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Use Cases and Non-functional Requirements Presented in Compact System Description A3s

Anders Fuglesteg Nilsen, HBV and Devotek
Gerrit Muller, HBV

Agenda

- Introduction
- Problem statement
- The system of interest
- The method
- Evaluation
- Conclution and further work

Introduction

The author

- B.sc in in industrial automation
- M.sc in systems engineering
- Researched an ongoing project in Kongsberg Devotek

Kongsberg Devotek

- Independent product development company
- Located in Kongsberg Norway

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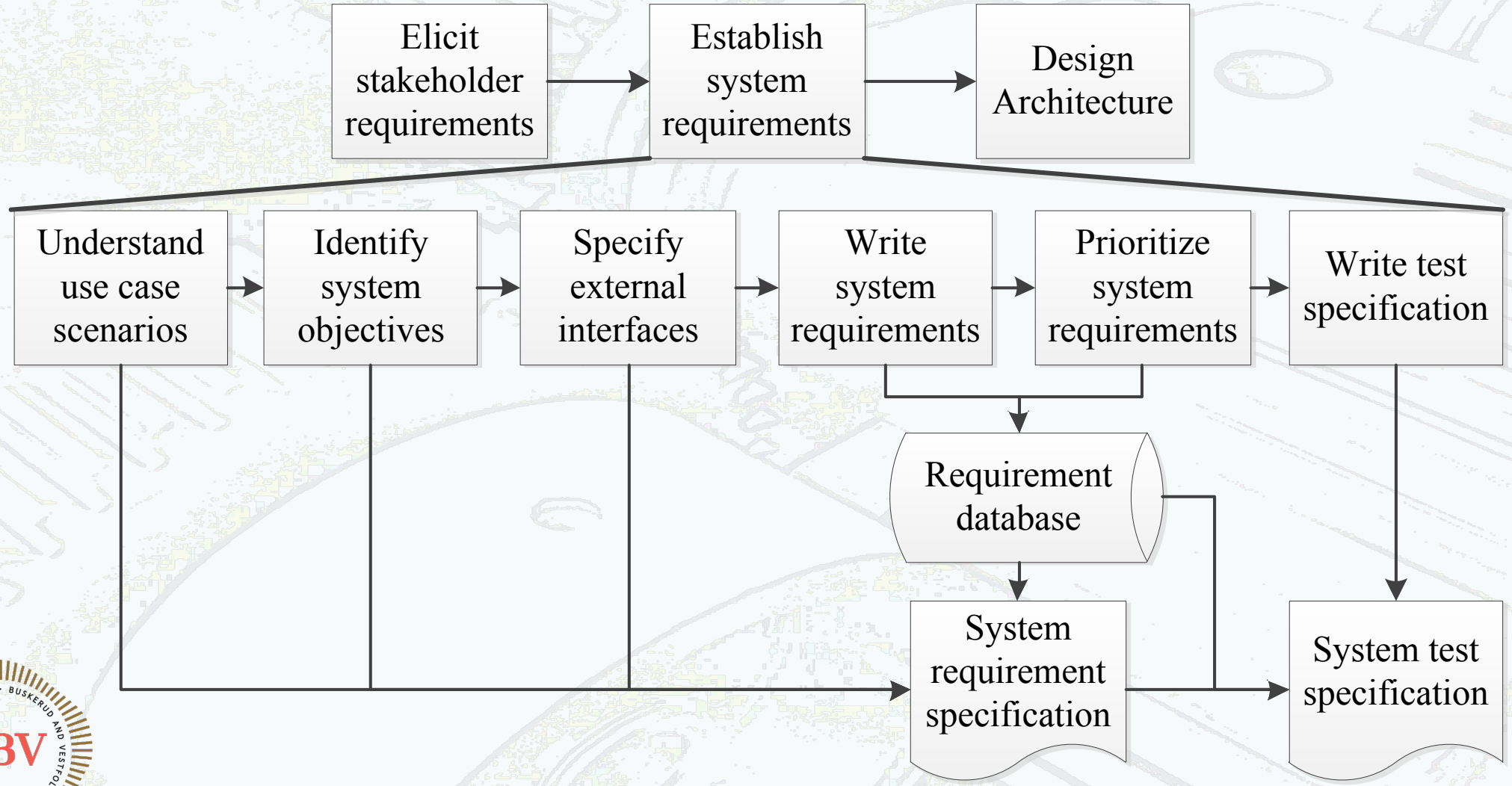
Problem Statement

