1T2T001.TIC.M
  - Manipulated variable is A1.T2.A1T2T001.TV.S
  - Setpoint is
    - Determined by recipe
    - Determined by operator
    - Interlocked
- Interlock conditions
  - Level in the reactor has to be at least 200 ml
  - Temperature must not exceed 60 ° C



SIEMENS
Ingenuity for life

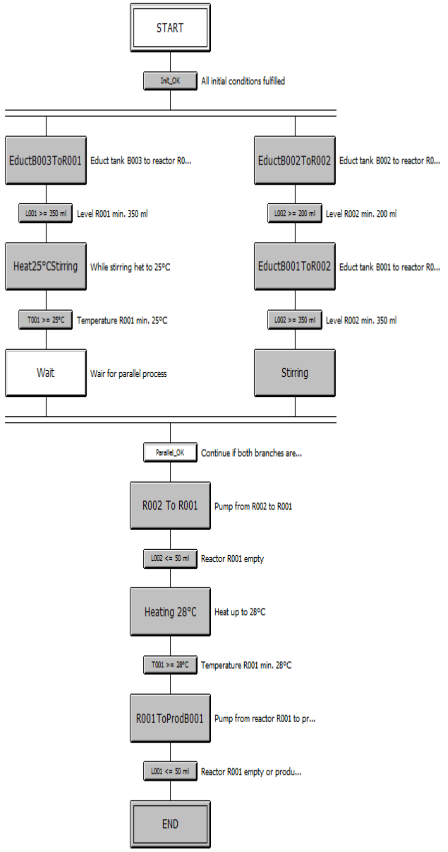
Process tag type and model of the laboratory plant

- Similar control modules
  - Pumps
    - A1T1P001 .. A1T1P003
    - A1T2P001 and A1T2P002
  - Valves
    - A1T1V001 .. A1T1V006
- Similar equipment modules
  - Tanks
    - A1T1B001, A1T1B002 and A1T1B003
    - A1T2R001 and A1T2R002
    - A1T3B001 and A1T3B002



Recipe of the laboratory plant

- First, 350 ml are to be drained from educt tank A1.T1.B003 into reactor A1.T2.R001 and at the same time 200 ml from educt tank A1.T1.B002 into reactor A1.T2.R002.
- When reactor A1.T2.R001 is filled, the liquid is to be heated to 25 ° C with the agitator switched on.
- When filling of reactor A1.T2.R002 is finished, 150 ml from educt tank A1.T1.B001 is to be added to reactor A1.T2.R002. When this is finished, the agitator of reactor A1.T2.R002 is to be switched on 10 s later.
- When the temperature of the liquid in reactor A1.T2.R001 has reached 25 ° C, the mixture is to be pumped from reactor A1.T2.R002 to reactor A1.T2.R001.
- Now, the mixture in reactor A1.T2.R001 is to be heated to 28 ° C and then drained into product tank A1.T3.B001.



Graphics of the laboratory plant

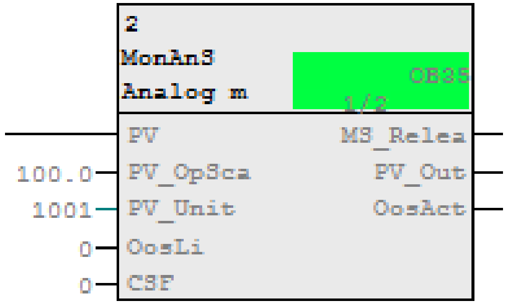
- Hierarchy includes level 1 and 2

A1_multipurpose_plant - A1_multipurpose_plant.pdl
- A1_multipurpose_plant/T1_educt_tanks - T1_educt_tanks.pdl
- A1_multipurpose_plant/T2_reaction - T2_reaction.pdl
- A1_multipurpose_plant/T3_ product_tanks - T3_product_tanks.pdl
- A1_multipurpose_plant/T4_rinsing - T4_rinsing.pdl

- Overview screen
  - Displays all units
  - Displays the most important information
  - Abstract
- Area display
  - Display of a unit
  - Display of faceplate icons of motors and valves
  - Display resembling the P&ID

Alarms for the laboratory plant

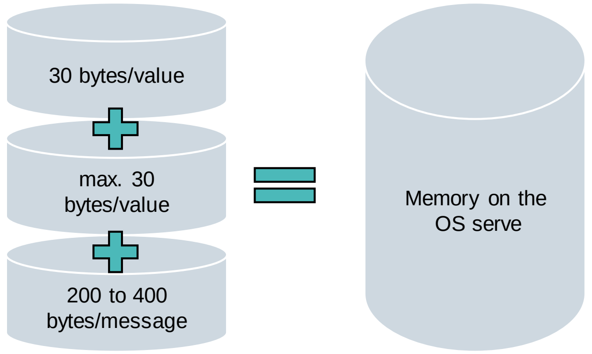
- Monitoring of level
- Monitoring of temperature
- Using MonAnS block (FB 1912) from Monitor folder of the PCS 7 Advanced Process Library V80
  - Monitoring a measured value (analog signal)
  - Adjustable parameters
    - Warning limit (high/low)
    - Alarm limit (high/low)
- Display of faceplate icon
  - In unit T2_reaction
  - Positioning and compiling



