Aalto University
School of Electrical
Engineering

# Introduction
# Enterprise architecture (EA)

# Information systems in industry
# ELEC-E8113

*Start at 12.15!*

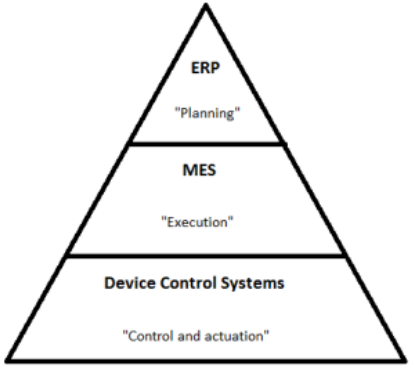
# Contents

- **Introduction to the topic of the course**
- **Information about the course**

***Rationale of the course: Automation systems are increasingly connected to information systems in practice for a good reason. 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.***

# Situation

- Industry takes place in supply chains forming value networks
- In a supply chain core processes of an enterprise are plan, source, deliver (using ERP) and make (e.g. using MES and automation)
- Systems in a single enterprise are often illustrated with a model called automation pyramid
- In this model upper levels control lower levels (human in the loop!)

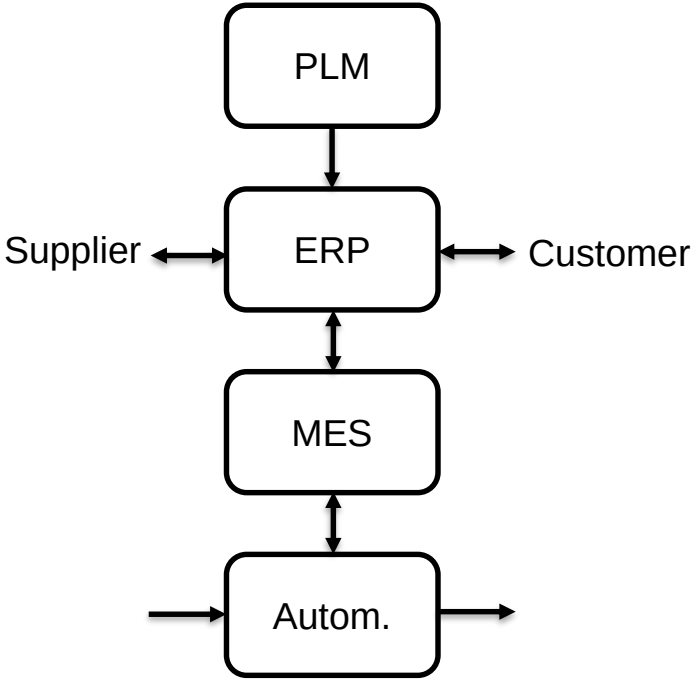



# Information processing task of a manufacturing company

- The task of a manufacturing company is to use information from its markets (downstream in the supply-chain) and plan and control purchases from its suppliers (upstream in the supply-chain), usage of its own resources and its deliveries for fulfilling that market demand while maximizing its own business result given constraints posed on it
- In order to do this the company needs information processing activities of its workers (i.e. humans!) supported by suitable information systems
- The processed information need to passed to the production system (controlled by an automation system) and the result information needs to communicated back
- Monetary criteria evaluate the quality of the activity and the supporting systems

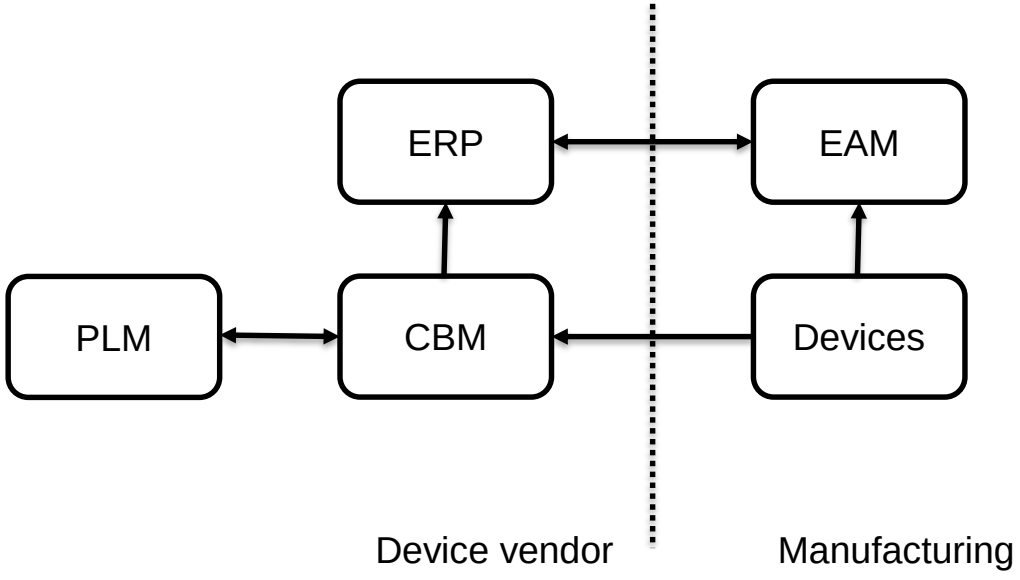
# Manufacturing supply chain: Customer orders of products

