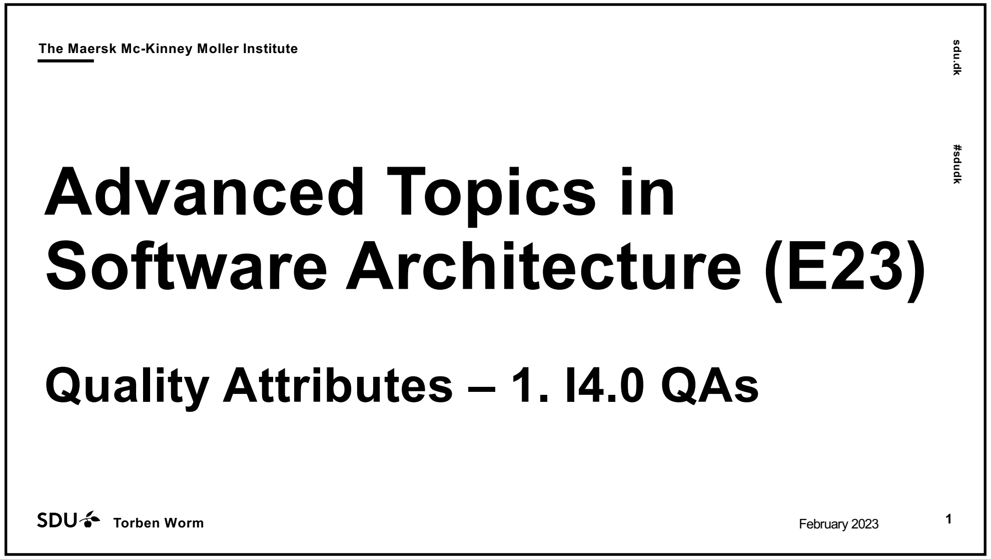

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Advanced Topics in Software Architecture (E23)

Quality Attributes – 1. I4.0 QAs

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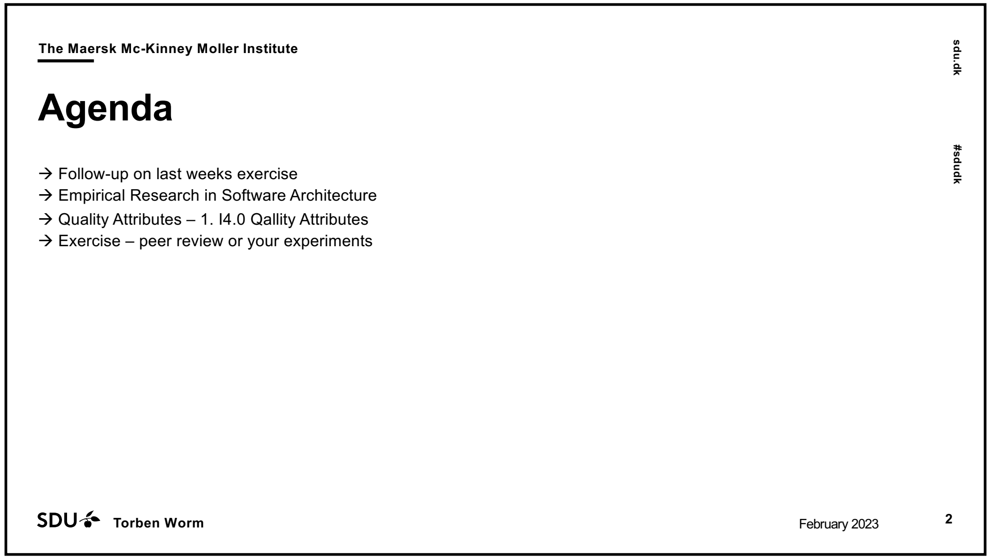

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Agenda

→ Follow-up on last weeks exercise
→ Empirical Research in Software Architecture
→ Quality Attributes – 1. I4.0 Qallity Attributes
→ Exercise – peer review or your experiments

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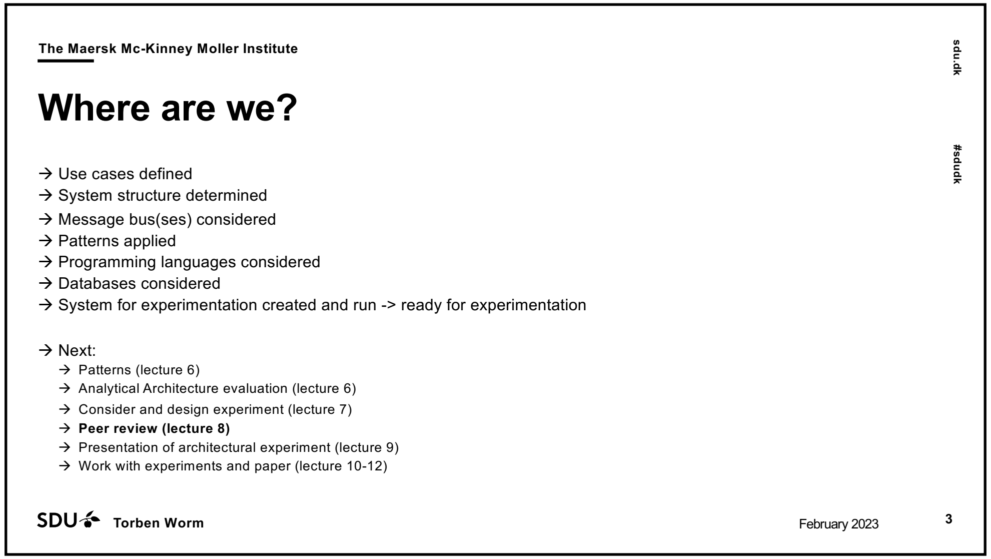

