



Aalto University
School of Electrical
Engineering

Summary

Information systems in industry ELEC-E8113

Start at 12.15!

Contents

- What you are supposed to know in the exam
- Summary of the main topics

Rationale of the course (from the introduction lecture): Automation systems are increasingly connected to information systems in practice. You can get a job from it. Even if you do not it is good to know about it. It is also a research topic.

Exam

- **Wednesday 7.12.2022 at 10.00-12.00 (remotely)**
- **Questions will be published at the Mycourses announcement forum at 10.00**
- **Send your answers through email to ilkka.seilonen@aalto.fi before 12.00**
- **Exams also in 30.1.2023 and 8.5.2023**
- **Do we need another exam on 7.12. in the afternoon?**
- **Two broad questions about selected topics of the course divided into more detailed questions**
- **Short essays are expected as answers**
- **The answers should indicate that the student understands what is a good answer**
- **Figures, tables and lists may be useful as part of the answer. However, the majority of the answer should be text**
- **Questions are in English. Answers can be in English or Finnish (or Swedish).**



Exam (continued)

- **What you should know:**
 - Lectures slides
 - Home works and their materials
 - Chapters 2 and 5 from the book Mahnke, W., Leither, S-H., Damm, M. OPC Unified Architecture, Springer, 2009 (in Mycourses)
 - The other material at Mycourses is not required in the exam
- **Example questions (of your possible future boss):**
 - What is a given topic about? Can you explain its details and its meaning in a larger context?
 - We have a certain situation. How can we analyze the situation? What are our alternatives? How could we design a solution? What kind of a project do we need?

Grading













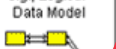

















- **Homeworks: 30 points**
- **Teamwork: 30 points**
- **Exam: 30 points**

Low	High	Grade
0	39	0
40	49	1
50	59	2
60	69	3
70	79	4
80	90	5

Typical limits. May change!

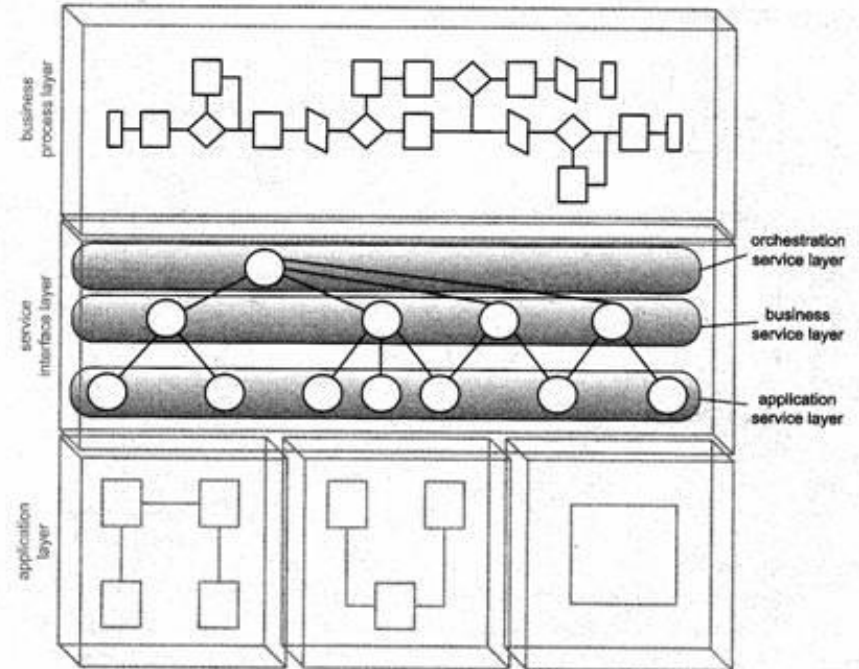
Lecture 1: EA

- The information processing activities, systems and organization of an enterprise can be modeled as an enterprise architecture (EA)
- EA outlines its target from several viewpoints and layers of abstraction. See the example.
- Information (EIA) and application (EAA) architecture are parts of EA