1. Customer orders
2. Rough production planning
3. Purchases
4. Detailed production planning
5. Execution and monitoring of production
6. Deliveries



# Supply chain of a device vendor: Life-cycle of intelligent devices

1. Design
2. Manufacturing
3. Installation
4. Monitoring
5. Maintenance
6. Disposal

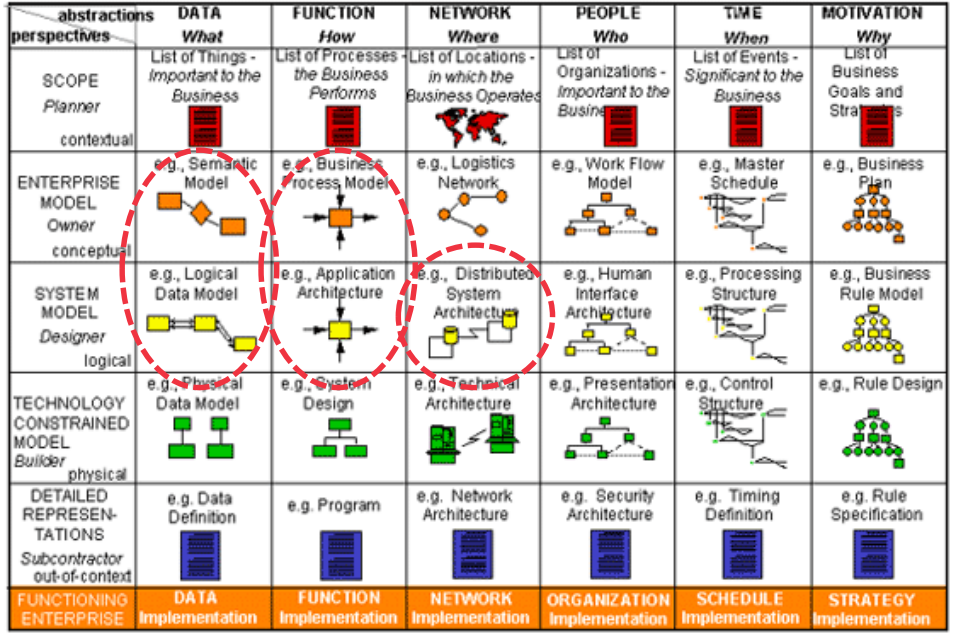


# Basic concepts

- **Enterprise architecture (EA) refers to a holistic approach for analyzing the information processing activities and information systems of an enterprise from several viewpoints and levels of abstraction**
- **Business processes are a very essential viewpoint in the EA (but only one of them)**
- **Manufacturing operations management (MOM) refers to the business processes particular in industrial companies performing production activities**