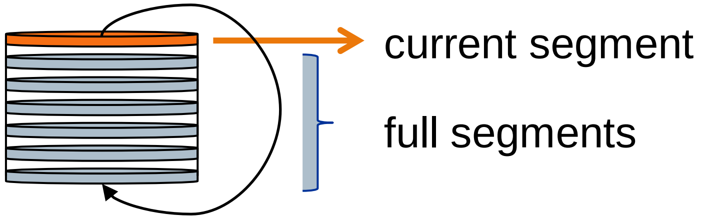
SIEMENS
Ingenuity for life

Archiving on the OS server

- Archiving on the OS server = short-term archiving
  - Process values
    - Slow cycle → Tag logging slow
    - Fast cycle → Tag logging fast
  - Messages/events → Alarm logging



- Structure of the archives (Tag logging slow/fast, Alarm logging)
  - Circular archive consisting of segments



Objectives

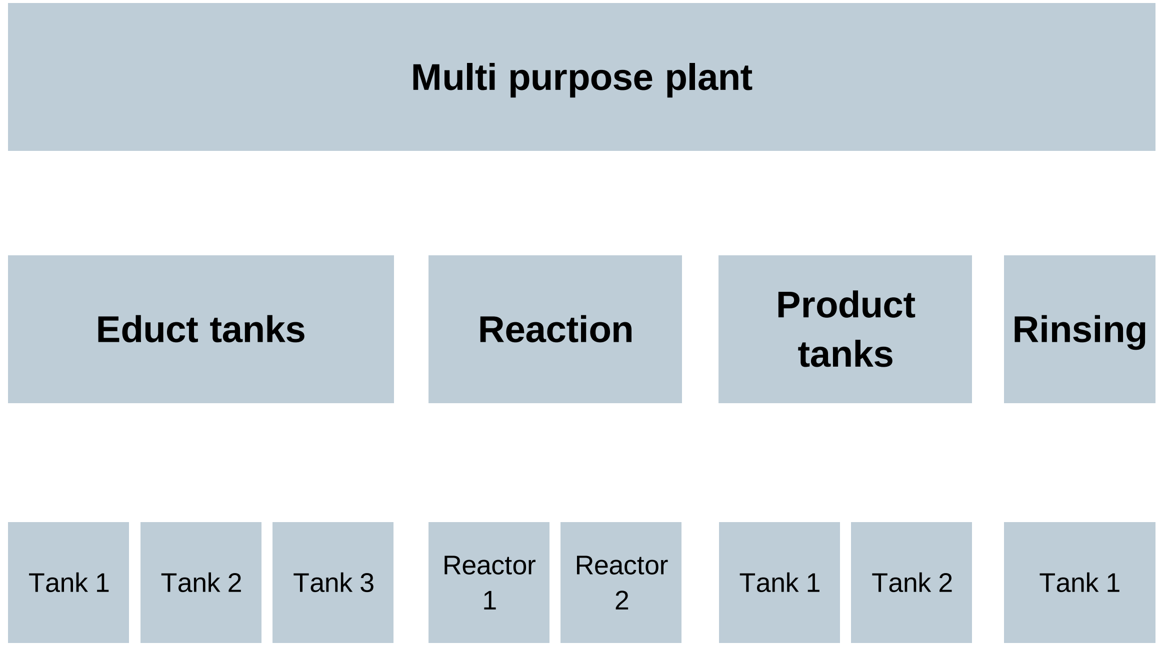
- Theory
  - Hierarchical levels of flowcharts
  - Trends for extending the detailed display
  - ActiveX controls and user defined objects

- Step-by-step instruction
  - Restructuring of the plant hierarchy
  - Creating user defined objects (short: UDO)
  - Expansion of detail displays to include ActiveX controls

SIEMENS
Ingenuity for life

Hierarchical levels of flowcharts

- Levels of flowcharts
  - Plant display
  - Area display
  - Unit display/group display
  - Detail display
- Higher levels (plant and area displays)
  - Overview of the plant/area status
  - Direct selection of an area possible
- Lower levels (unit/group display, detail display)
  - Display of context and detailed information
  - Additional use of filtered alarm lists and adapted trends