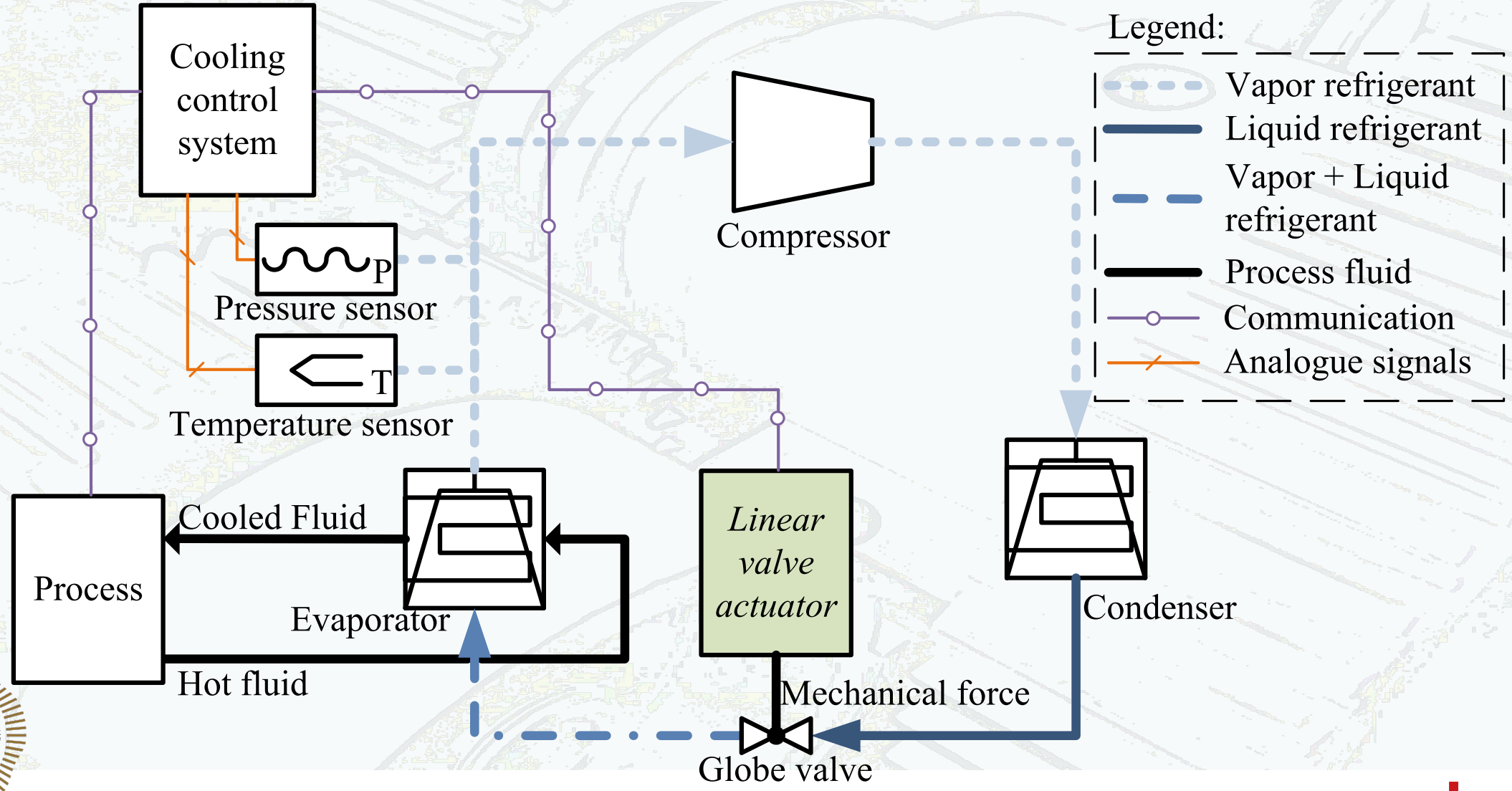
- System architects fail to establish all relevant performance requirements
- Leads to loopbacks in design
- Requirement specifications does not receive sufficient feedback from customer/stakeholders

- Use case modelling combined with Non-Functional Requirements (NFRs) expected to capture more relevant performance requirements
- Compact system description A3s expected to increase feedback from stakeholders/customers

Current Way of Working



System of Interest – The Context



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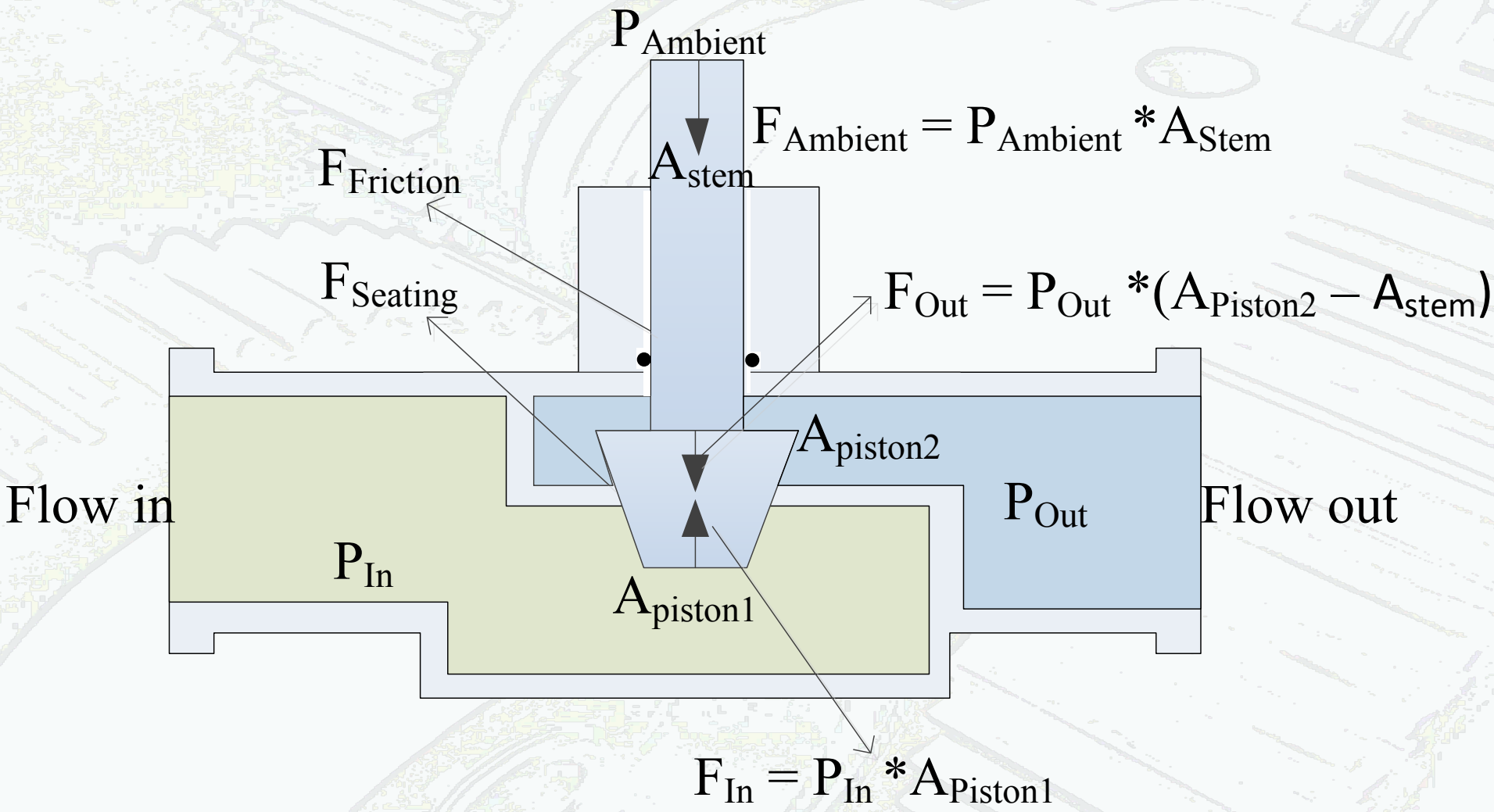
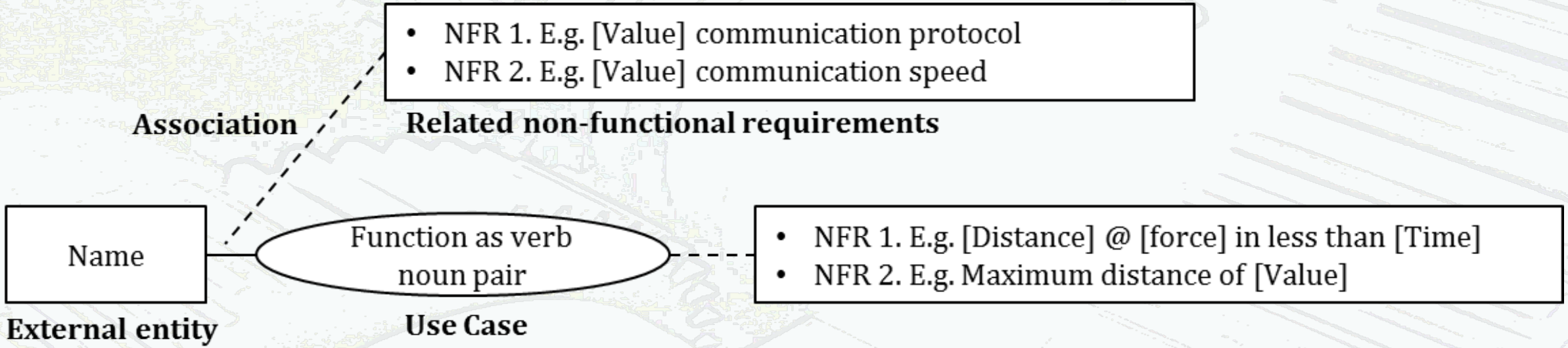
System of Interest - Forces