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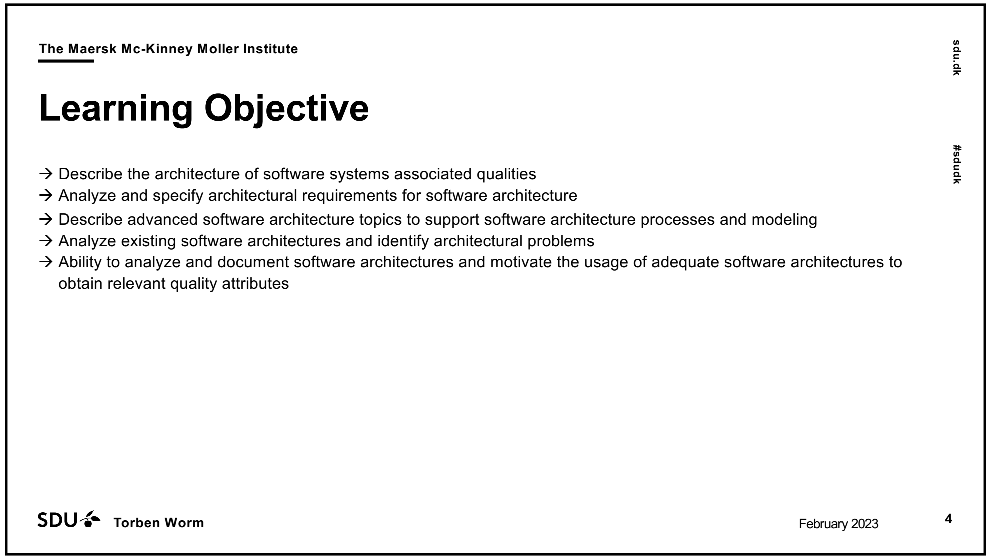
Where are we?

→ Use cases defined
→ System structure determined
→ Message bus(ses) considered
→ Patterns applied
→ Programming languages considered
→ Databases considered
→ System for experimentation created and run -> ready for experimentation

→ Next:
- → Patterns (lecture 6)
- → Analytical Architecture evaluation (lecture 6)
- → Consider and design experiment (lecture 7)
- → **Peer review (lecture 8)**
- → Presentation of architectural experiment (lecture 9)
- → Work with experiments and paper (lecture 10-12)



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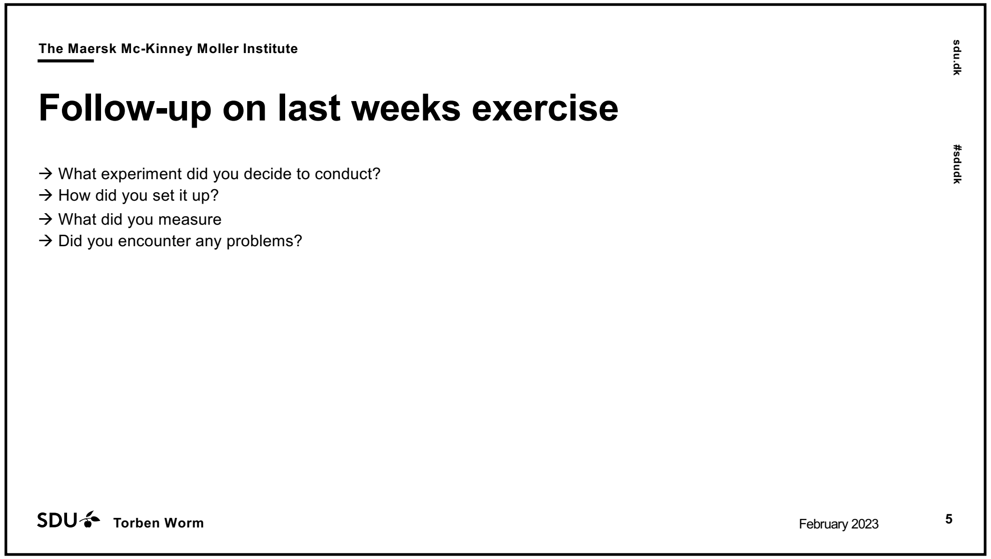
Learning Objective

→ Describe the architecture of software systems associated qualities
→ Analyze and specify architectural requirements for software architecture
→ Describe advanced software architecture topics to support software architecture processes and modeling
→ Analyze existing software architectures and identify architectural problems
→ Ability to analyze and document software architectures and motivate the usage of adequate software architectures to obtain relevant quality attributes



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Follow-up on last weeks exercise

→ What experiment did you decide to conduct?
→ How did you set it up?
→ What did you measure
→ Did you encounter any problems?

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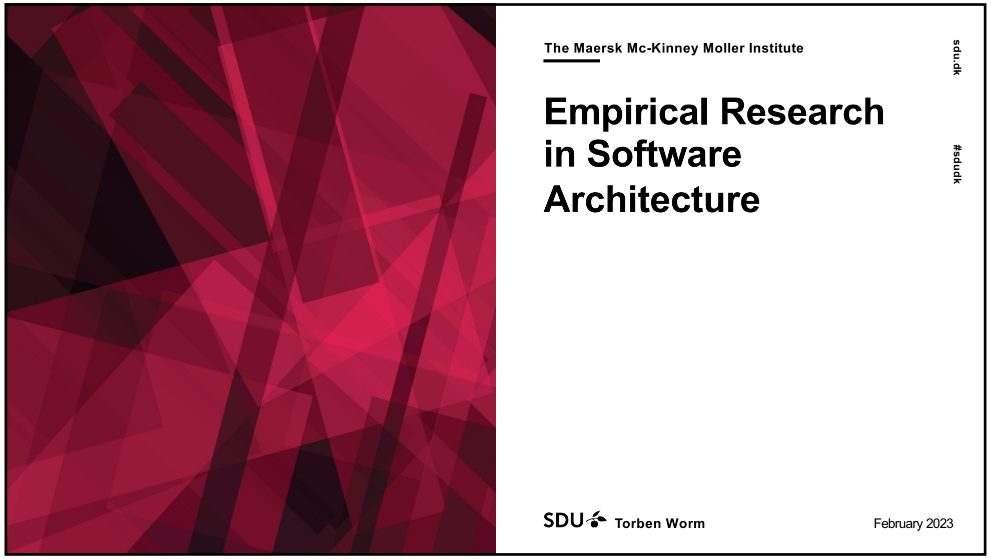