SIEMENS
Ingenuity for life

Trends for extending the detailed display

Trends = Display of process value variation over time

Depending on the time frame, different tasks can be implemented

- History = past without present is used, for example, for fault analysis and process control optimization
- Recent history = present with recent past is used for analyzing trends and is the most frequently used display
- Predictive display = recent past, present and future is used for predicting a process value and is intended to enable timely invention by the operator

Advantages of trends

- Compressed and self-explanatory form for displaying many characteristics of a process value, for example, marked changes in the variation, gradients, dependencies, extreme values, fluctuation margins, setpoint deviations, frequency

SIEMENS
Ingenuity for life

ActiveX controls and user defined objects

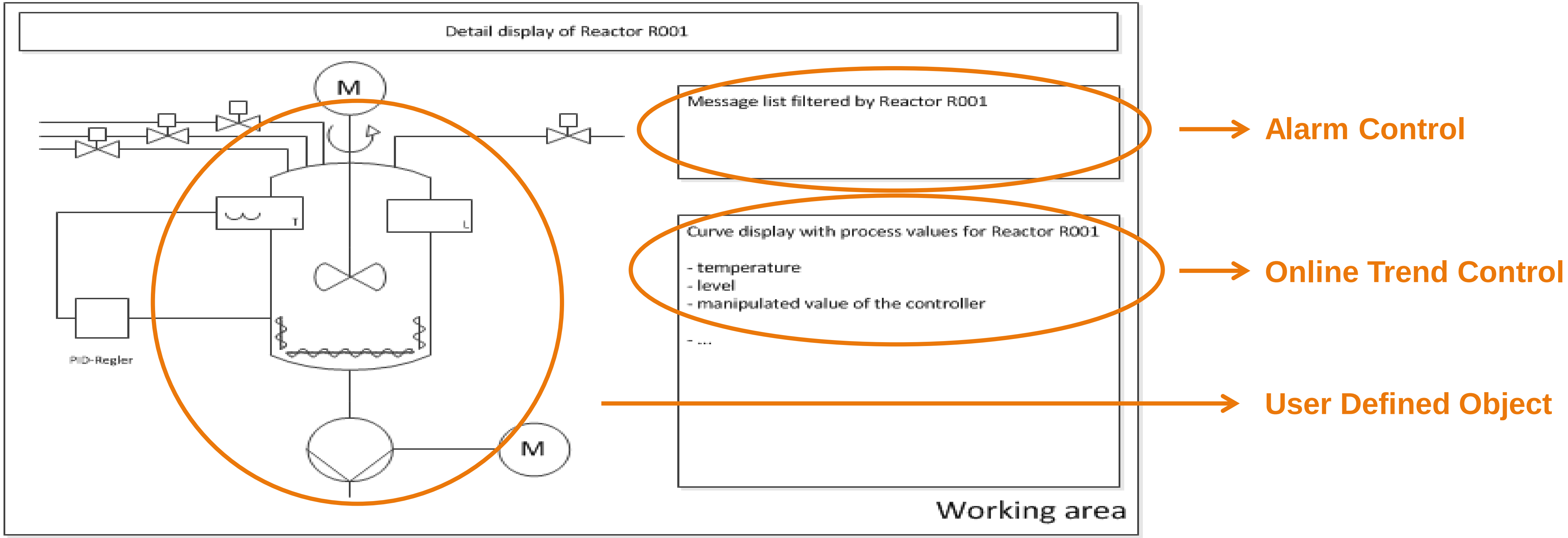
ActiveX control (provides additional information on detail level)

- Online Trend Control, Function Trend Control
  (display of process values in diagrams, definition of process values to be displayed)
- Online Table Control (display of process values in tables)
- Alarm Control (display of messages and events in lists, filtering by criteria such as source)

User defined object

- Grouping of individual objects into one object
- Reduction of parameters of all objects to defined parameters of the object
- Storage in library for reuse
- Increases the performance for C-Actions used for dynamization