Use Case Modelling and NFRs



Boundary conditions

- NFR 1. E.g. [Value]°C ambient temperature
- NFR 2. E.g. [Range]Hz with ± [Value]mm displacement vibrations

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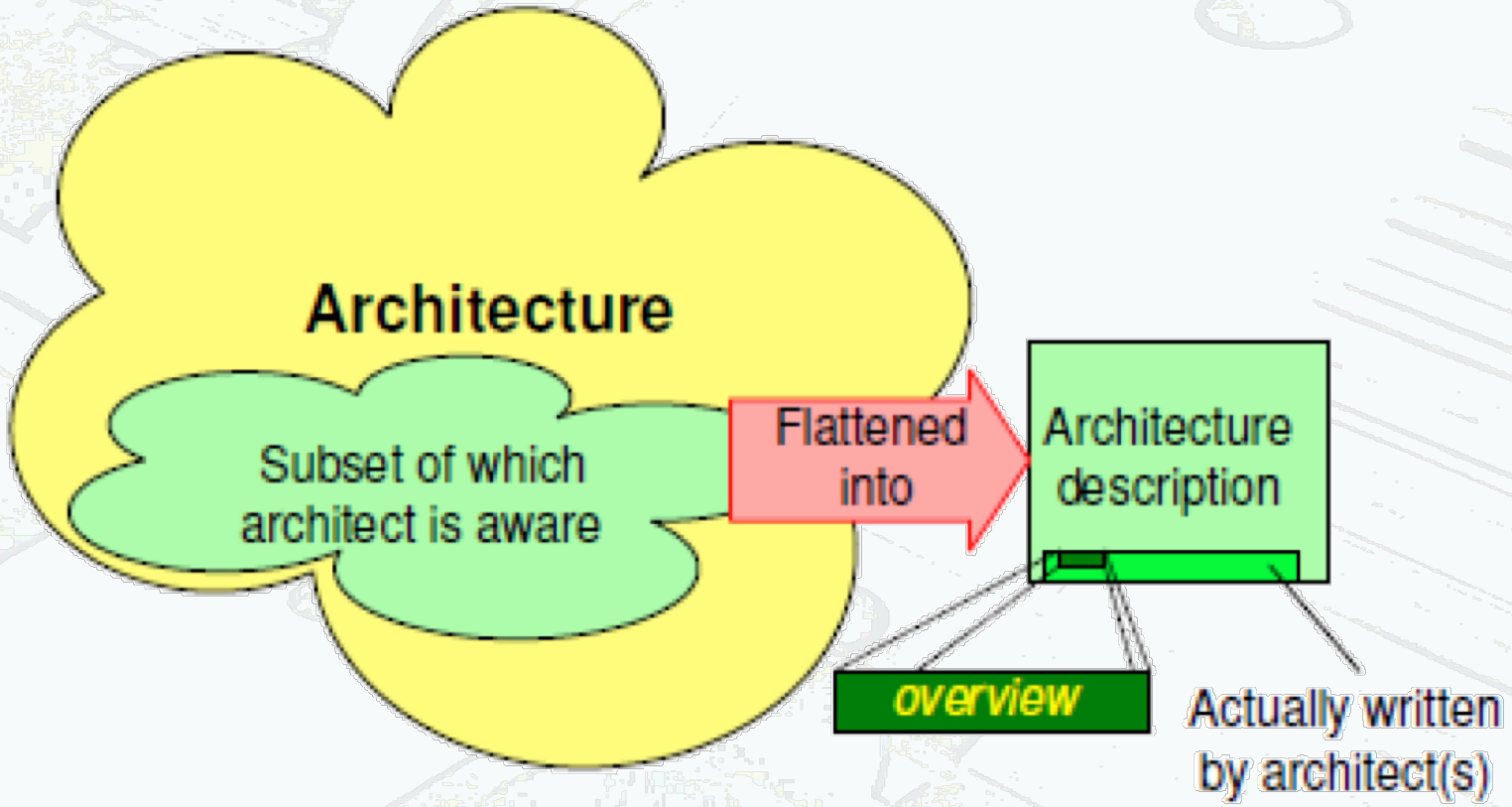
Architecture Overview



Muller 2013, http://www.gaudisite.nl/OverviewHowToPaper.pdf

System Description A3 Template

Doc.nr: Author: Project & task:
Issue: Responsible: Date:

Name of system

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Locate system of interest in higher level of hierarchy

Explain abbreviations and definitions

Explain the design strategy for the system. E.g. Which system qualities shall receive most attention

Background or rationale for working on this component.