abstractions perspectives	DATA <i>What</i>	FUNCTION <i>How</i>	NETWORK <i>Where</i>	PEOPLE <i>Who</i>	TIME <i>When</i>	MOTIVATION <i>Why</i>
SCOPE Planner contextual	List of Things - Important to the Business 	List of Processes - the Business Performs 	List of Locations - in which the Business Operates 	List of Organizations - Important to the Business 	List of Events - Significant to the Business 	List of Business Goals and Strategies 
ENTERPRISE MODEL Owner conceptual	e.g., Semantic Model 	e.g., Business Process Model 	e.g., Logistics Network 	e.g., Work Flow Model 	e.g., Master Schedule 	e.g., Business Plan 
SYSTEM MODEL Designer logical	e.g., Logical Data Model 	e.g., Application Architecture 	e.g., Distributed System Architecture 	e.g., Human Interface Architecture 	e.g., Processing Structure 	e.g., Business Rule Model 
TECHNOLOGY CONSTRAINED MODEL Builder physical	e.g., Physical Data model 	e.g., System Design 	e.g., Technical Architecture 	e.g., Presentation Architecture 	e.g., Control Structure 	e.g., Rule Design 
DETAILED REPRESENTATIONS Subcontractor out-of-context	e.g. Data Definition 	e.g. Program 	e.g. Network Architecture 	e.g. Security Architecture 	e.g. Timing Definition 	e.g. Rule Specification 
FUNCTIONING ENTERPRISE	DATA Implementation	FUNCTION Implementation	NETWORK Implementation	ORGANIZATION Implementation	SCHEDULE Implementation	STRATEGY Implementation

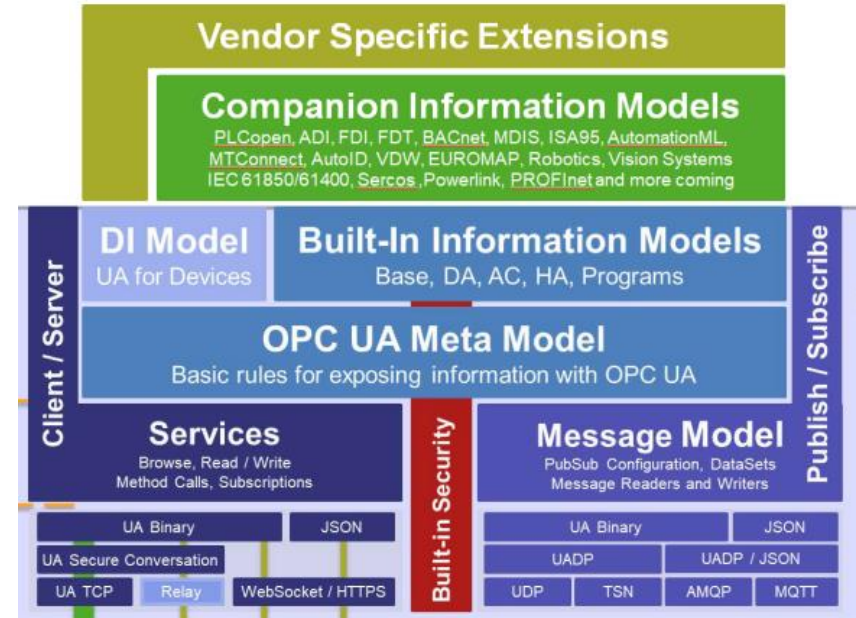
Lecture 3: SOA

- SOA consist of services, defined according to their interfaces, connecting applications to business processes
- SOA can be implemented e.g. according to WS-* standards, REST or with OPC UA
- Development process of SOA applications follows certain steps (entity services before other ones) and reuse existing systems and knowledge in different forms (applications, interfaces, frameworks, patterns, standards)



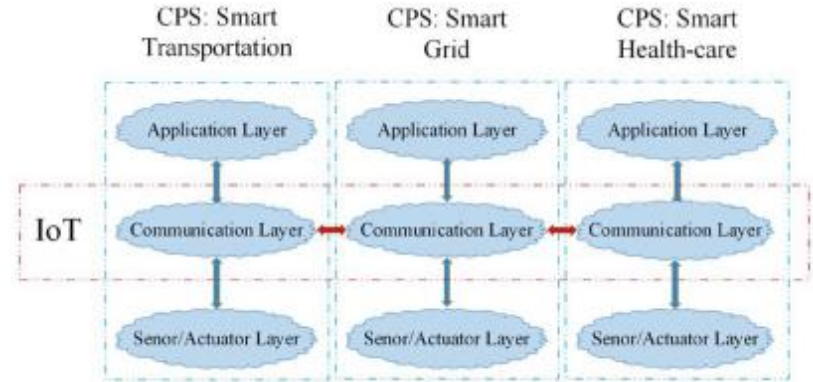
Lectures 4-5: OPC UA

- OPC UA is standardized technology for communicating mainly between automation and information systems
- The most essential part of OPC UA is its address space model which represents object-oriented data as a network of nodes with different types (objects, object types, variables, variable types, etc.)
- Information models define types and instances for some application area
- Actual communication can be done through services or messaging