Layout of a detail display



Objectives

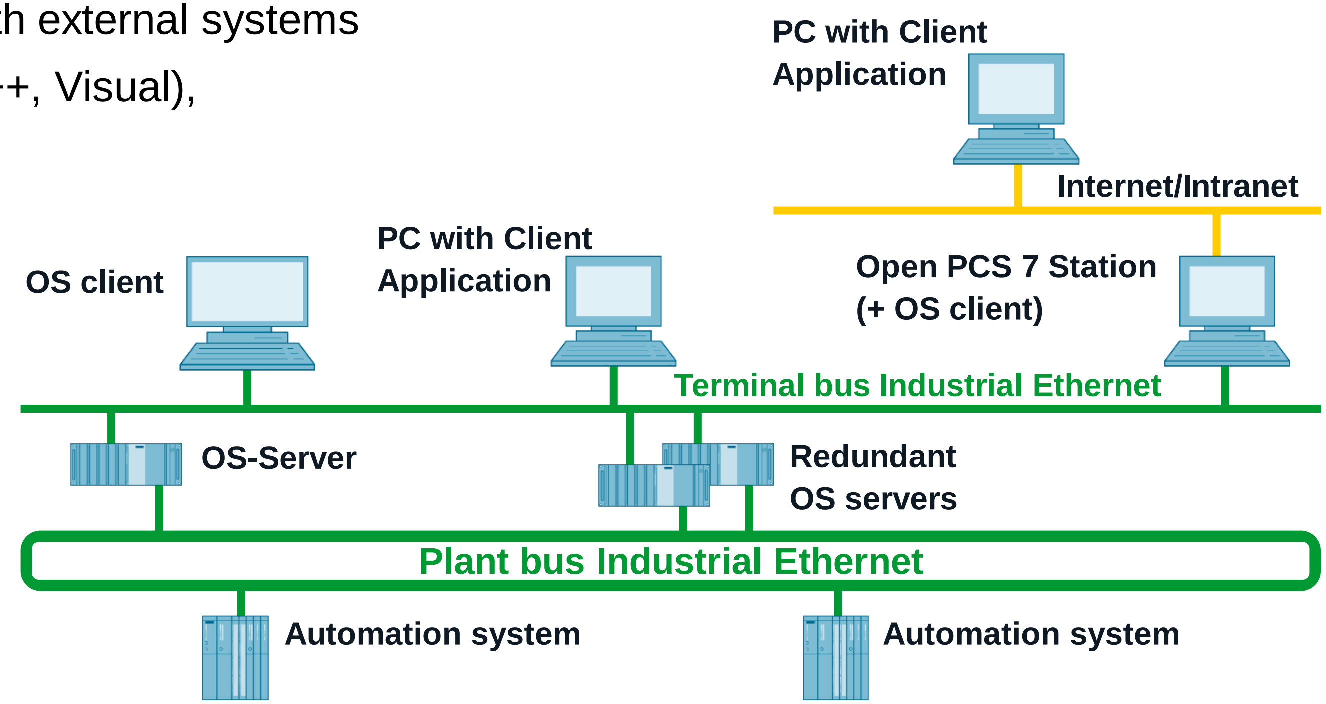
- Theory
  - Integration of automation systems from different manufacturers into higher-level programs of the plant control level
  - Basics for structure and operating principle of OPC
  - Integration by means of PCS 7

- Step-by-step instruction
  - Configuration of the PCS 7 project
  - Parameterization of the OPC server
  - Reading of OPC variables into Office applications

SIEMENS
Ingenuity for life

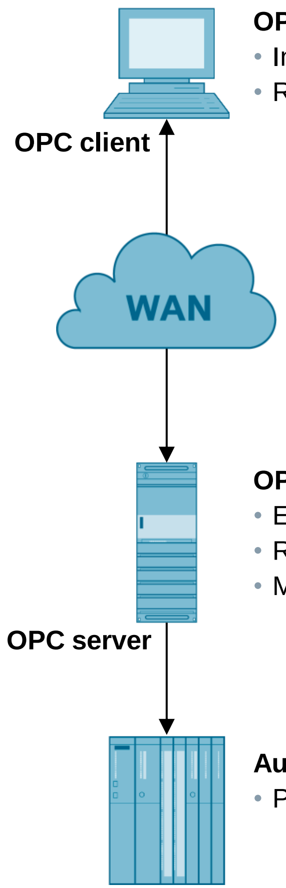
Overview

- OPC (OLE for Process Control) provides a standardized, open and manufacturer-independent software interface
- Based on the OLE/COM technology from Microsoft
- PC station with Open PCS 7 can exchange data with external systems
- As viewed from higher programming languages (C++, Visual), OPC is a bridge to process and device data of automation systems
- Equipment manufacturers must develop one OPC server instead of specific drivers



Client-Server principle

- **OPC communication** is based on the client-server principle
- **OPC server:** Component that offers data after the request from an OPC client
  - Is connected to the automation system
- **OPC clients** use OPC servers as a data source
  - Usually a component of a user program that must be configured



OPC client e.g. Excel application
- Initiates OPC communication
- Read/write requests for process values