Illustrate the system and briefly highligh the components

Show the system in it's intended context

Functional view
- Use case modeling combined with non-functional requirements
- Functional flow diagram

Timing aspects
System characteristics
Other important information...

List concerns and possible mitigations to keep focus on currently known issues

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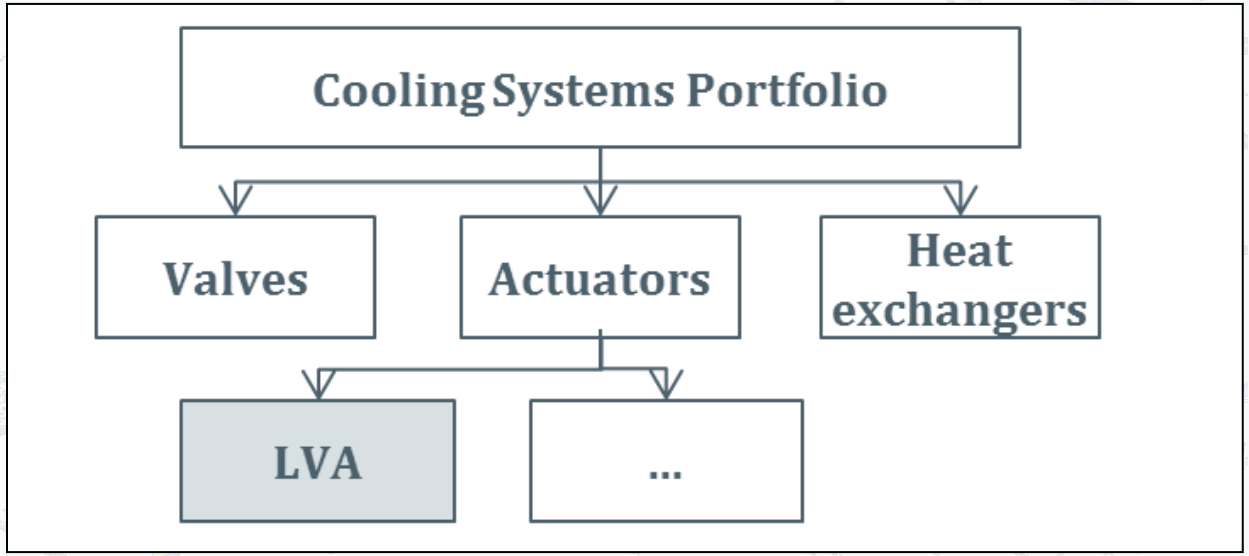
Product Portfolio View

Locates system in customers portfolio

Serves as navigational map when representing a set of related A3s together



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Definitions View

Make it easier to create nice diagrams

In a set of related A3s, only one page should contain definitions

Ctrl.	-	Control
Mvt.	-	Movement
PV	-	Process Value (% valve opening)
Pwr.	-	Power
SP	-	Set Point (% valve opening)
TBC	-	To Be Confirmed
TBD	-	To Be Decided

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Design Strategy View

Direct focus in concept selection

- ❑ High efficiency and reliability
- ❑ Modular design
- ❑ Smaller, lighter and cheaper than competing products.

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Background View

Why do the customer need this project

Why does the system need this component

- ❑ Cooling Systems are expanding their product portfolio with actuators that can operate their valves
- ❑ First actuator to be developed is the linear valve actuator.