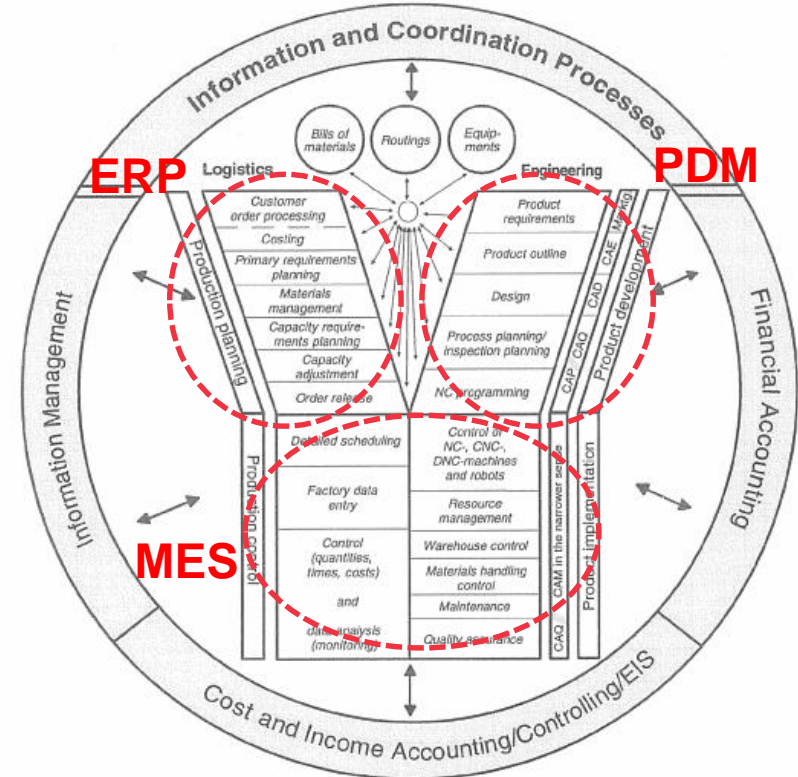
Lecture 6: IIoT

- IIoT refers to the idea of having physical industrial things with sensing or actuating, computing and communication capabilities, which enable them to communicate with information systems and with each other using Internet protocols
- IIoT may be designed according to SOA and implemented with the help of particular IoT platforms providing suitable middleware with IoT protocols
- Many (but not all) IIoT applications have so-called Big data, i.e. large amount of diverse data whose quality and value is not necessary known beforehand



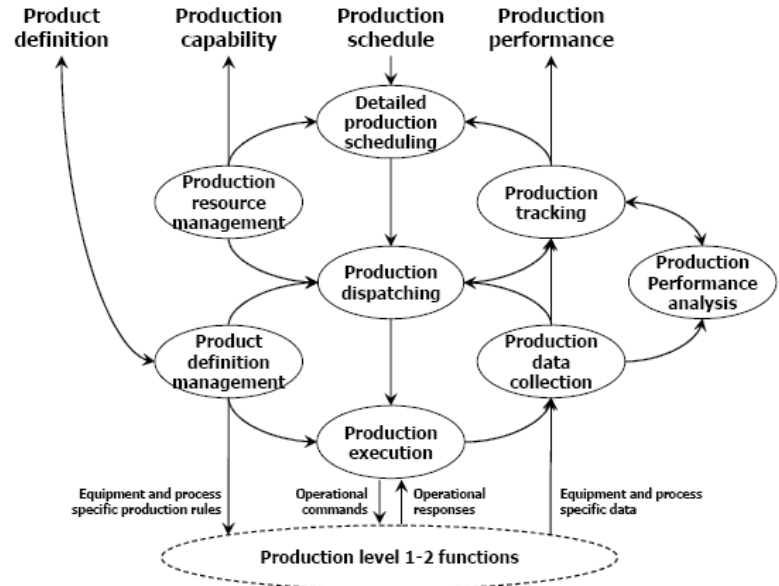
Lecture 7: ERP and PLM

- ERP is typically a modularized database oriented system supporting management of logistic and business operations of an enterprise
- PDM is a data server system providing semi-structured data about products to people and other systems of an enterprise
- PLM is a broader concept than PDM. It is usually not one system but activities and systems to manage product data during whole life cycle