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Empirical Research in Software Architecture

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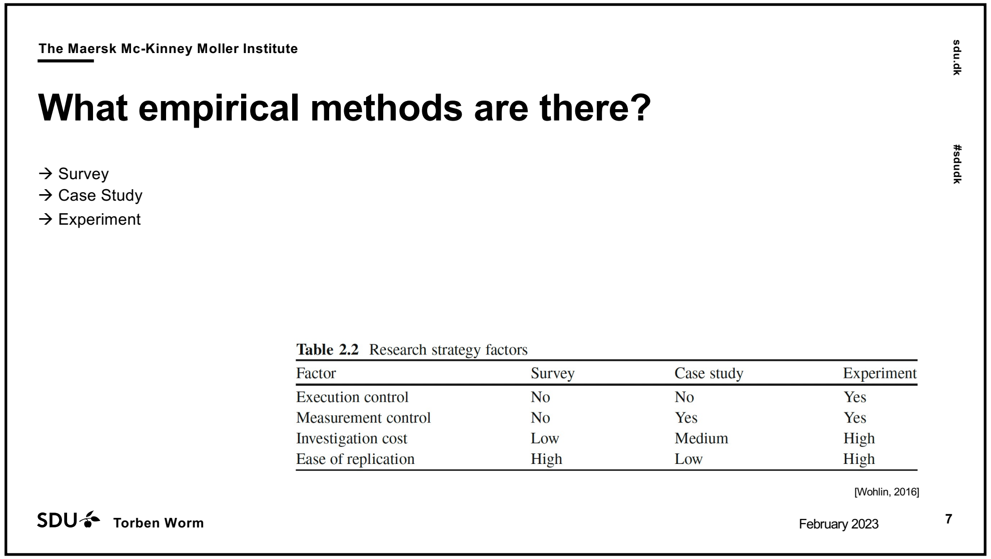

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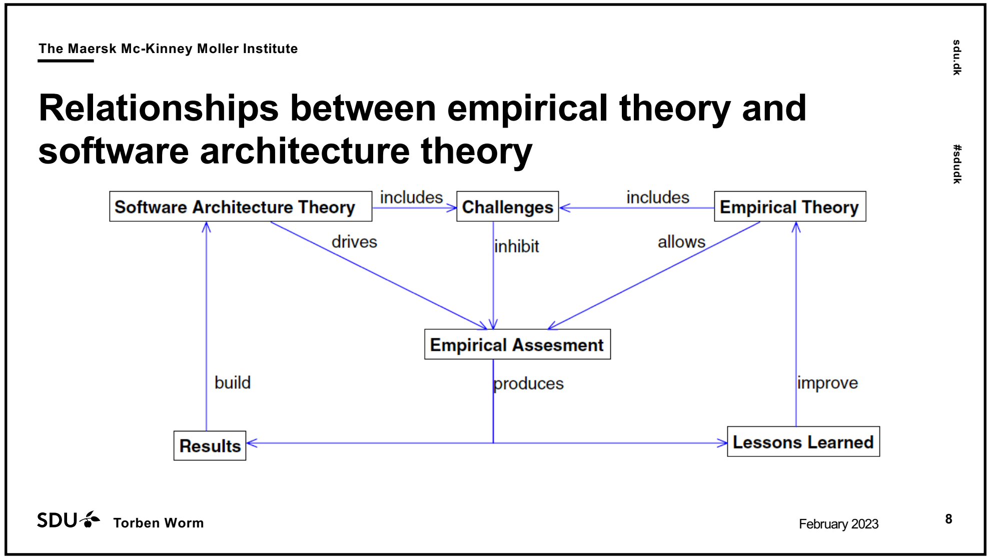
What empirical methods are there?

→ Survey
→ Case Study
→ Experiment

Table 2.2 Research strategy factors

Factor	Survey	Case study	Experiment
Execution control	No	No	Yes
Measurement control	No	Yes	Yes
Investigation cost	Low	Medium	High
Ease of replication	High	Low	High

[Wohlin, 2016]