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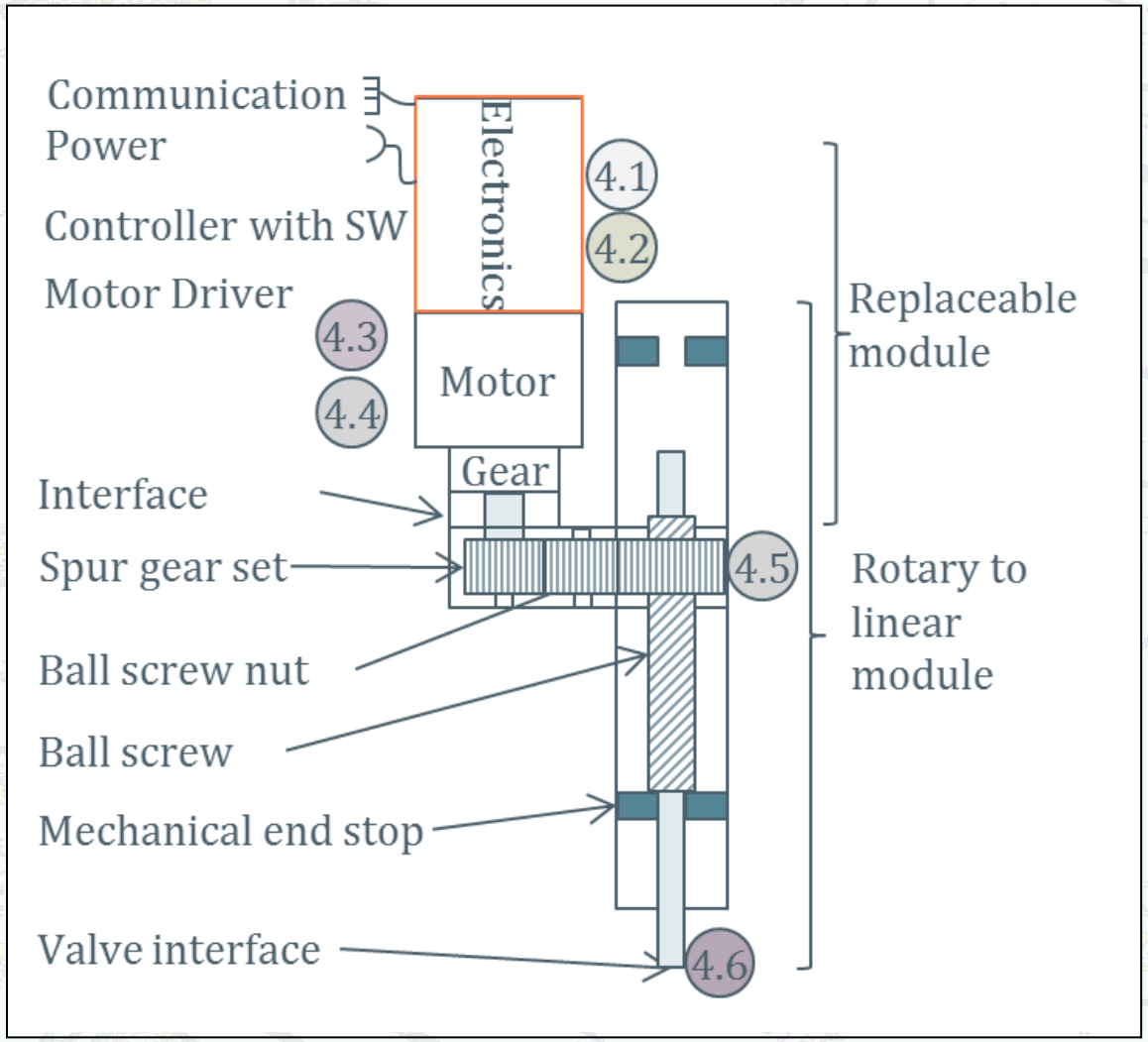
Physical Diagram

Should give the reader an immidiate impression on the topic of the A3

Should be as visual and as close to the actual realization of the system as possible



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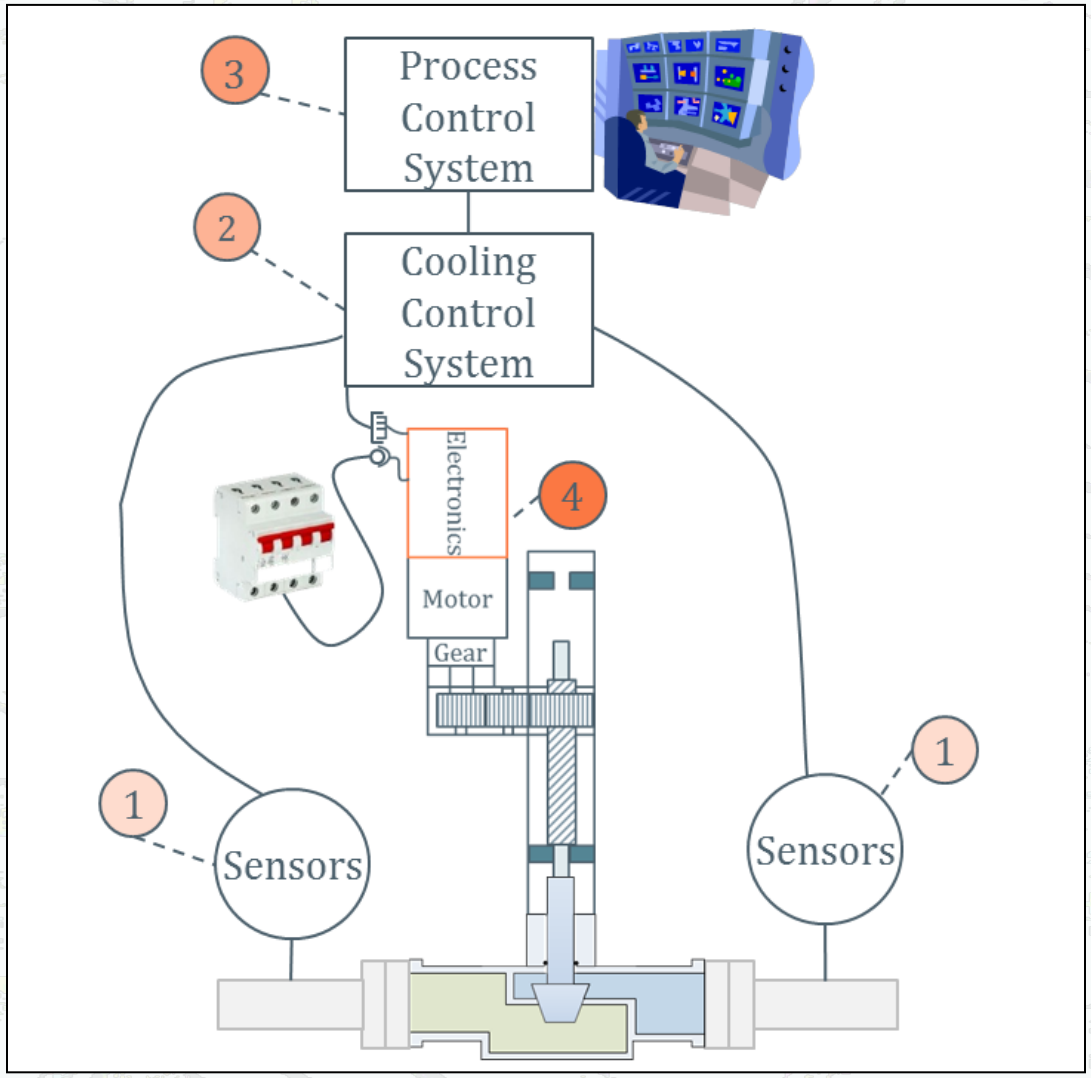
Context Diagram