Lecture 8: MOM and MES

- **MOM refers to management, i.e. planning, execution and monitoring, of manufacturing operations typically at one production site**
- **MOM can be divided to management of production, quality, inventory and maintenance operations**
- **MES is typically a modularized database-oriented planning and/or monitoring system supporting MOM and integrated to automation and other information systems of the enterprise, e.g. ERP**

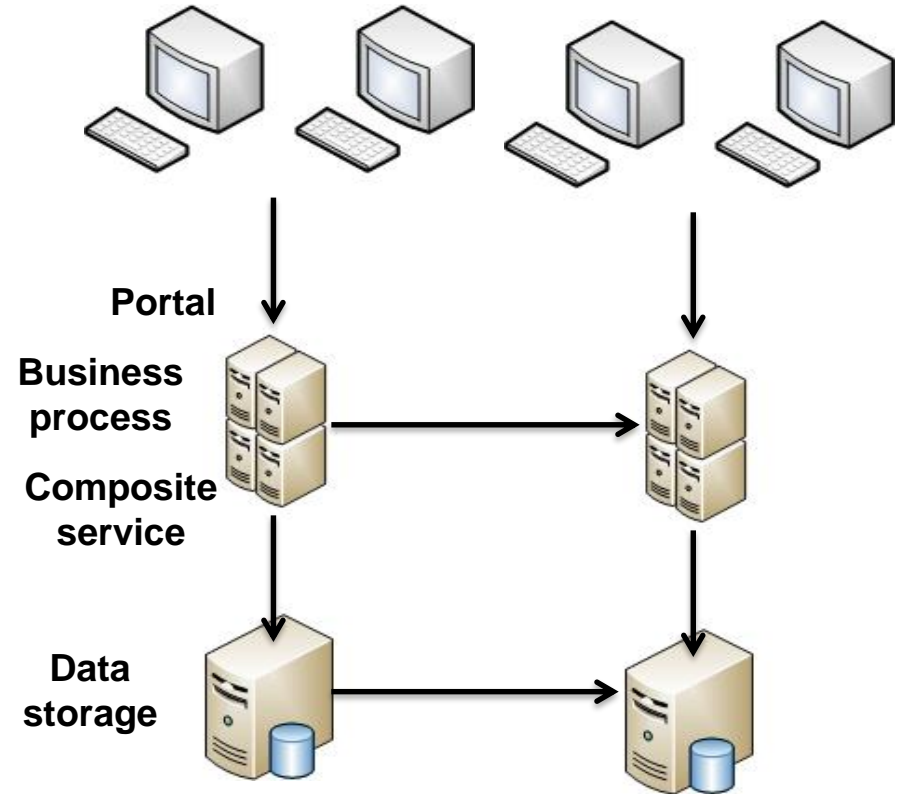


Lecture 9: Development

- **Development of business processes means creating new or modifying existing processes of an enterprise, i.e. how they are performed by the people with help of information systems and other tools**
- **Development of information systems means creating new or modifying existing systems so that new requirements are fulfilled or existing ones are fulfilled better**
- **It is reasonable to utilize existing systems and available technologies, knowledge and standards**
- **Outline the phases of development :**
 1. Identifying needs
 2. Setting objectives
 3. Analyzing current situation
 4. Designing target situation
 5. Choosing a solution approach
 6. Developing services and applications
 7. Implementation, testing and deployment
 8. Utilization, analysis, maintenance and redevelopment
- **Phases 5-8 are the development of information systems**

