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Bachelorarbeit

Dynamic Generation of Modular Industrial Plant Visualizations on a Manufacturing Execution System (MES) Interface



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Statutory Declaration

I hereby confirm to have written the present dissertation independently and only with the use of the sources and resources I have indicated. Both content and literal content were identified as such. The work has not been available in this or similar form to any other panel of examiners.



Date: Signature:

Abstract

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Kurzzusammenfassung

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Abbreviations

|  |  |
| --- | --- |
| Abbreviation | Description |
|  |  |
| API | Application Programming Interface |
| GUI | Graphical User Interface |
|  |  |
| MES | Manufacturing Execution System |
| ProcAppCom | Process Application Composer |
| PCS | Process Control System |
| PLT | Prozessleittechnik |
|  |  |

1. Introduction
   1. Overview and Motivation

The ProcAppCom (Process Application Composer) research project represents a cooperation of various industrial partners, namely 3S-Smart Software Solutions GmbH, Gefasoft GmbH, Johann Albrecht Brautechnik GmbH and APE Engineering GmbH with the Technical University of Munich. The main objective of the research project is the automatic configuration and generation of control codes and visualizations for production plants in process engineering.

GEFASOFT GmbH is a leading and innovative provider of production-related software solutions. With the product Legato Sapient® Gefasoft offers a completely web-based production control system (MES / Manufacturing Execution System) for u. a. the cross-plant evaluation of messages, measured values ​​and key figures.

At present, the development of control software and visualization interfaces for the operation of smaller process engineering systems, as well as their connection to Manufacturing Execution Systems (MES), are very costly. Because of this, creating (or later modifying) plant-specific visualization interfaces is one of the cost and cost drivers of such projects. Motivation of the work is a concept for the visualization of convertible process plants in order to reduce costs and / or expenditure with the implementation of MES, so that any enterprises can dispose of and profit from these software solutions. In general, the dynamic composition of GUIs based on visualization components.

* 1. Problem Definition

Today's trends and demands on production technology lead to a permanent increase in the complexity of industrial production facilities and to a permanent technical change. This has a significant impact on the engineering, operation and adjustments of production control systems (MES) and leads to the fact that its connection and configuration must be individually created and manually adjusted, with the creation and modification of plant-specific visualization interfaces (GUI) a significant cost or cost driver is.

* 1. Initial Situation

Within the framework of various research projects at Gefasoft, the foundations of this project work have already been laid. A modeling approach and description models for process plants have been developed. Based on these models, it is already possible to rewrite the component or node hierarchy in the database tables of the MES Legato Sapient®. In addition, it is already possible to dynamically generate factory edge gateways for the data-related connection of the control of systems to the MES. The dynamic visualization generation represents the last stone of this research project.

<INSERT GLOBAL ProcAppCom PROJECT ARCHITECTURE/CONCEPT SHOWING ALL PUZZLE PIECES, ASK DANIEL FOR PHOTO>

* 1. Aim of the Bachelor Thesis

Aims:

* Reduction of effort and acceleration of development and adaptation of visualization generation of industrial processes.
* Uniform and modular design of the visualization components for generating clear, standard-defined visualization interfaces at the process control level for monitoring the process variables.
* Integration of the software solution in the MES Legato Sapient®.

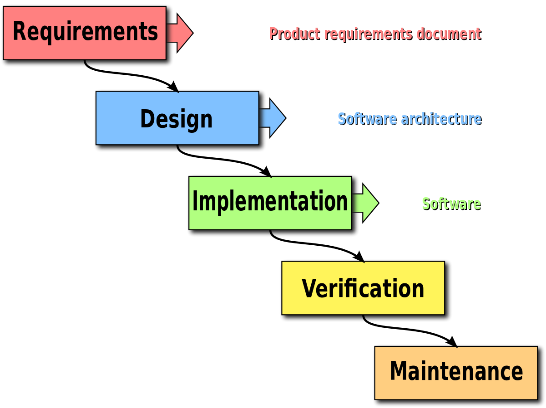
Requirements:

* INSERT ANFORDERUNGSLISTE HIER

Main Tasks / Milestones

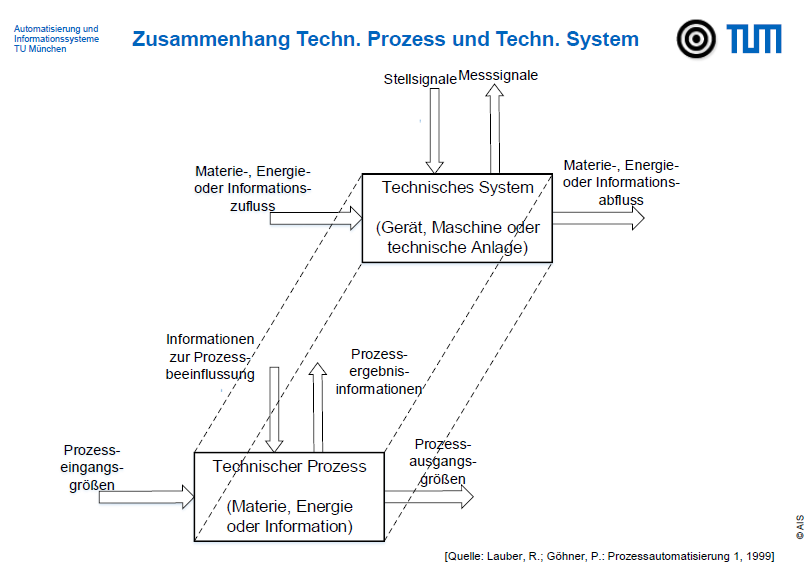
* 1. Composition of the Bachelor Thesis
     1. Project Management
     2. Agile Development Methodology