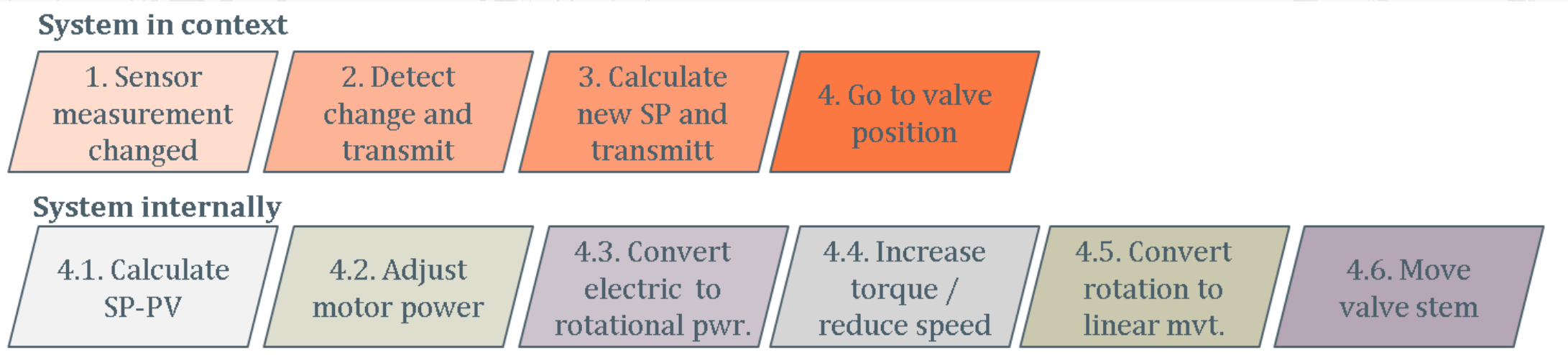
Visual illustration of the system in context

Shows external interfaces



Functional Flow

What does the system do in its context and how is that function realized inside the system



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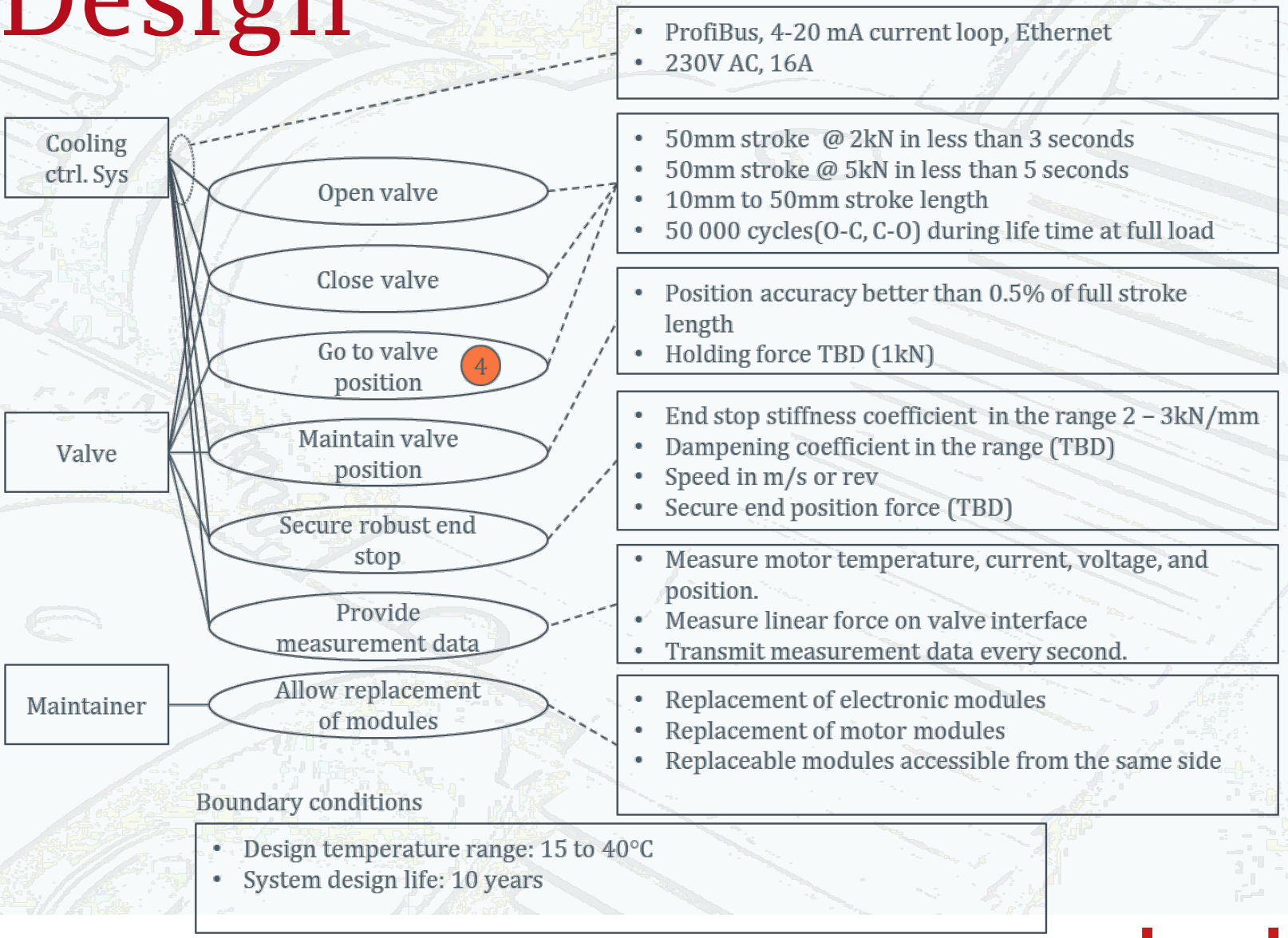
Functional Design