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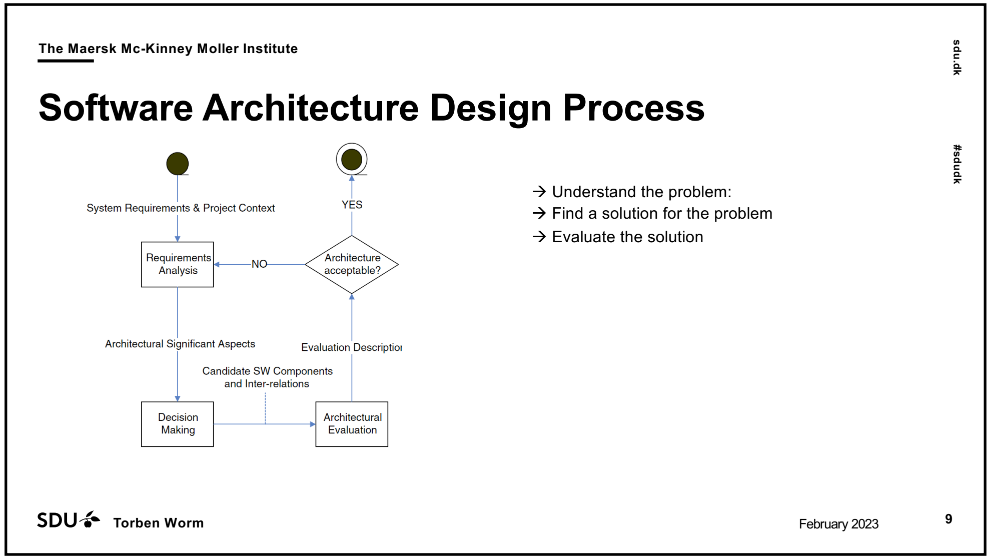
Relationships between empirical theory and software architecture theory

Software Architecture Theory
includes
Challenges
includes
Empirical Theory
drives
inhibit
allows
Empirical Assesment
build
produces
improve
Results
Lessons Learned



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Software Architecture Design Process

System Requirements & Project Context
Requirements Analysis
NO
YES
Architecture acceptable?
Architectural Significant Aspects
Evaluation Descriptio
Candidate SW Components and Inter-relations
Decision Making
Architectural Evaluation

→ Understand the problem:
→ Find a solution for the problem
→ Evaluate the solution

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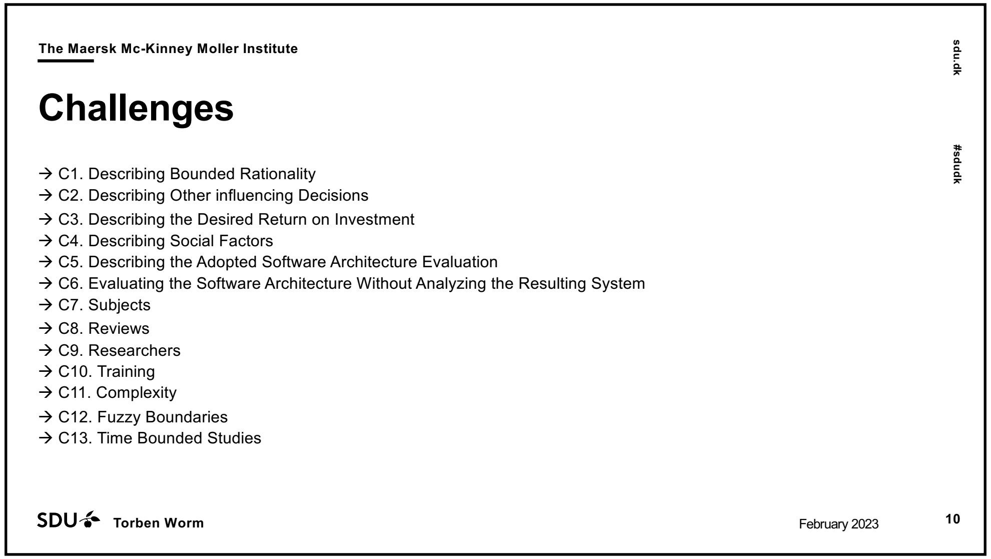

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Challenges

→ C1. Describing Bounded Rationality
→ C2. Describing Other influencing Decisions
→ C3. Describing the Desired Return on Investment
→ C4. Describing Social Factors
→ C5. Describing the Adopted Software Architecture Evaluation
→ C6. Evaluating the Software Architecture Without Analyzing the Resulting System
→ C7. Subjects
→ C8. Reviews
→ C9. Researchers
→ C10. Training
→ C11. Complexity
→ C12. Fuzzy Boundaries
→ C13. Time Bounded Studies

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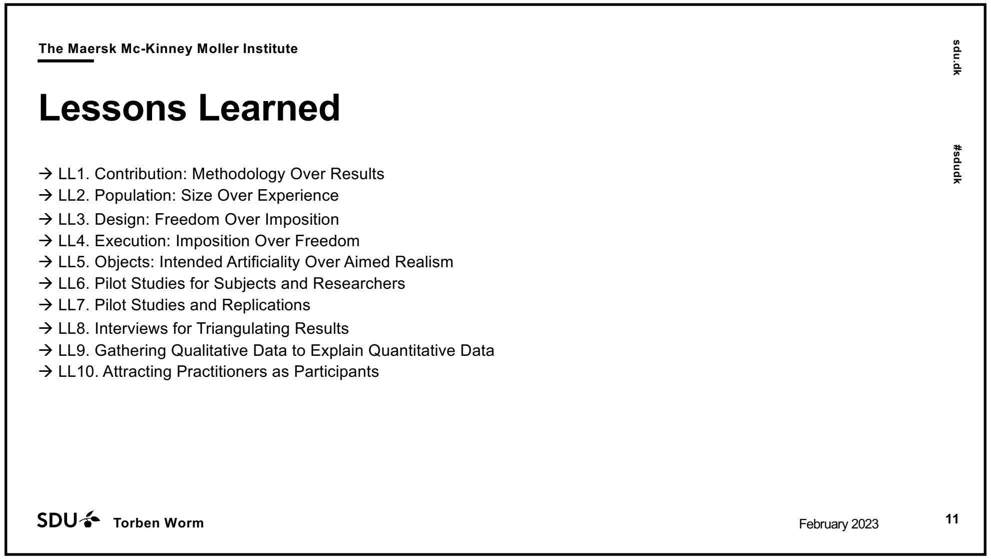