Agile Development Cycles

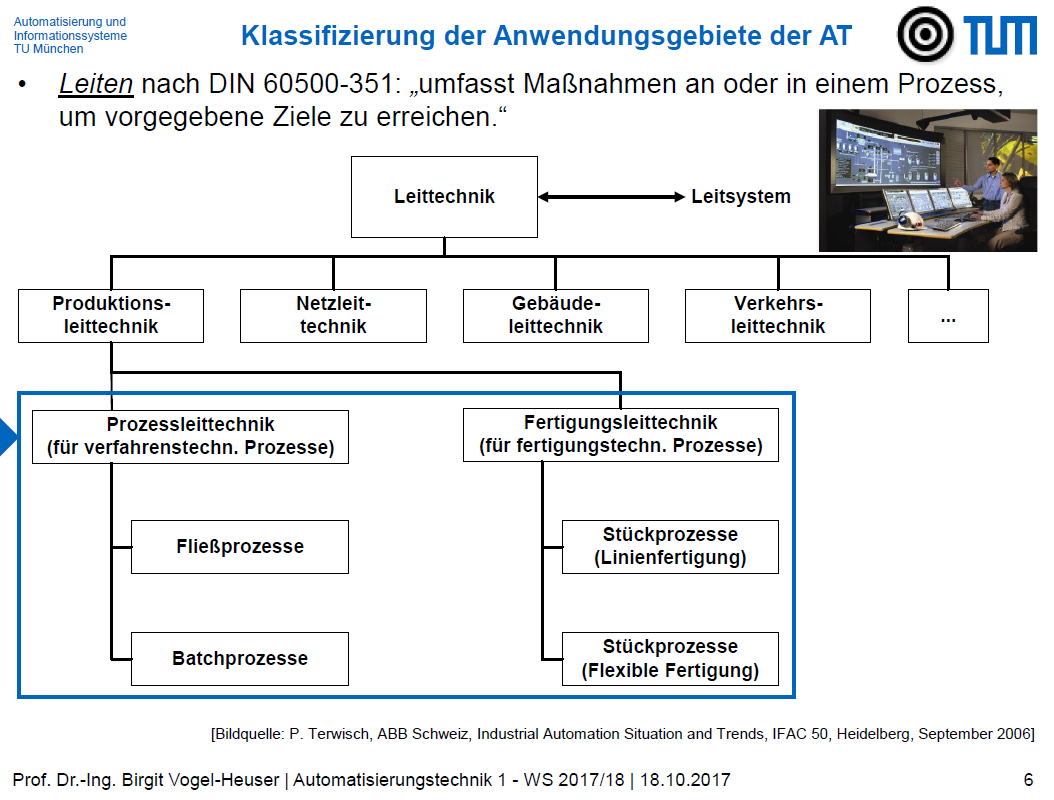


1. Technological Standpoint
   1. Industrial Control in General
      1. Definitions

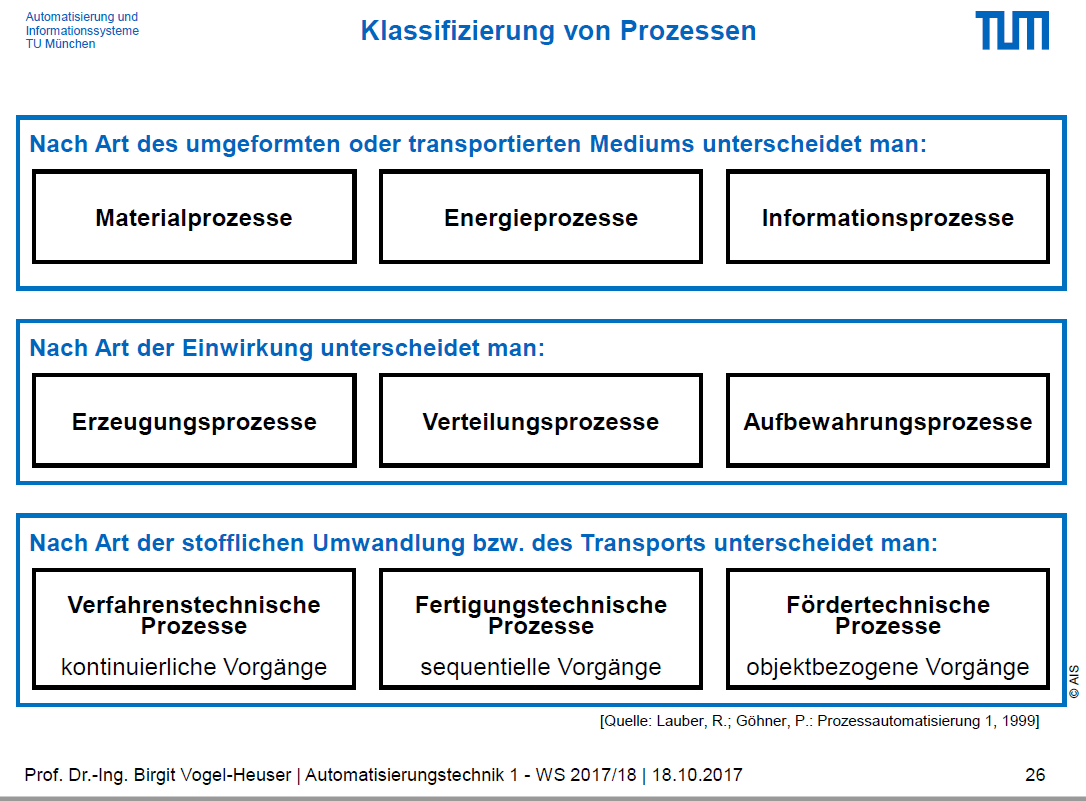
* Model
* Technical Process
* Tech. System AT23,
* Relationship Diagram AT24



* + 1. Historical Industrial Context
    2. Current Trends
    3. Areas of Application