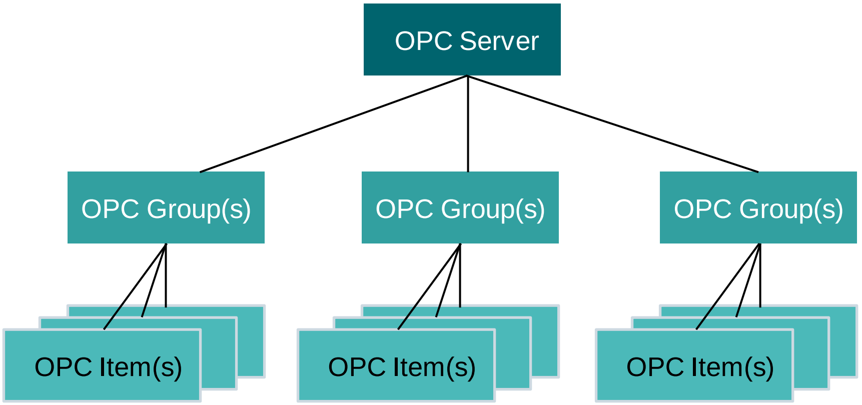
OPC server
- Executes client requests
- Reads process variables cyclically
- Monitors process variables for value changes

Automation device
- PLC (process values)

SIEMENS
Ingenuity for life

OPC Specification

- **OPC Data Access (OPC DA):** Specification for access to process data through variables
  - Read, change (overwrite), monitor value of one or more process variables or report changes
- Hierarchical class model of Data Access
  - **OPC group** structures process variables
  - **OPC item** represents process variables

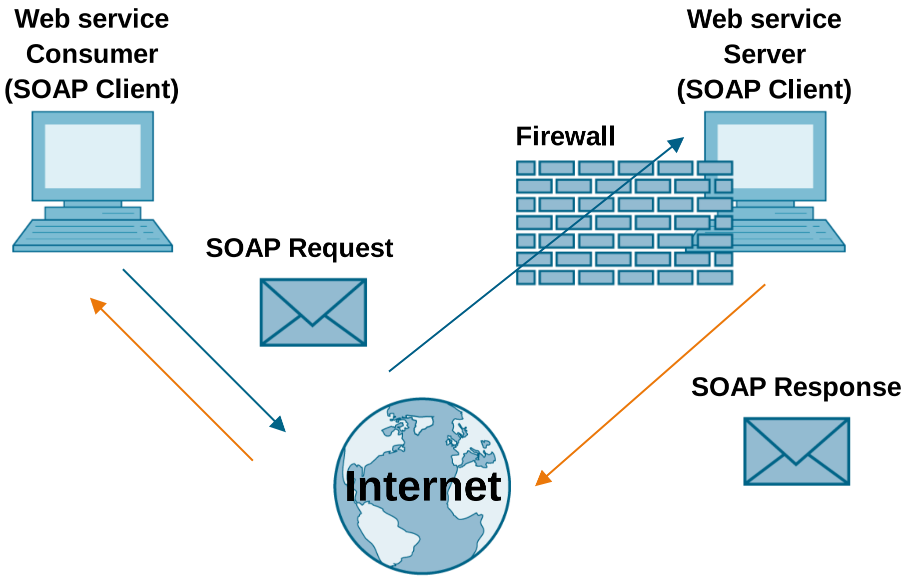


Provided variables:

- Process variables (measured und controlled variables of input/output devices)
- Controlled variables (triggers additional services, such as transmission of passwords)
- Information variables (information about status of connections, devices, etc.)

OPC Specification

- **OPC extensible Markup Language DA (OPC-XML DA):** Standard for communication with a platform-independent protocol over the Internet
  - Based on HTTP and SOAP
  - Functionality similar to OPC Data Access
- **OPC Alarms & Events (OPC A&E):** Additional specification for transfer of process alarms and events
- Three types of events
  - Condition related events
  - Tracking events
  - Simple events