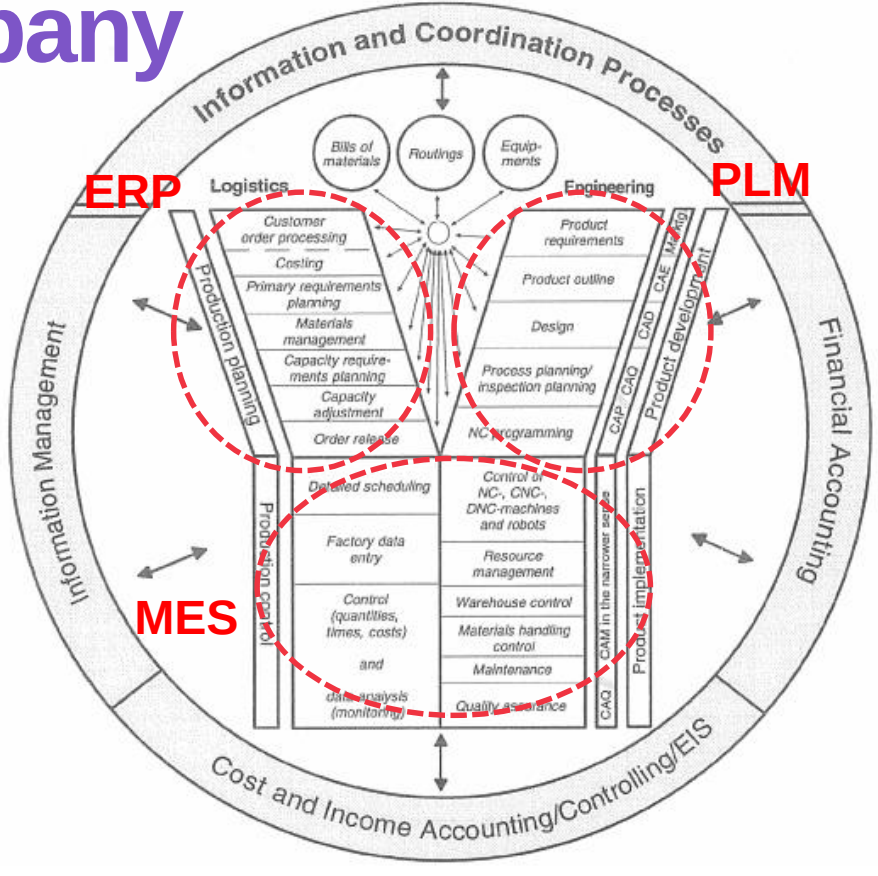
# Enterprise architecture

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



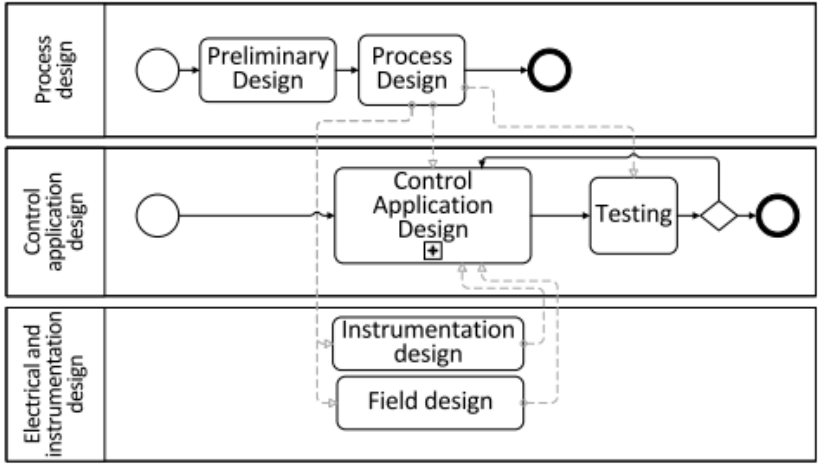
# Y-CIM model of activities in a manufacturing company

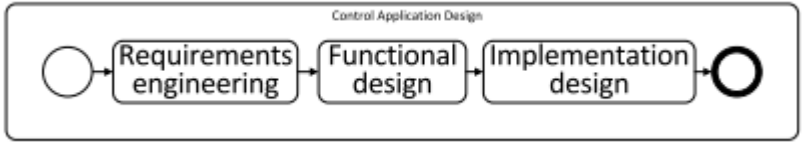
- In this model core processes are called logistics and engineering
- Logistics consists of production planning (using ERP) and control
- Engineering consists of product development (using PLM) and implementation
- MOM (using MES) consists roughly of production control and product implementation
- After-sales services (using PLM) are not included in the model



# Methods for modeling business processes

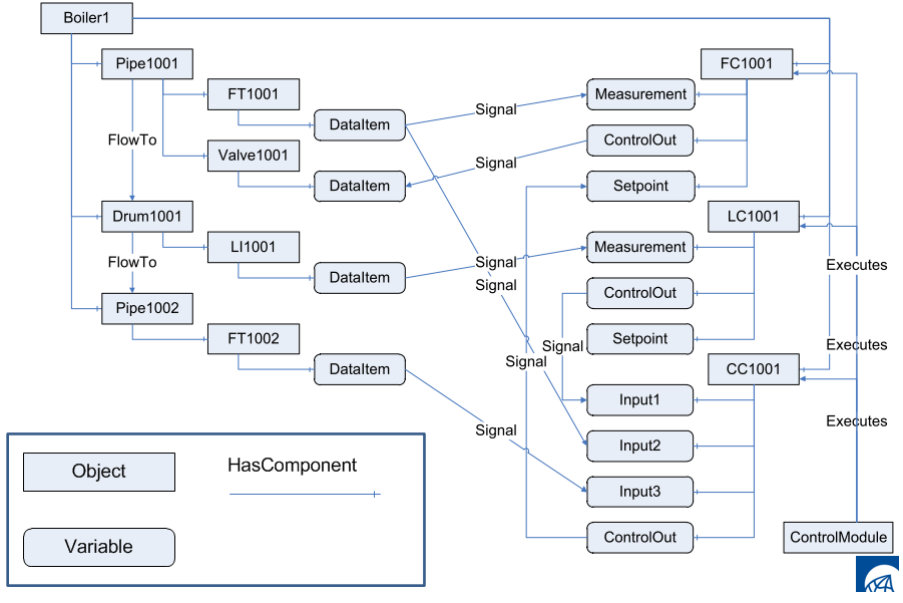
- **Business processes are typically modeled with a few basic types of diagrams: data flow, workflow or sequence diagrams**
- **Currently the maybe most well known notation is BPMN (Business Process Model and Notation)**
- **Other notations include UML (Unified Modeling Language), ARIS (Architecture of Integrated Information Systems)**