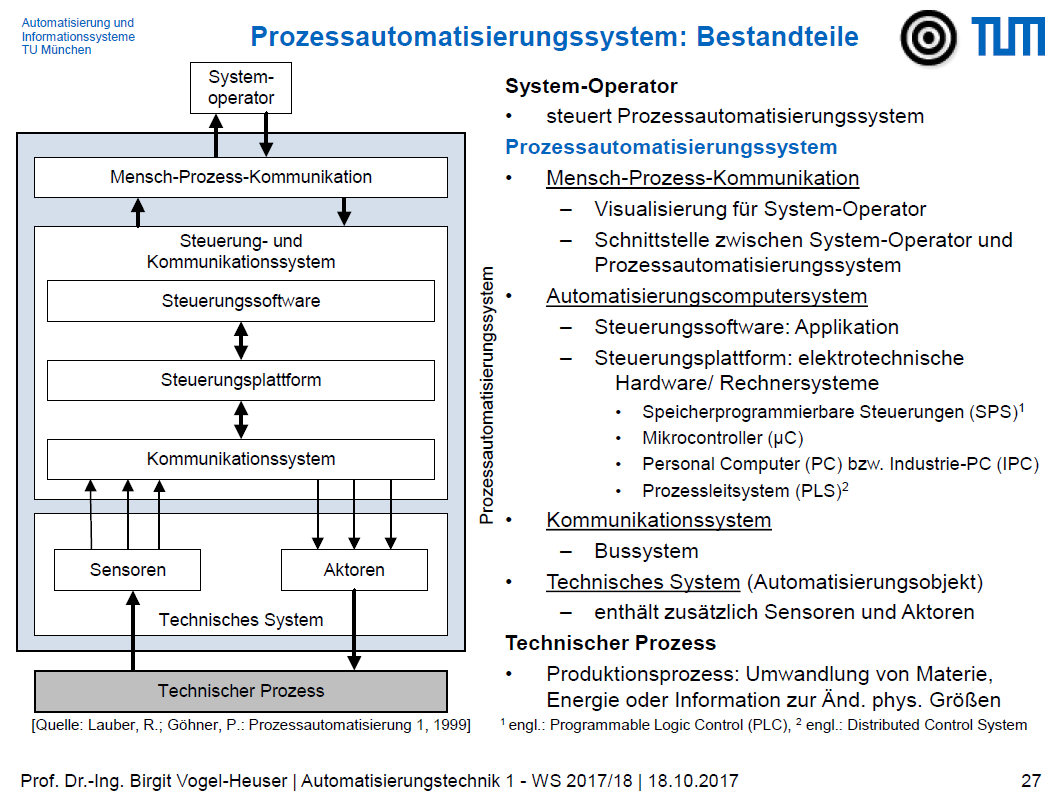


* 1. Industrial Process Control
     1. Classification of Industrial Processes



* + 1. Process Control System (PCS)

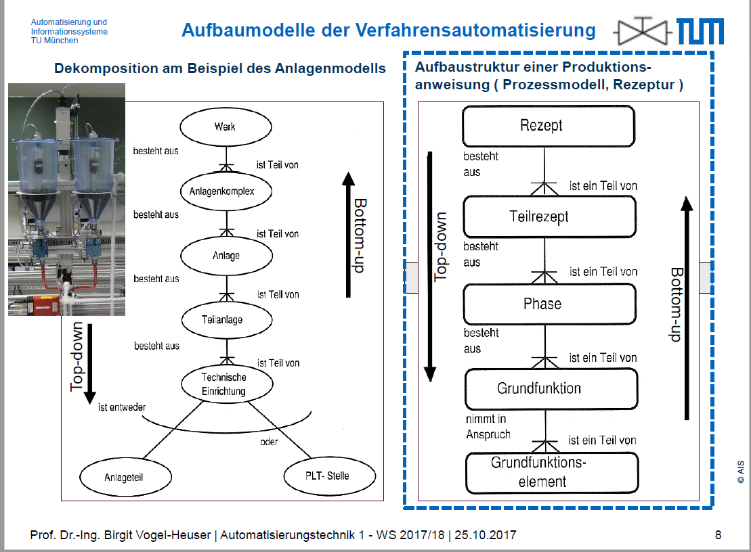
Definiton



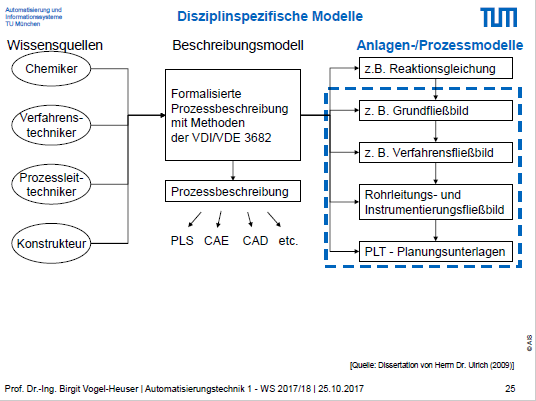
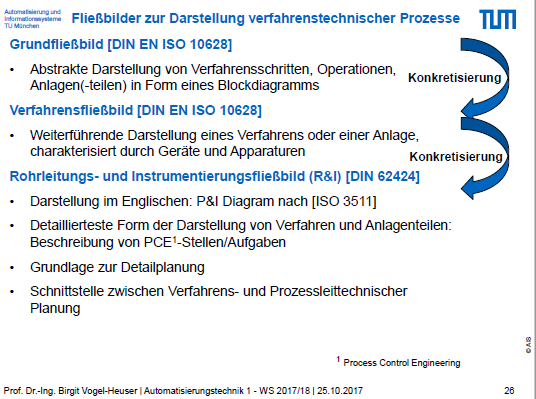
* + 1. Plant Hierarchy Model (ISA-95)

[ISA-95](https://en.wikipedia.org/wiki/ISA-95) as it is more commonly referred, is an international standard for developing an automated interface between enterprise and control systems.

