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Advanced Topics in Software Architecture (E23)

Exam and Task

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Agenda

→ Exam format
→ Task

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Exam

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→ Written exam consisting of a hand-in with
  → group report
  → reflection document
  → Source code developed through the course

→ In the hand-in the contribution of each of the members of the group must be clearly stated

→ The deadline for the hand-in will be the December, 15th

→ Grade: Individual pass/fail

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Introduction

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The purpose is to work with different architectures and technologies.

The domain we will be focusing on is the Industry 4.0 production domain as an example domain to design a complex system.

One of the architectural challenges in a production system is to design how production components interact with each other to achieve some common task to support a flexible production system.

Components:
- Connectors/adapters to production components and machinery
- Coordinators of the components and machinery
- Optimizers of the overall production flow.

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Introduction

Typically, a production system already contains different components from different vendors and technologies, which needs to be considered when new components are designed for the system.

It is unavoidable that some technologies are chosen already, which might constrain the architecture in future development.

Also, it is impossible to be up to date with all the technologies existing, and therefore, it raises the need for architects to be acquainted with the characteristics and consequences of design decisions and trade-offs choosing a given technology.

Remember to apply methods and techniques from the earlier software architecture course.

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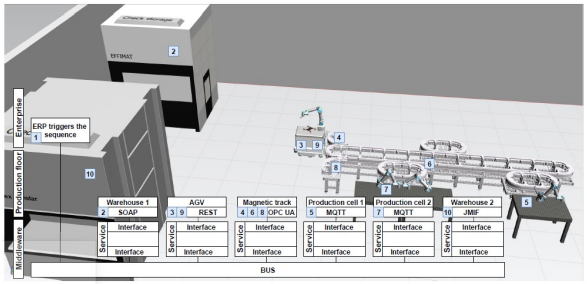
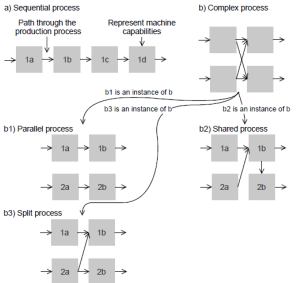
Industry 4.0 example



Industry 4.0 Middleware Software Architecture Interoperability Analysis



A Research Setup Demonstrating Flexible Industry 4.0 Production

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Requirements

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The task is to design and implement *architecture prototypes* of production system components that interact to achieve some common task.

Following production system requirements needs to be satisfied in the design:

→ Production software must be able to exchange and coordinate information to execute a production and change production
→ Production software must run 24/7
→ Production software must be continuously deployable

The design must at least address quality attributes interoperability, availability, deployability…

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Requirements

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Part of the design solution must consider and implement
→ different programming languages
→ different databases
→ different message buses
→ different containers
→ Point-to-point communication between two or more programming languages, e.g. protocol buffers
→ different architectural styles, e.g. event driven, client-server, microservice, layers
→ different architectural patterns/tactics, e.g. circuit breaker, visitor pattern

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Outcome

Research questions the project needs to answer:
1. How can different architectures support the stated production system requirements?
2. Which architectural trade offs must be taken due to the technology choices?

Outcome (handed in as a group)
1. Group report max 10 pages resembling a scientific paper (pdf and compilable latex code)
2. Reflection report max three pages (pdf and compilable latex code)
3. Zip-file of Github repository with code and guide how to use (and link to the repository)

Templates
1. Templates for
   1. Report
   2. Reflection document
2. Distributed as Github repository to be cloned (will contain the needed structure and latex files to get started)

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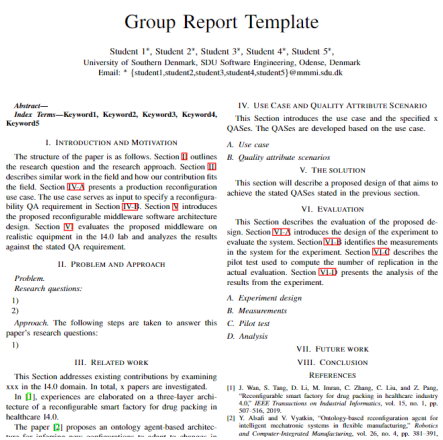
Group Report Template

→ The work must be documented in maxium 10 double column pages using the latex template:

- → Introduction and motivation
- → Problem and approach
- → Use case
- → QAS
- → Design
- → Evaluation (Empirical)
- → Future work
- → Conclusion
- → And 1 page of reflections



Group Report Template

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Abstract—
***Index Terms*—Keyword1, Keyword2, Keyword3, Keyword4, Keyword5**

I. Introduction and Motivation

The structure of the paper is as follows. Section II outlines the research question and the research approach. Section III describes similar work in the field and how our contribution fits the field. Section IV-A presents a production reconfiguration use case. The use case serves as input to specify a reconfigurability QA requirement in Section IV-B. Section V introduces the proposed reconfigurable middleware software architecture design. Section VI evaluates the proposed middleware on realistic equipment in the I4.0 lab and analyzes the results against the stated QA requirement.

II. Problem and Approach

Problem.
Research questions:
1)
2)
Approach. The following steps are taken to answer this paper's research questions:
1)

III. Related work

This Section addresses existing contributions by examining xxx in the I4.0 domain. In total, x papers are investigated.
In [1], experiences are elaborated on a three-layer architecture of a reconfigurable smart factory for drug packing in healthcare I4.0.
The paper [2] proposes an ontology agent-based architec-

IV. Use Case and Quality Attribute Scenario

This Section introduces the use case and the specified x QASes. The QASes are developed based on the use case.

A. Use case
B. Quality attribute scenarios

V. The solution

This section will describe a proposed design of that aims to achieve the stated QASes stated in the previous section.

VI. Evaluation

This Section describes the evaluation of the proposed design. Section VI-A introduces the design of the experiment to evaluate the system. Section VI-B identifies the measurements in the system for the experiment. Section VI-C describes the pilot test used to compute the number of replication in the actual evaluation. Section VI-D presents the analysis of the results from the experiment.

A. Experiment design
B. Measurements
C. Pilot test
D. Analysis

VII. Future work

VIII. Conclusion

References

[1] J. Wan, S. Tang, D. Li, M. Imran, C. Zhang, C. Liu, and Z. Pang, "Reconfigurable smart factory for drug packing in healthcare industry 4.0," *IEEE Transactions on Industrial Informatics*, vol. 15, no. 1, pp. 507–516, 2019.
[2] Y. Ahait and V. Vyatkin, "Ontology-based reconfiguration agent for intelligent mechatronic systems in flexible manufacturing," *Robotics and Computer-Integrated Manufacturing*, vol. 26, no. 4, pp. 381–391,

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Group Report Structure For the Exam

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→ **Abstract:**
  → Breifly describe introduction to the topic, what is the gab, aim, approach, and results (0,25 page)

→ **Introduction and motivation:**
  → Introduction and motivation to the problem domain. (0,5 page)

→ **Problem, research questions, and approach**:
  → What is the problem* to be solved with the architecture you build, and how will the problem be addressed. *The stated problem leads to the stated research question. (0,5 page)

→ **Literature review**:
  → The literature review should review the state of the art consisting of 8-10 papers and should contextualize how this study provides new knowledge to the field. Here you can combine the work from scientific methods. (1/2 page)

→ **Use case**:
  → Unfold the problem with a use case and describe what the use case is about. (0,5 page)

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Group Report Structure For the Exam

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→ **Quality attribute scenario**:
  → The use case is the foundation to describe and specify architectural requirements. (1,5 page)

→ **Design**:
  → Describe the design and argue for the design decision and how it meets the QASes. Part of the design decision must specify which tactics/patterns are used (provide arguments) and the trade-offs. (1,5 pages)

→ **Evaluation**:
  → Describe the evaluation design, measurements of the QASes, pilot test, and an analysis of the results. Describe the design for the evaluation, measurements of the QASes, pilot test, and an analysis of the results. From the analysis, how it answers the research questions must be clear. (3 pages divided into 0,5;0,5;0,5;1,5)

→ **Discussion/Future work**:
  → Discuss how the work can be extended with respect to the approach and/or evaluation (0,5 page)

→ **Conclusion:**
  → A brief closing summary of the work, design, and results. (0,25 page)

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Reflection Report For the Exam

→ **Contribution**: Specification of your contribution. It must be clearly detailed for each of the sections in the report (introduction; problem, research questions, and approach; etc.) (0.5-0.75 page)

→ **Discussion**: Discuss to what extent the solution achieves the design goals, and if not, why not. Refer to the literature to support your statements. (0.75-1 pages)

→ **Reflection**: Elaborate on what parts of the addressed problem are (not) solved. Reflect on the project, as such, in regard to the stated problem and objectives. The process. Any technical issues, etc. (0.75-1 pages)

→ **Conclusion**: Summarize and outline relevant future work based on your discussions and reflections (0.5 page)

→ Max three pages.