Contains the most important system requirements

NFRs is connected directly to functions



Boundary conditions

- Design temperature range: 15 to 40°C
- System design life: 10 years

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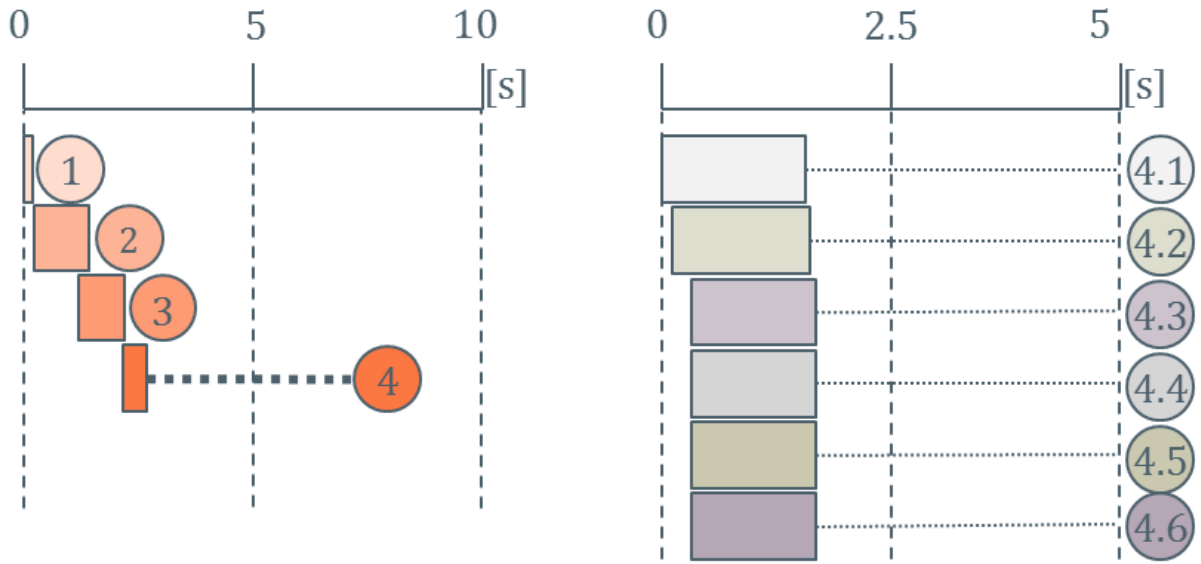
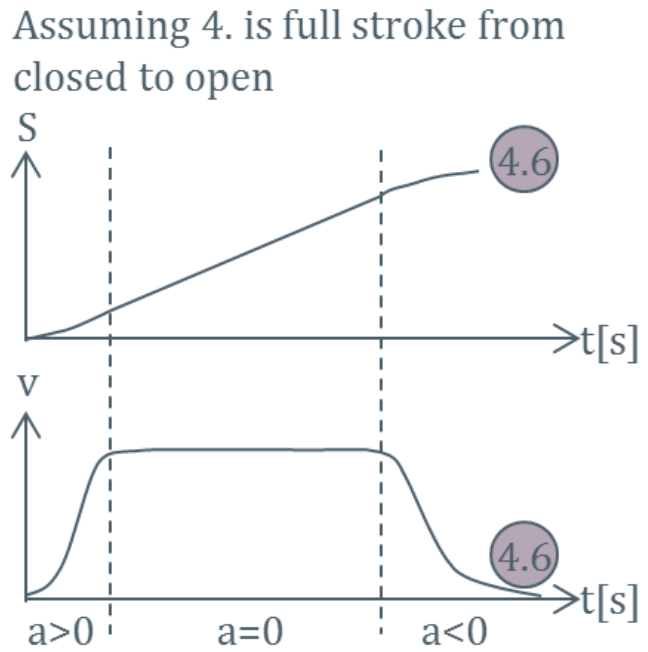
Timing Diagram

Timing on several levels of system hierarchy





Concerns and Mitigations

Capture concerns that needs to be handled in design of the system

Concern	Mitigation
The duty cycle of the actuator is determined by control loop outside system boundary. Continous operation with small changes in actuator set point is expected. Friction loss will be converted to heat.	Design the actuator with as high efficiency as possible to reduce friction loss.

Doc.nr: Author: Project & task:

Issue: Responsible: Date:

Linear Valve Actuator (LVA)

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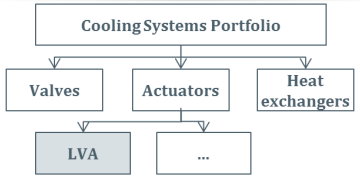
Product Portfolio



Definitions

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Design Strategy

- ❑ High efficiency and reliability
- ❑ Modular design
- ❑ Smaller, lighter and cheaper than competing products.

Background

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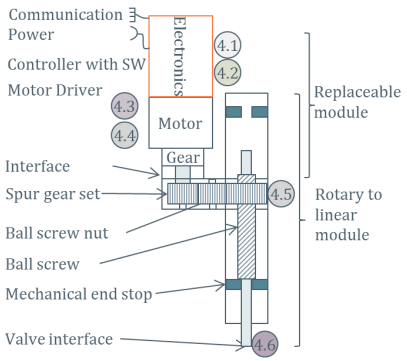
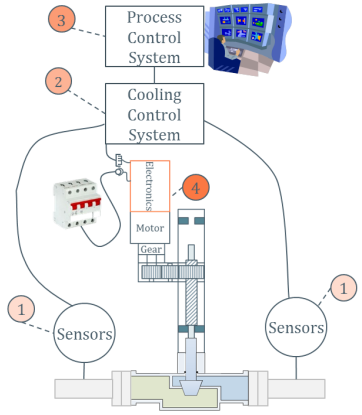
Physical Diagram