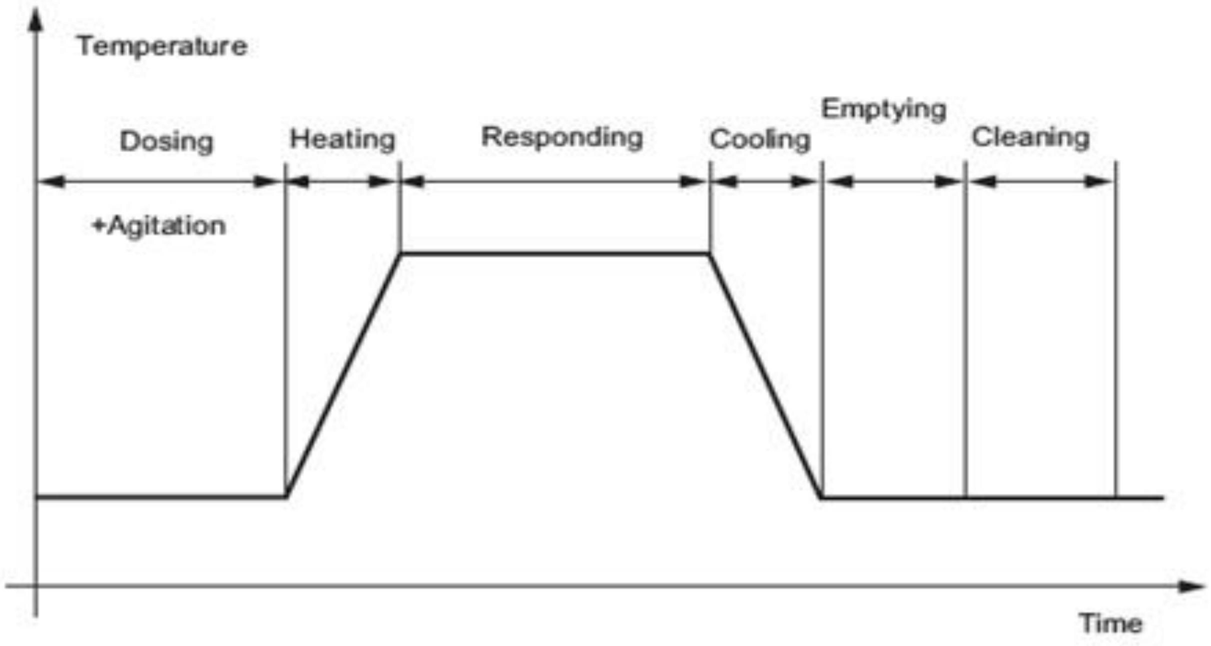


SIEMENS
Ingenuity for life

Objectives

- Theory
  - Modeling an industrial batch process
  - Recipe control for production of batch products
  - Definition of process steps

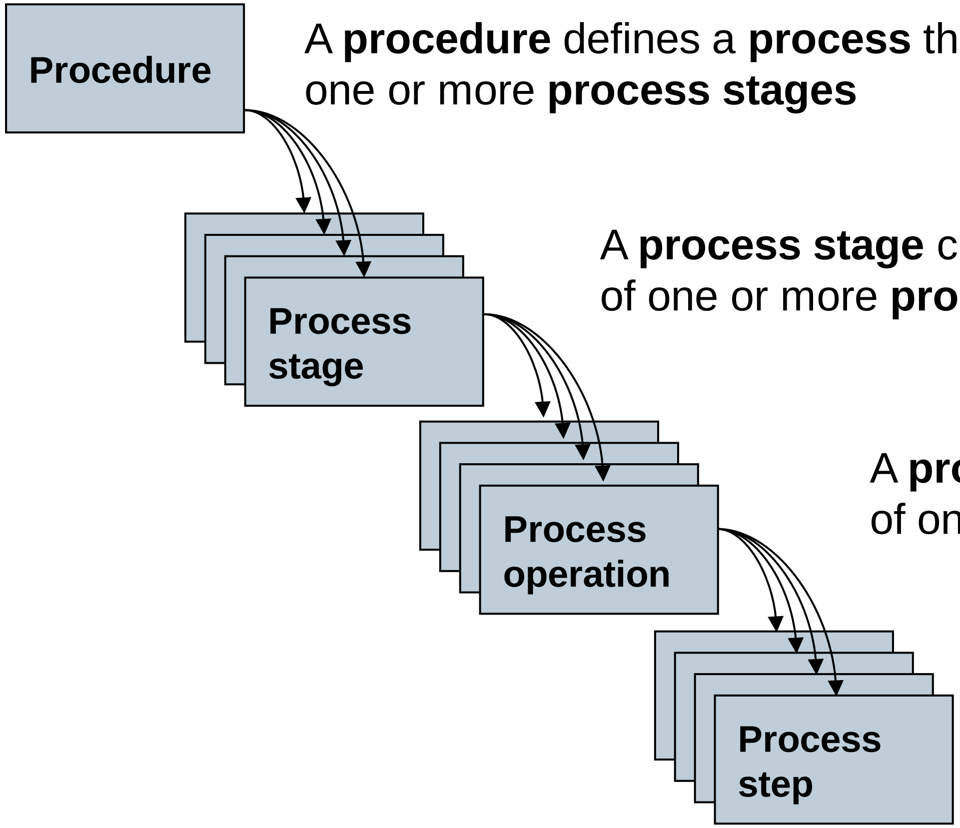
- Step-by-step instruction
  - Setting up an ISA S88 hierarchy
  - Preparing the PCS 7 project with preconfigured SFC types
  - Setting up a project in BATCH Control Center



SIEMENS
Ingenuity for life

Hierarchical modeling

- Managing the complexity of a batch process through a hierarchical structure



A **procedure** defines a **process** that consists of an ordered set of one or more **process stages**