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Lessons Learned

→ LL1. Contribution: Methodology Over Results
→ LL2. Population: Size Over Experience
→ LL3. Design: Freedom Over Imposition
→ LL4. Execution: Imposition Over Freedom
→ LL5. Objects: Intended Artificiality Over Aimed Realism
→ LL6. Pilot Studies for Subjects and Researchers
→ LL7. Pilot Studies and Replications
→ LL8. Interviews for Triangulating Results
→ LL9. Gathering Qualitative Data to Explain Quantitative Data
→ LL10. Attracting Practitioners as Participants

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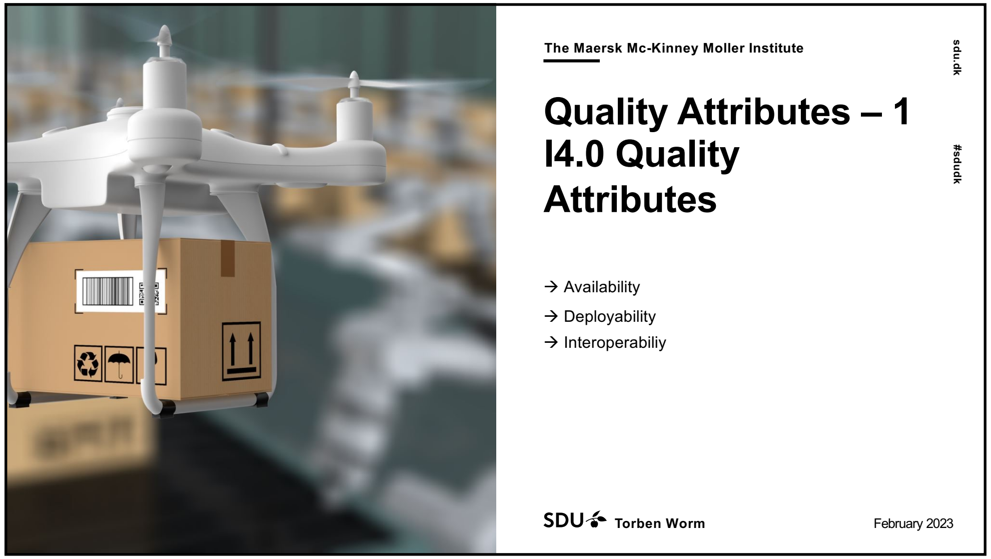

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Quality Attributes – 1 I4.0 Quality Attributes

→ Availability
→ Deployability
→ Interoperabiliy

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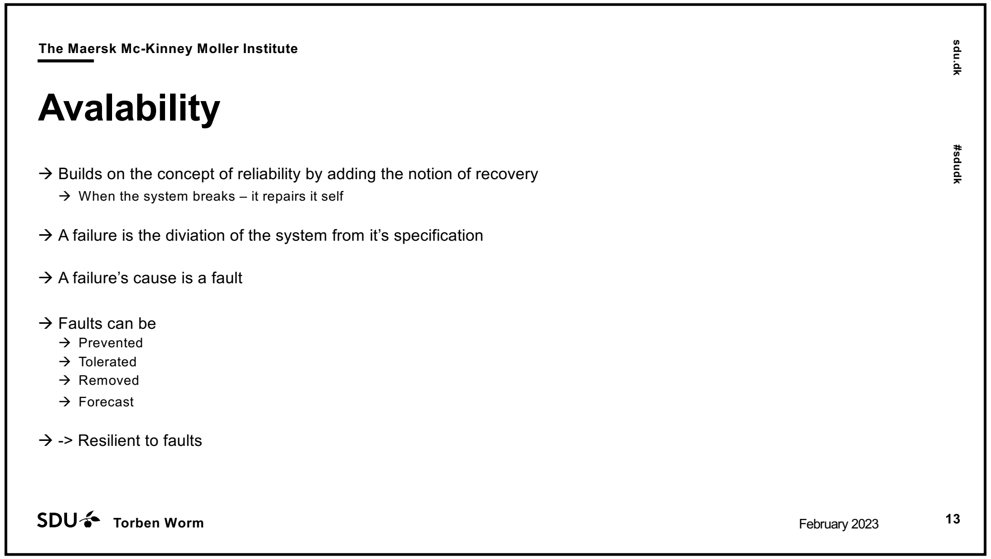

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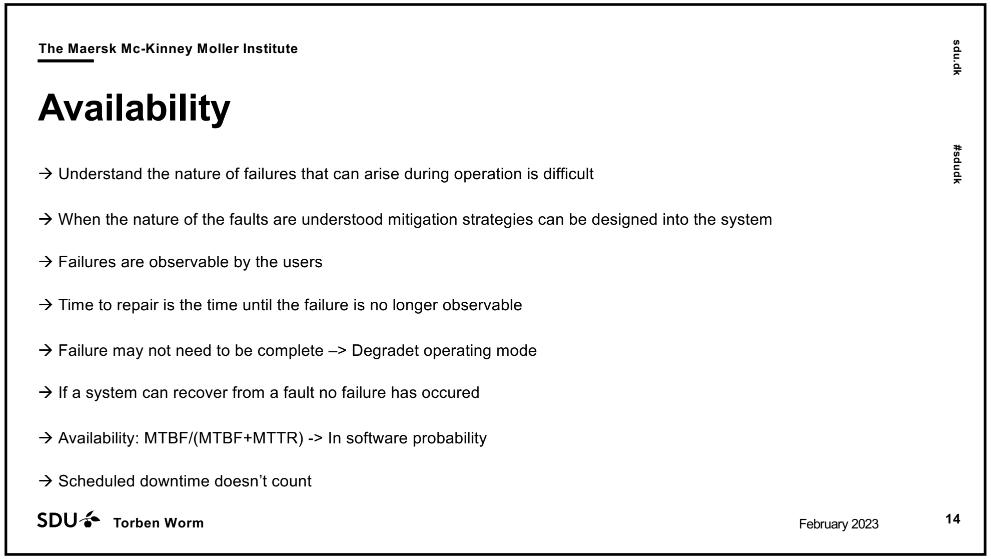
Avalability