# Modelling data of industrial information systems

- **Data is another important view in EA. Data is a valuable asset.**
- **Data is modelled with different data models: basic data types, structures, hierarchies, networks, mathematics**
- **Data models enable different operations on data. Transformations between models are needed.**
- **Often information systems need more complicated data models than automation. Also information systems are different in this respect**



# Teaching

- **13 lectures on Mondays at 12.15 – 14.00 in AS6 and Zoom.**
- **10 homeworks according to a defined schedule. Roughly one homework per week.**
- **Teamwork in groups of two students starting on 12.9.**
- **Exam on 7.12.2022.**

# Lectures

| No | Date | Topic |
|---|---|---|
| 1 | 5.9. | Introduction, Enterprise architecture (EA) |
| 2 | 12.9. | Teamwork kickoff |
| 3 | 19.9. | Service-oriented architecture (SOA) |
| 4 | 26.9. | OPC Unified Architecture (OPC UA), Client-Server |
| 5 | 3.10. | OPC Unified Architecture (OPC UA), PubSub |
| 6 | 10.10. | OPC Unified Architecture (OPC UA), Industrial Internet of Things (IIoT) |
| 7 | 24.10. | Enterprise resource planning (ERP), Product life-cycle management (PLM) |
| 8 | 31.10. | Manufacturing operations management (MOM), Manuf. execution systems (MES) |
| 9 | 7.11. | Development process of information systems in industry |
| 10 | 14.11. | Visiting lecture abut MOM |
| 11 | 21.11. | Integration of information systems in industry |
| 12 | 28.11. | Teamwork results |
| 13 | 5.12. | Summary |

# Homeworks

| No. | Deadline | Topic | Type |
|---|---|---|---|
| 1 | 12.9. | Teamwork pre-assignment | Reading |
| 2 | 19.9. | SOA | Reading |
| 3 | 26.9. | OPC UA | Reading |
| 4 | 5.12. | OPC UA Client | Programming |
| 5 | 5.12. | OPC UA PubSub | Programming |
| 6 | 24.10. | ERP, PLM | Reading |
| 7 | 31.10. | MOM, MES | Reading |
| 8 | 7.11. | Development of information systems | Reading |
| 9 | 21.11. | Integration of information systems | Reading |
| 10 | 5.12. | Case study | Case study |

# Teamwork

- **The only mandatory task in this course!**
- **Alternative 1: The task is to design a standard-based address space for an example automation system and then implement it with OPC UA Java SDK.**
- **Alternative 2: The task is to analyze data of electric power consumption stored and updated in an SQL database with mathematical models implemented with R library.**
- **Teams of 2 students. 1 allowed if absolutely necessary**
- **Kick-off 12.9, deadline 28.11.**

# Exam

- Not mandatory but very much recommended
- Material contains lecture slides and texts for homeworks
- Just two relatively broad questions
- Emphasis is on understanding the topics, not remembering details that would be easy to check in practice
- However, you have to understand the important concepts and also remember their acronyms
- First exam on 7.12. Later exams in year 2023.

# Grading

- **Teamwork: 30 (avg 24)**
- **Homeworks: 30 (avg 22)**
- **Exam: 30 (avg 14)**
- **Total: 90 (avg 60)**

| 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!**

# Information

- **https://mycourses.aalto.fi**
- **Materials page will contain lecture slides, and texts for homeworks and exam**
- **Assignments page will contain homework questions and instructions for the teamwork**
- **Contact the teacher through email**

# Personnel

- **Teacher**
  **Dr Ilkka Seilonen**
  **TUAS Building, room 3562**
  **ilkka.seilonen@aalto.fi**

# Some MSc theses 2015-2017

| Year | Topic | Organization |
|---|---|---|
| 2017 | Fulfillment Automation in E-Grocery | Digital Foodie |
| 2016 | Scalable application programming interface for clinical laboratory request registration | Software Point |
| 2016 | A modern user interface for manufacturing execution systems | Roima Intelligence |
| 2016 | Production of large travel time matrices on the Finnish road network | Mtech |
| 2016 | Integration of voice picking software with enterprise resource planning and a warehouse control system | Oriola |
| 2016 | Automated analysis of environmental measurements as part of quality management | HSY |
| 2016 | Converting an OPC UA software development kit from Java to Delphi | Prosys |
| 2016 | OPC UA performance evaluation | Prosys |
| 2015 | OPC UA app development for Android | Prosys |
| 2015 | Intelligent wear plate condition monitoring system | Metso Automation |