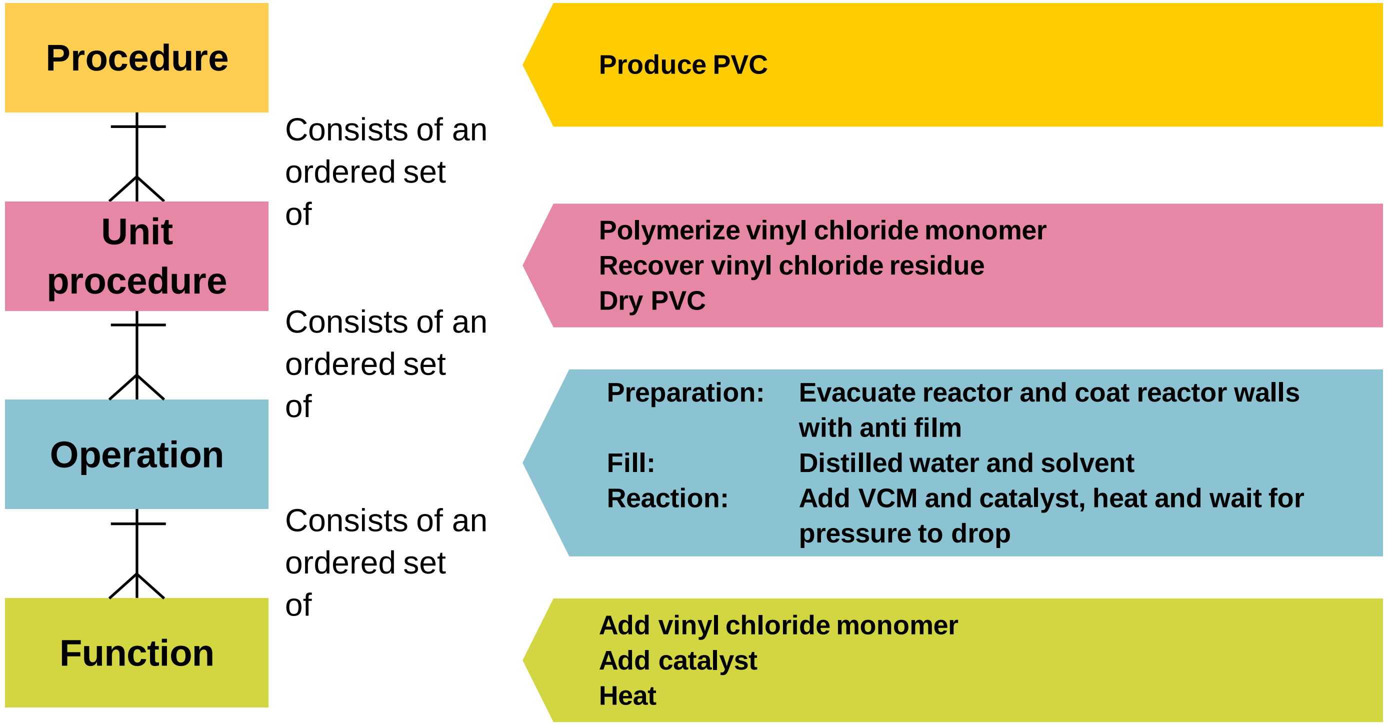
A **process stage** consists of an ordered set of one or more **process operations**

A **process operation** consists of an ordered set of one or more **process steps**

SIEMENS
Ingenuity for life

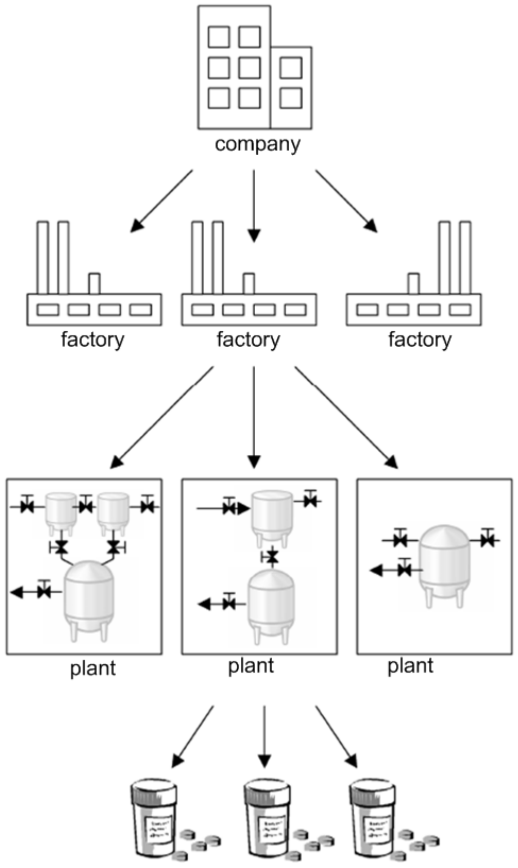
Concepts of batch control

- Prerequisite is **basic automation** (Basic automation module)
- **Procedural control:** equipment-oriented actions take place in an ordered sequence
- **Procedure** is highest level in the hierarchy and defines the strategy
- **Unit procedure** consist of operations for a continuous production sequence
- **Operation** is a set of functions and transforms substances from one state to another
- **Phase(Function)** is the smallest element of a procedural control