- → Builds on the concept of reliability by adding the notion of recovery
  - → When the system breaks – it repairs it self
- → A failure is the diviation of the system from it's specification
- → A failure's cause is a fault
- → Faults can be
  - → Prevented
  - → Tolerated
  - → Removed
  - → Forecast
- → -> Resilient to faults



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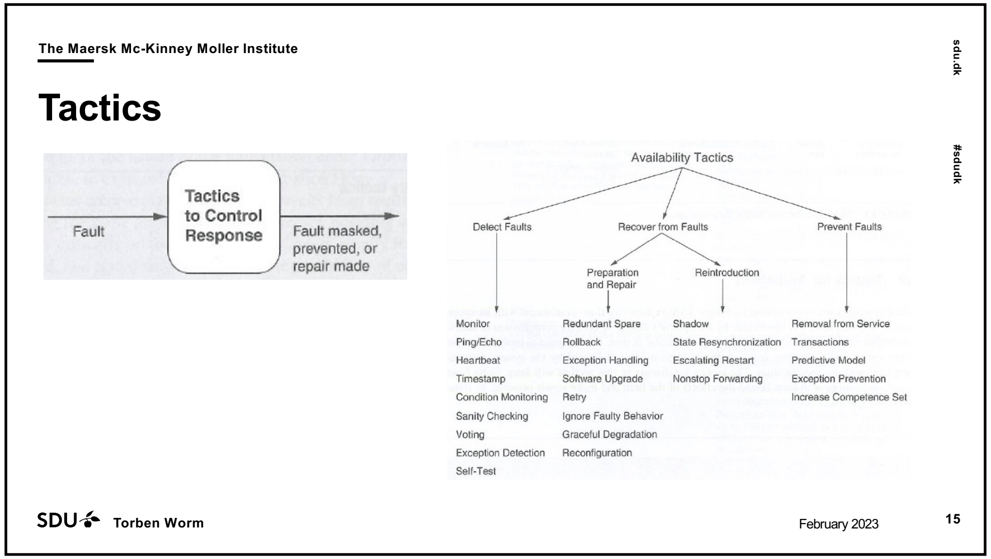
Availability

- → Understand the nature of failures that can arise during operation is difficult
- → When the nature of the faults are understood mitigation strategies can be designed into the system
- → Failures are observable by the users
- → Time to repair is the time until the failure is no longer observable
- → Failure may not need to be complete –> Degradet operating mode
- → If a system can recover from a fault no failure has occured
- → Availability: MTBF/(MTBF+MTTR) -> In software probability
- → Scheduled downtime doesn't count



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Tactics

Fault

Tactics to Control Response

Fault masked, prevented, or repair made

Availability Tactics

Detect Faults

Recover from Faults

Prevent Faults

Preparation and Repair

Reintroduction

Monitor
Ping/Echo
Heartbeat
Timestamp
Condition Monitoring
Sanity Checking
Voting
Exception Detection
Self-Test

Redundant Spare
Rollback
Exception Handling
Software Upgrade
Retry
Ignore Faulty Behavior
Graceful Degradation
Reconfiguration

Shadow
State Resynchronization
Escalating Restart
Nonstop Forwarding

Removal from Service
Transactions
Predictive Model
Exception Prevention
Increase Competence Set

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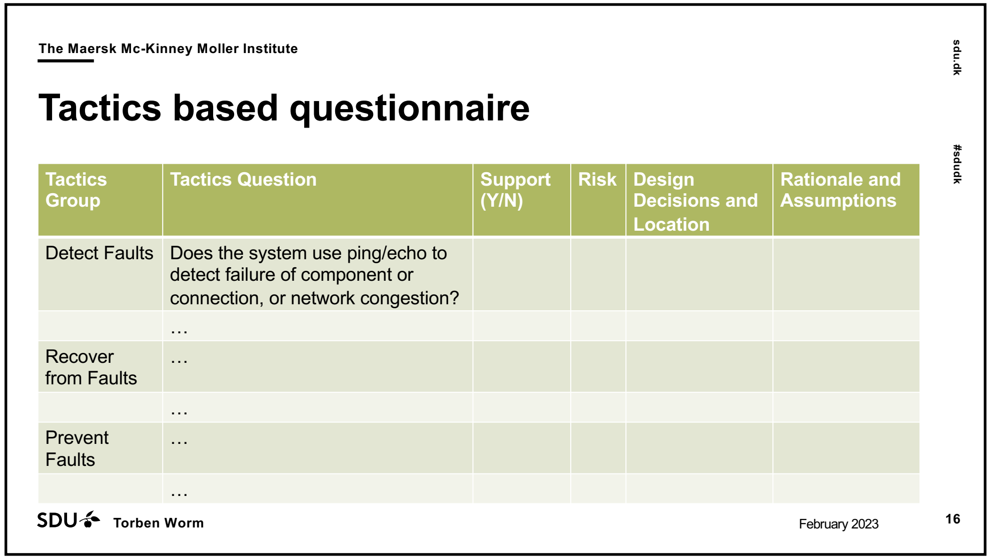

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Tactics based questionnaire

Tactics Group	Tactics Question	Support (Y/N)	Risk	Design Decisions and Location	Rationale and Assumptions
Detect Faults	Does the system use ping/echo to detect failure of component or connection, or network congestion?				
	…				
Recover from Faults	…				
	…				
Prevent Faults	…				
	…				