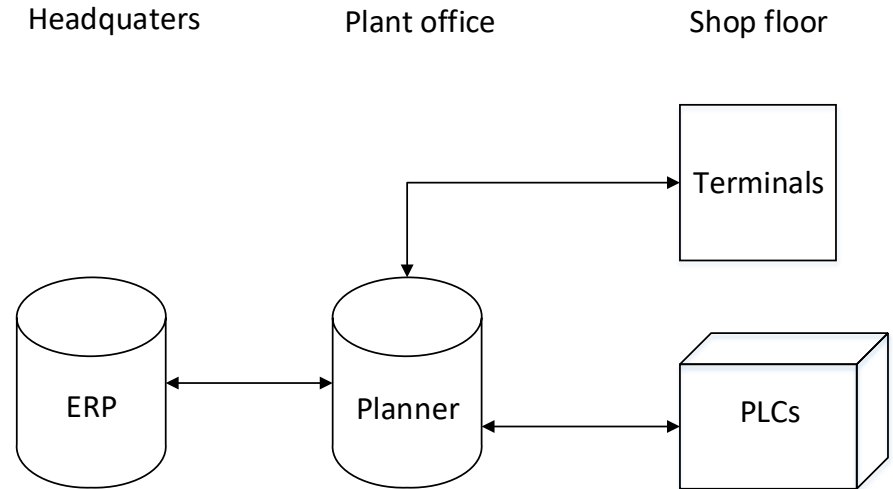
Lectures 10: System integration

- Approaches to integration of information systems are oriented to data, services, business processes or portals
- Messaging is a basic design for integration, implemented with middleware (e.g. MOM) possibly provided by a server (e.g. ESB)
- OPC UA is a standardized technology for B2P integration with a particular method for representing data
- System integration is a very essential part of many development projects



Homework 10: example situation

- Steps, people and issues from the model of development process (L9)
- Configuration and integration of Planner with other systems according to the MOM model (L8)
- Integration, e.g (L10):
 - XML file import/export at ERP (L7)
 - Integration application at Planner using the REST API (L3, L10)
 - OPC UA with the PLCs (L4)
 - Portal type of integration for the terminals (L10)



Example MSc thesis: Integration of voice picking software with Enterprise Resource Planning and a Warehouse Control System (2016)

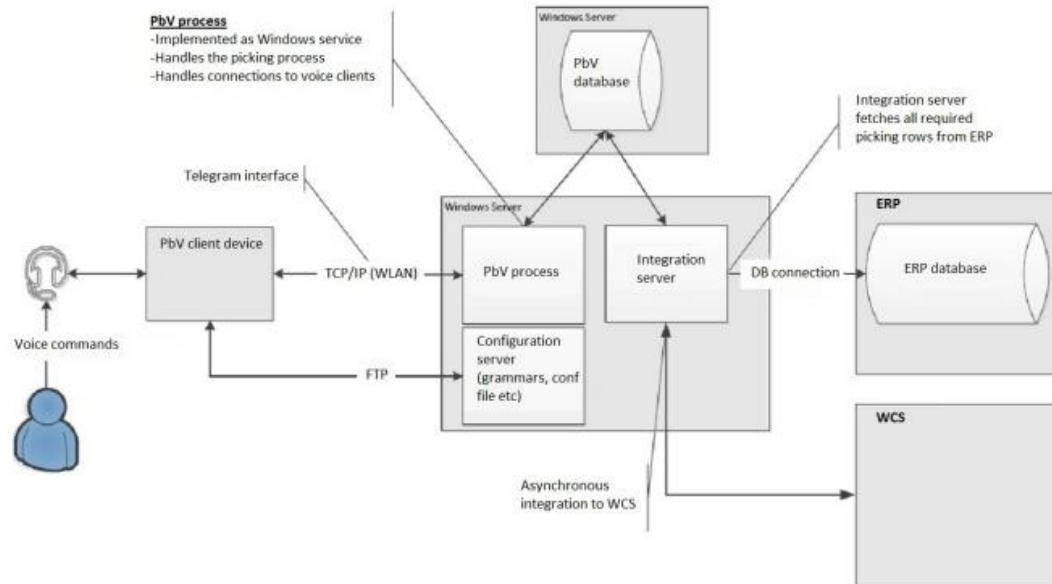


Figure 11: Architecture of the PbV system

Example MSc thesis: Scalable application programming interface for clinical laboratory request registration (2016)