(<https://en.wikipedia.org/wiki/Enterprise_control#ISA95_.E2.80.9Clevels.E2.80.9D_for_enterprise_integration>)



* + 1. Process Visualizations

* + 1. Piping and Instrumentation Diagram (P&ID)
       1. Definition
       2. Functions
       3. Advantages
       4. Disadvantages
  1. Manufacturing Execution Systems
     1. Overview (Automatisierungspyramid -> decentral Network)
     2. Functions
     3. MES in Context of the 4th Industrial Revolution
     4. Overview of Legato Sapient®

Entirely Web-based architecture and modular and customizable to the core to keep of with requirements.

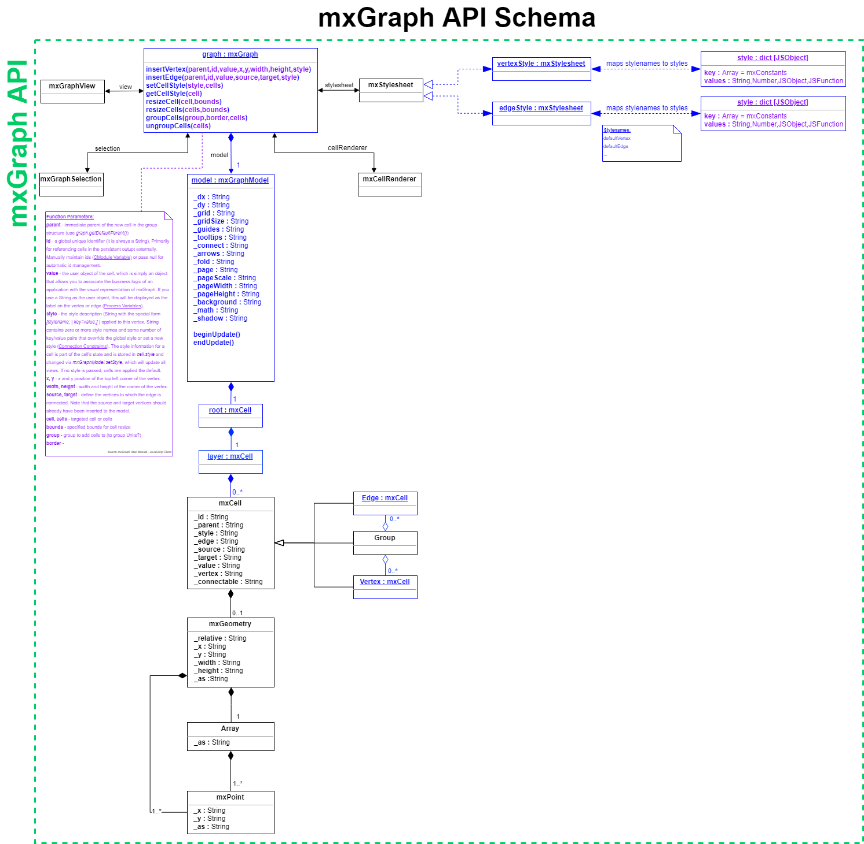
* + - 1. Design

Component based, modular design of dashboards (easy creation by adding boardlets)