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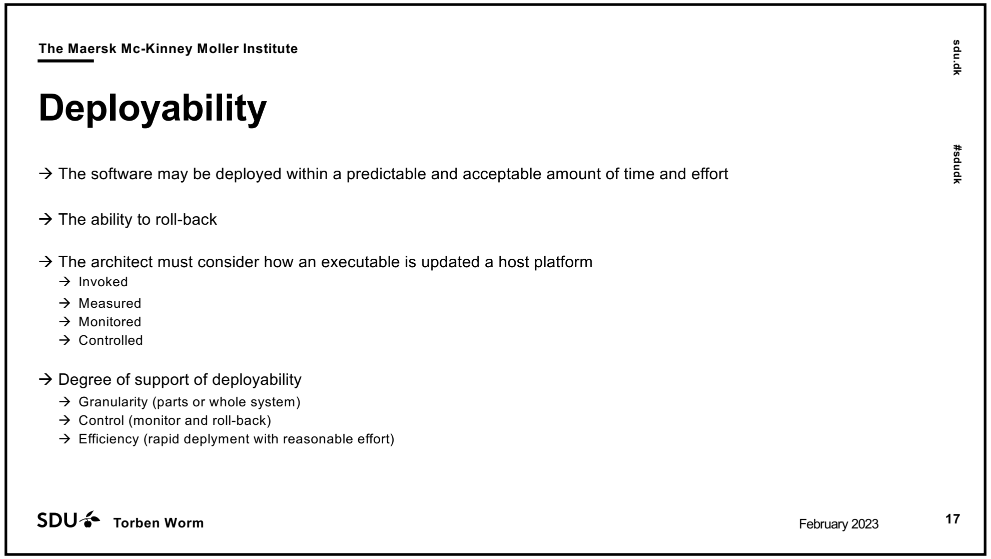


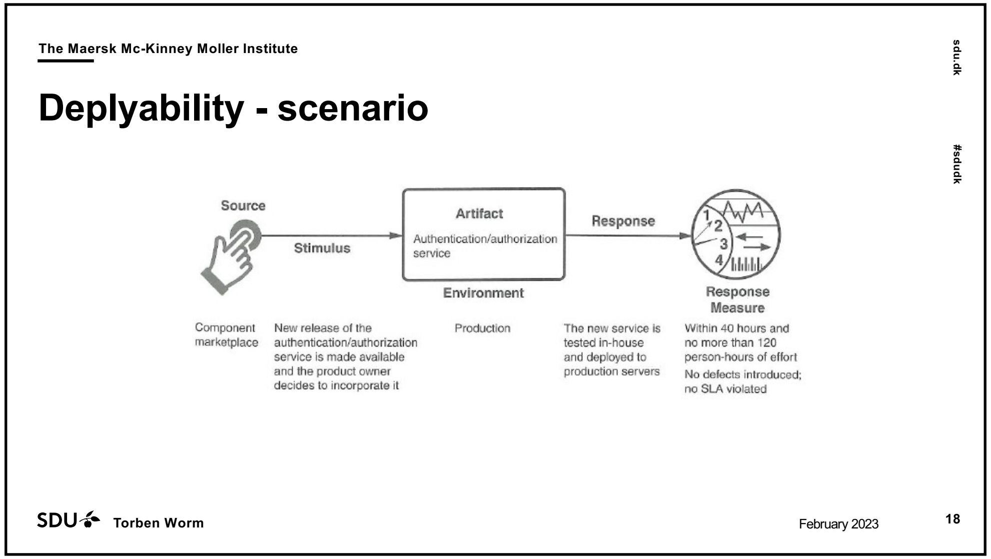
Deployability

→ The software may be deployed within a predictable and acceptable amount of time and effort

→ The ability to roll-back

→ The architect must consider how an executable is updated a host platform
  - → Invoked
  - → Measured
  - → Monitored
  - → Controlled

→ Degree of support of deployability
  - → Granularity (parts or whole system)
  - → Control (monitor and roll-back)
  - → Efficiency (rapid deplyment with reasonable effort)

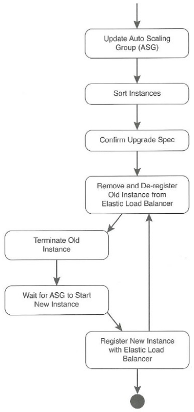


Deplyability - scenario

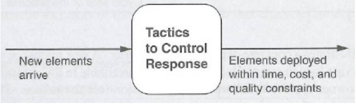
Source	Stimulus	Artifact	Environment	Response	Response Measure
Component marketplace	New release of the authentication/authorization service is made available and the product owner decides to incorporate it	Authentication/authorization service	Production	The new service is tested in-house and deployed to production servers	Within 40 hours and no more than 120 person-hours of effort No defects introduced; no SLA violated

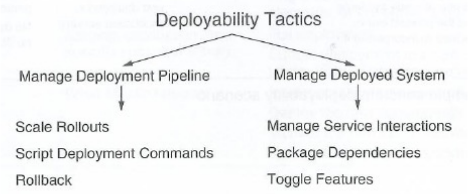
Patterns

- → Structure
  - → Microservice architecture
- → Complete replacement of services
  - → Blue/green
  - → Rolling upgrade
- → Partial replacement of services
  - → Canary testing
  - → A/B testing


Update Auto Scaling Group (ASG)
Sort Instances
Confirm Upgrade Spec
Remove and De-register Old Instance from Elastic Load Balancer
Terminate Old Instance
Wait for ASG to Start New Instance
Register New Instance with Elastic Load Balancer