Recipes and recipe types

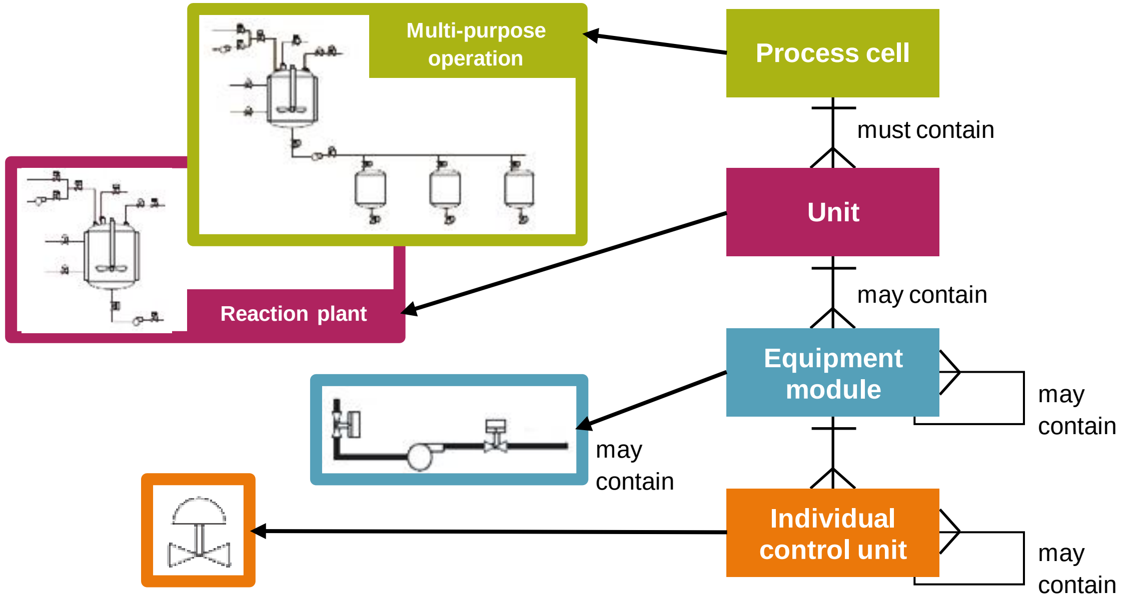
- Company-wide standardized recipes and location-dependent differences require
  - Abstract definition, independent of specific plant
  - Simple adaptation to the specific plant
- **General recipe** Recipe at company level
- **Site recipe** Combination of factory-specific information and general recipe
- **Basic recipe** Recipe at the level of a plant or a group of equipment of a plant
- **Control recipe** Generated as a copy for a specific version of the basic recipe
  - Modified according to materials planning and execution to be specific for an individual batch



SIEMENS
Ingenuity for life

Physical model

- **Process cell** contains all equipment required to make a batch
- **Unit** is made up of equipment modules and control modules, such as a mixing tank or reactor
- **Equipment module** can be made up of control modules and subordinate equipment modules, such as a filter
- **Control module** is a collection of measuring devices, final controlling elements, other control modules and associated processing equipment



Benefits

Theoretical and practical introduction to process control engineering of a process plant – in general and with PCS 7 at the university level

Guided implementation based on available projects or implementation of your own designs possible

Testing the implementation in a simulated plant

Learn-/Training Documents PCS 7
Outlook

SIEMENS
Ingenuity for life

Use of the documents in training/education

- As a lecture (= theory) with practice (= exercises) to design a solution and to implement the design in SIMATIC PCS 7
- As practical training (= exercises) to design a solution and to implement the design in SIMATIC PCS 7

or

- As self-study to implement projects with SIMATIC PCS 7

Thank you for your attention!

SIEMENS
Ingenuity for life

Siemens Automation
Cooperates with
Education

Subject to changes and errors. The information given in this document only contains general descriptions and/or performance features which may not always specifically reflect those described, or which may undergo modification in the course of further development of the products. The requested performance features are binding only when they are expressly agreed upon in the concluded contract.

All product designations, product names, etc. may contain trademarks or other rights of Siemens, its affiliated companies or third parties. Their unauthorized use may infringe on the rights of the respective owner.

siemens.com/sce

SIEMENS
Global Industry Partner of WorldSkills International

worldskills