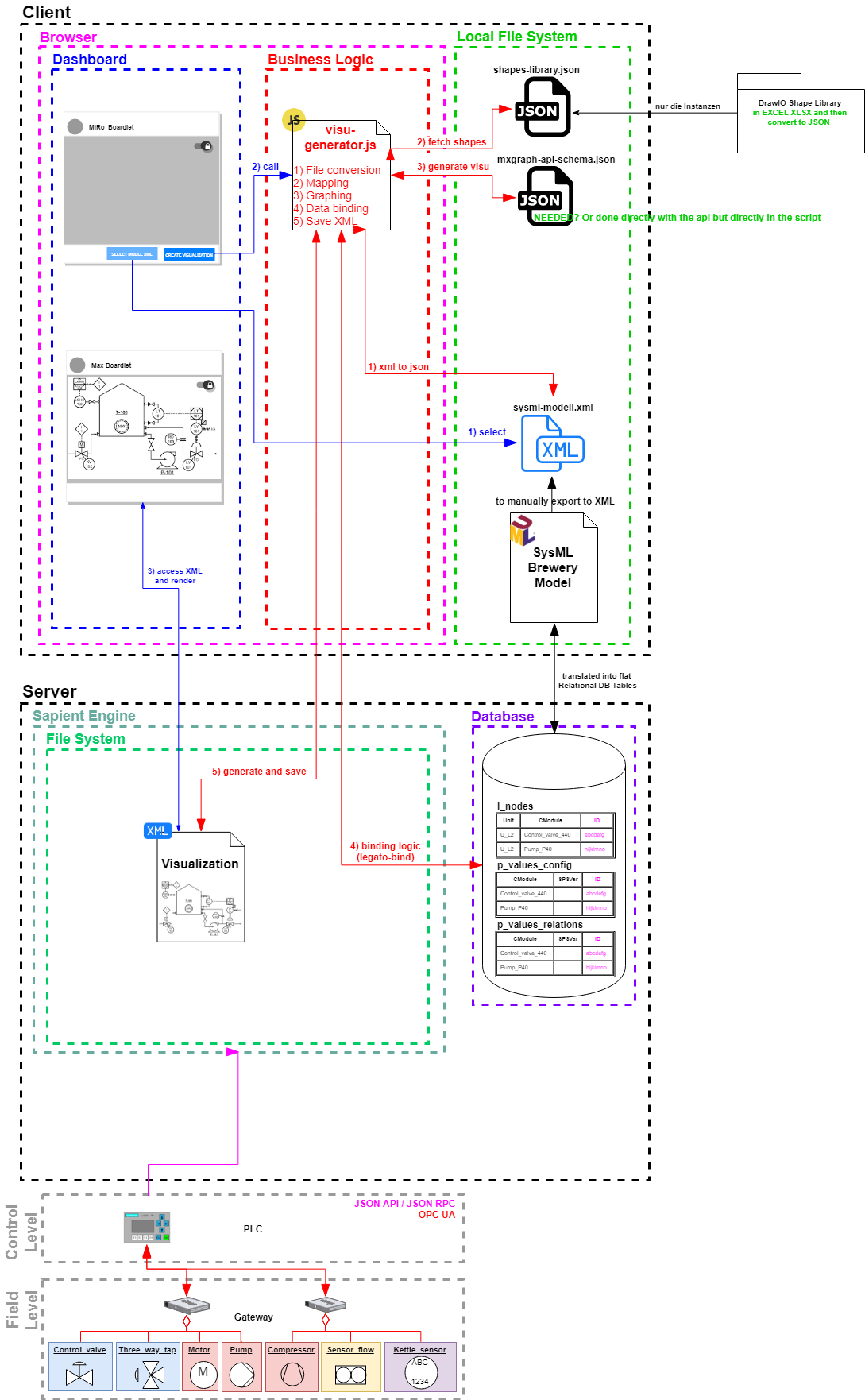
Dashboard > Boardlet > Ember Components

* + - 1. Features
      2. Software Architecture

1. P&ID Shapes Library
   1. Overview
   2. mxGraph API
      1. Schema



1. Legato Sapient® Boardlet
   1. Overview of Software Architecture

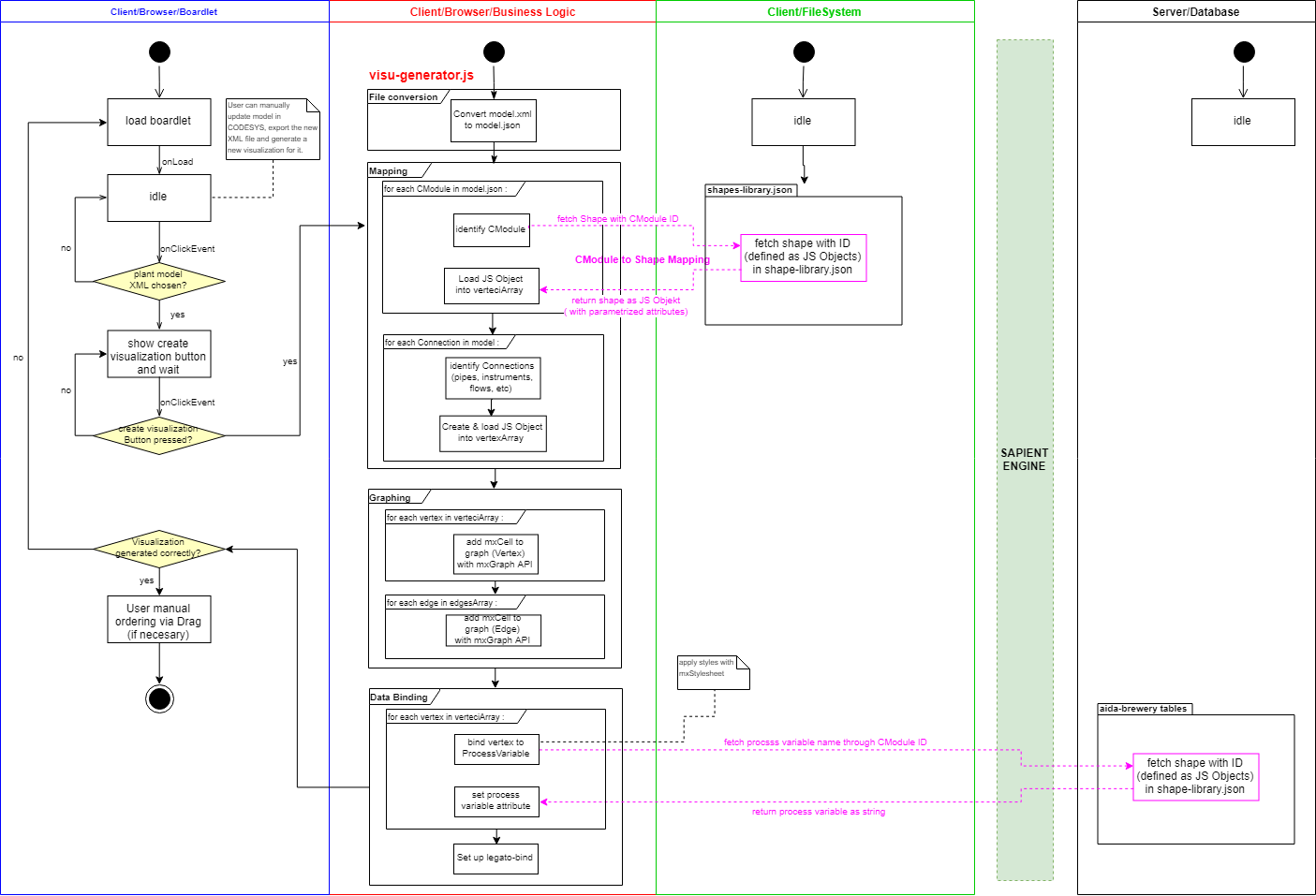


* + 1. Requirements
  1. Design

<INSERT PHOT OF P&ID VISUALIZER DASHBOARD WITH ALL BOARDLETS, SQUARE ON THE P&ID CREATOR BOARDLET AND SQUARE ON INDIVIDUAL EMBER COMPONENTS? OR TOO UNUBERSICHTLICH >

Modular Component-based solution. All included, up and ready boardlet.

* + 1. User Interface (UI)
    2. User Experience (UX)
  1. Business Logic
     1. Overview



* + 1. Presentation Logic
    2. Database Queries
       1. PostgreSQL Queries
       2. Get Data Generic Function via getRecords()
       3. Waiting for Asynchronous Requests to Complete

Asynchronous

* + 1. Object Relational Data Mapping
    2. Graph Layout Algorithm
       1. Build Hierarchy
       2. Hierarchy Traversal

Pathfinder in form of posrt-order depth-first search to find ordered path of node visited while traversing hierarchy.

* + - 1. Vertex Placement
* Overview
* Settings

Settings implemented as parameters allow for fine tuning of the algorithm.

<INSERT Table with list of settings>

* Fine Tuning of Parameters
  + 1. Generation of the XML File
       1. Structure of XML File
       2. Recursive Instantiation

1. Testing, Verification and Validation
   1. Prototypical Implementation in an Industrial Context

For Comercial Deployment and Industrial Application

1. Synopsis