Tactics


New elements arrive
Tactics to Control Response
Elements deployed within time, cost, and quality constraints



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Interoperability

→ Interoperability is about the degree to which two or more systems can usefully exchange meaningful information via interfaces in a particular context

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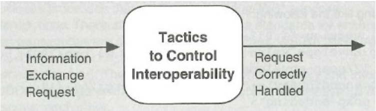
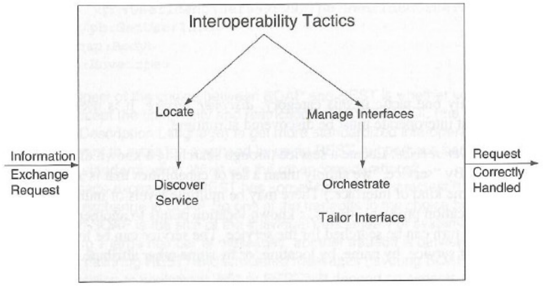
Tactics





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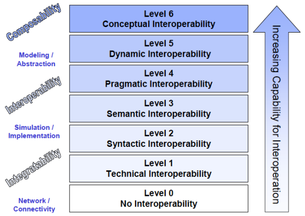
Levels of interoperability


Composability
Modeling / Abstraction
Interoperability
Simulation / Implementation
Integratability
Network / Connectivity
Level 6
Conceptual Interoperability
Level 5
Dynamic Interoperability
Level 4
Pragmatic Interoperability
Level 3
Semantic Interoperability
Level 2
Syntactic Interoperability
Level 1
Technical Interoperability
Level 0
No Interoperability
Increasing Capability for Interoperation

→ Level 0: Stand-alone systems have No Interoperability

→ Level 1: On the level of Technical Interoperability, a communication protocol exists for exchanging data between participating systems

→ Level 2: The Syntactic Interoperability level introduces a common structure to exchange information, i.e., a common data format is applied

→ Level 3: If a common information exchange reference model is used, the level of Semantic Interoperability is reached

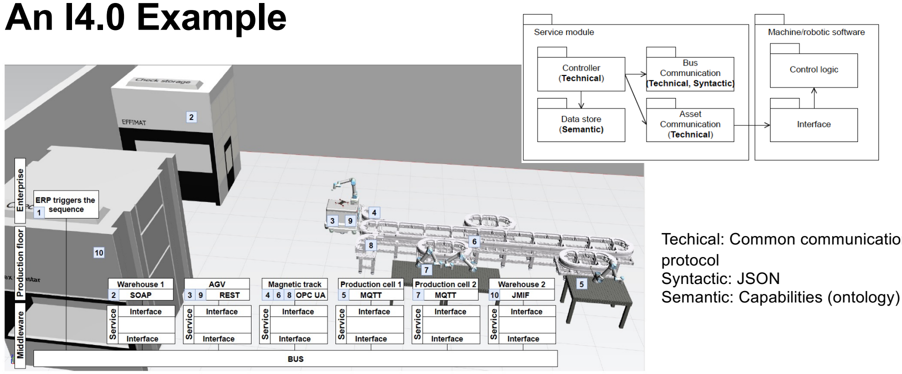
→ Level 4: Pragmatic Interoperability is reached when the interoperating systems are aware of the methods and procedures that each other are employing

→ Level 5: Dynamic Interoperability means the systems are able to comprehend the state changes that occur in the assumptions and constraints that each other is making over time, and are able to take advantage of those changes

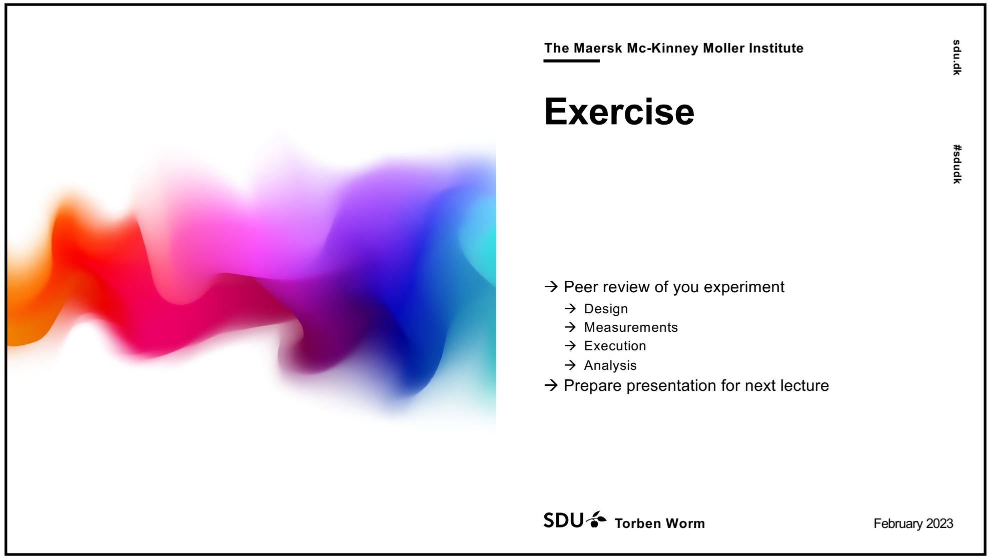
→ Level 6: Conceptual Interoperability requires a "fully specified but implementation independent model"

[Tolk, 2007]

An I4.0 Example



Techical: Common communication protocol
Syntactic: JSON
Semantic: Capabilities (ontology)



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Exercise

- → Peer review of you experiment
  - → Design
  - → Measurements
  - → Execution
  - → Analysis
- → Prepare presentation for next lecture

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End of Presentation

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