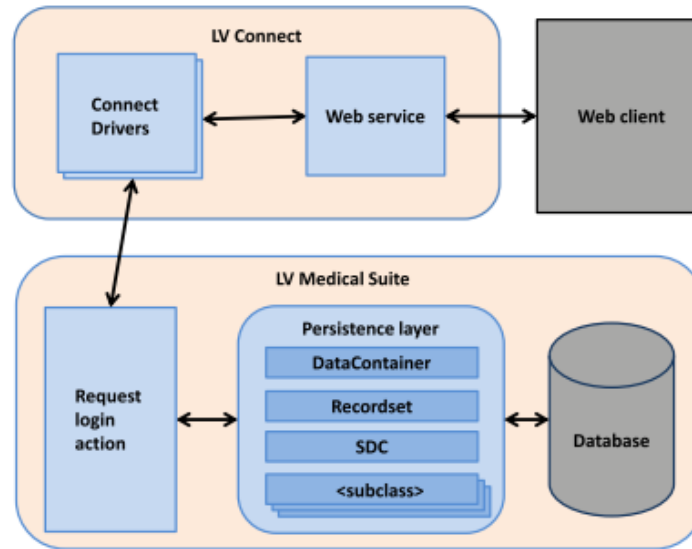
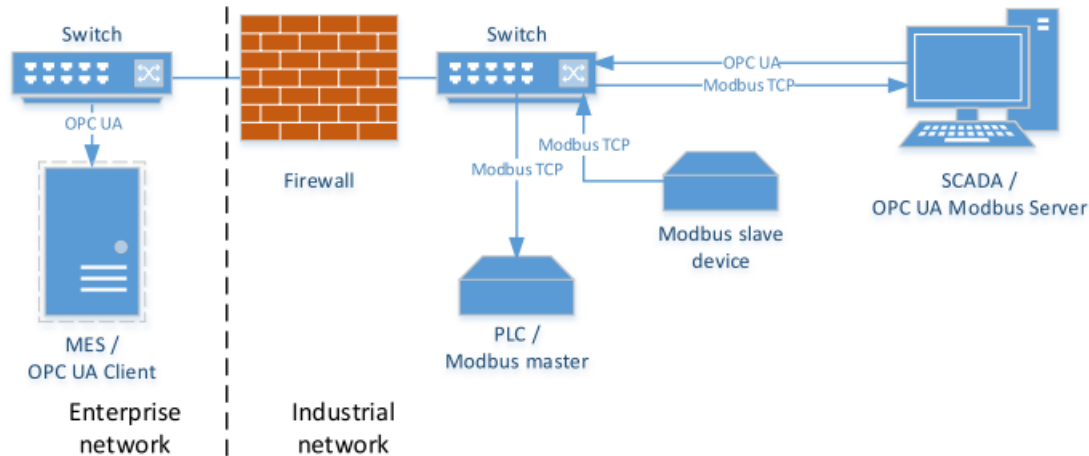


Figure 5.2: The architecture of the request login API.

Example MSc thesis: Mapping Modbus to OPC Unified Architecture (2018)



OPC UA and Information Modeling for Pharmaceutical Manufacturing (2020)

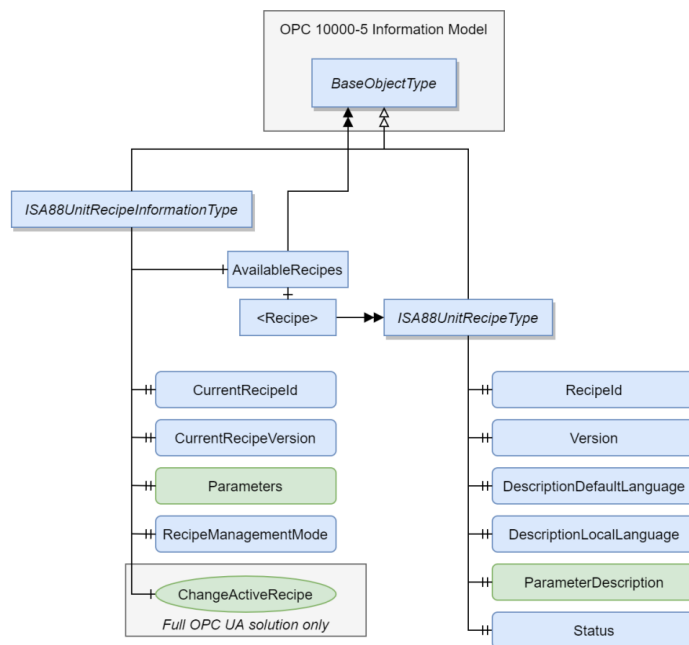


Figure 22: Recipe information model in tag-based, and full OPC UA solutions.

A few more MSc theses about OPC Unified Architecture

- **Java Based OPC UA Client Development (2012)**
- **Java source code generation from OPC UA information models (2013)**
- **OPC UA Java History Gateway with Inherent Database Integration (2014)**
- **JavaFX based OPC UA Simulation Server (2014)**
- **OPC UA App development for Android (2015)**
- **Aggregating OPC UA Server for Generic Information Integration (2017)**
- **Simulating OPC UA Information Models (2018)**
- **OPC UA and Information Modeling for Pharmaceutical Manufacturing (2020)**