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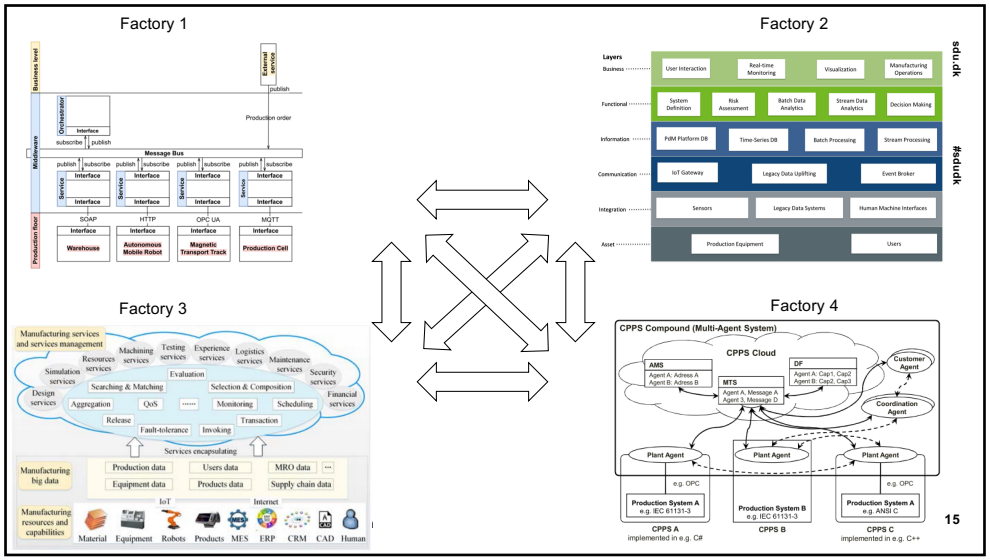

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Project Phases

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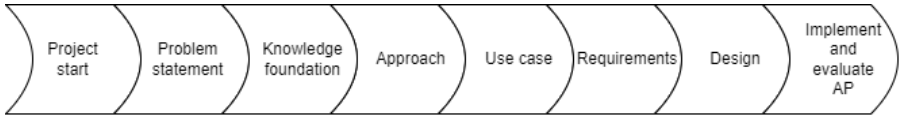
→ Phase 1: Find out which knowledge foundation you need and how you want to approach the problem
→ Phase 2: Define use case and architectural requirements
→ Phase 3: Create design that achieves the architectural requirements
→ Phase 4: Implement and evaluate architectural prototype

The report must document the work focusing on software architecture through out the phases.



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Project Plan

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→ Week 35: Project start/introduction
→ Week 36: Standup meeting
→ Week 38: Peer review
→ Week 39: Student pitches (approach, use case, architecture requirement, and early design and evaluation plan)
→ Week 41: Standup meeting
→ Week 44: Standup meeting
→ Week 45: Peer review
→ Week 46: Final presentation (design, implementation, and early evaluation)
→ Week 47: Standup meeting
→ Week 48: Standup meeting
→ Week 50: Exam hand-in (15 december)

Please use TAs in the course for any technical questions you might have between the meetings.

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Practicalities

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Hardware
→ 2 CPUs (64 bit intel/AMD) per person
→ 4-8 GB ram
→ 40 GB disk
→ Newest Ubunutu LTS
→ SSH access through VPN
→ Remember to allocate space to this course

Groups
→ 6 members per group
→ You are encouraged to mingle with others
→ Be kind to invite new students to the group
→ You will more or less be working in this group throughout the semester and across courses

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Some friendly advice

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→ Make good working habits from the beginning, e.g.
  → Commit and build every time you make any changes (think DevOps)
  → Build all you outputs from the beginning

→ Use vector graphics in your latex documents

→ Be aware that the grading is individual, i.e.
  → be considerate to each other and don't "devide and conquer"
  → Document who does what

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Whats next

→ Next lecture we will present the exercises in greater detail

→ Github repository

→ Exercise description

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End of Presentation

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