Context Diagram



Functional Flow

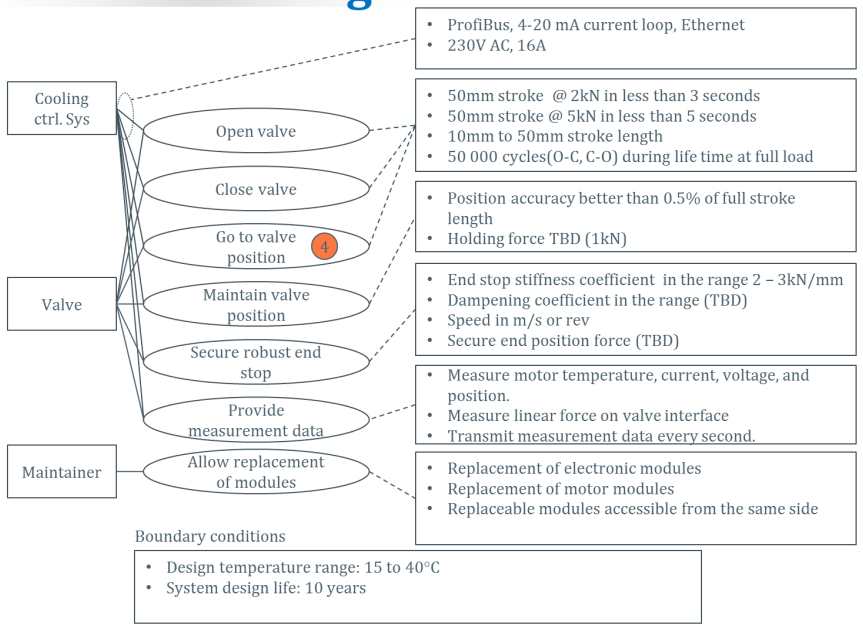
System in context

1. Sensor measurement changed
2. Detect change and transmit
3. Calculate new SP and transmitt
4. Go to valve position

System internally

4.1. Calculate SP-PV
4.2. Adjust motor power
4.3. Convert electric to rotational pwr.
4.4. Increase torque / reduce speed
4.5. Convert rotation to linear mvt.
4.6. Move valve stem

Functional Design



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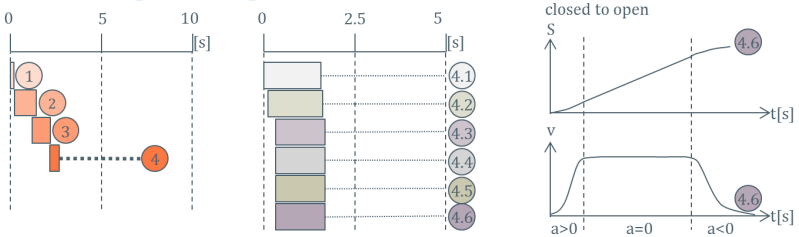
Timing Diagram



Assuming 4. is full stroke from closed to open

Conserns & Mitigations

Concern	Mitigation
The duty cycle of the actuator is determined by control loop outside system boundary. Continous operation with small changes in actuator set point is expected. Friction loss will be converted to heat.	Design the actuator with as high efficiency as possible to reduce friction loss.

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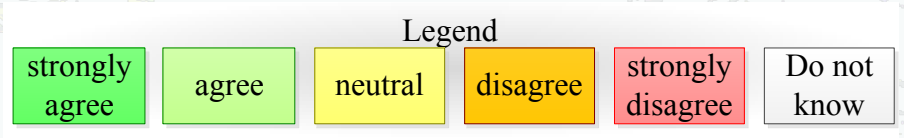
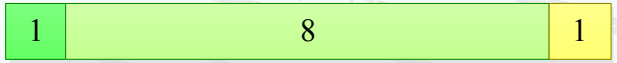
Evaluation

Use cases combined with NFRs



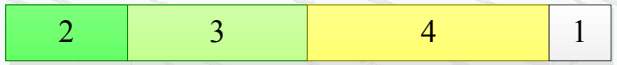
1. Use case modeling combined with non-functional requirements help capture the performance aspect of the system

2. Use case modeling combined with non-functional requirements communicate the requirements well

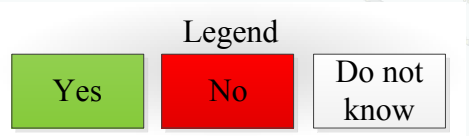


3. Use case modeling combined with non-functional requirements provides input to the system requirement specification, which might otherwise be forgotten

4. Use case modeling combined with non-functional requirements can help you discover performance requirements in future projects



5. Use case modeling combined with non-functional requirements communicate functional and performance requirements better than requirements specification documents used today



6. I will use use case modeling combined with non-functional requirements to discover missing performance requirements and communicate them to stakeholders in future projects

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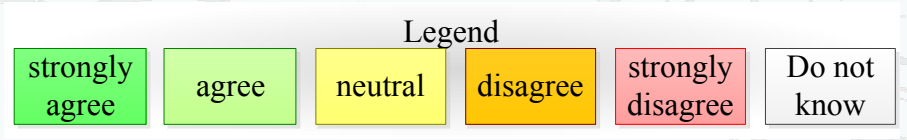
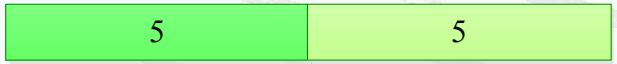
Evaluation

Compact system description A3



7. The A3 communicates the most important aspects of the system well

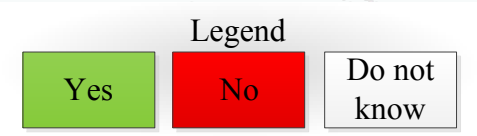


8. The A3 will receive more feedback than a PowerPoint presentation containing the same information on several slides

9. It is easier to understand single viewpoints of the system, e.g. Functional design, when shown together with other system viewpoints.

10. It is easier to provide feedback on A3 reports than requirement specification documents.

11. Graphical models communicate the system architecture better than text descriptions



12. I will use compact system description A3s to communicate the system architecture in future projects

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Derived Requirements

50mm stroke @ 2kN force in less than 3 seconds
50mm stroke @ 5kN force in less than 5 seconds
50 000 cycles (O-C, C-O) during life time at full load
Holding force TBD (1kN)
End stop stiffness coefficient in the range 2 - 3kN/mm
Dampening coefficient in the range (TBD)
Speed in m/s or rev
Secure end position force (TBD)

Conclusions

Survey participants view on use cases combined with NFRs

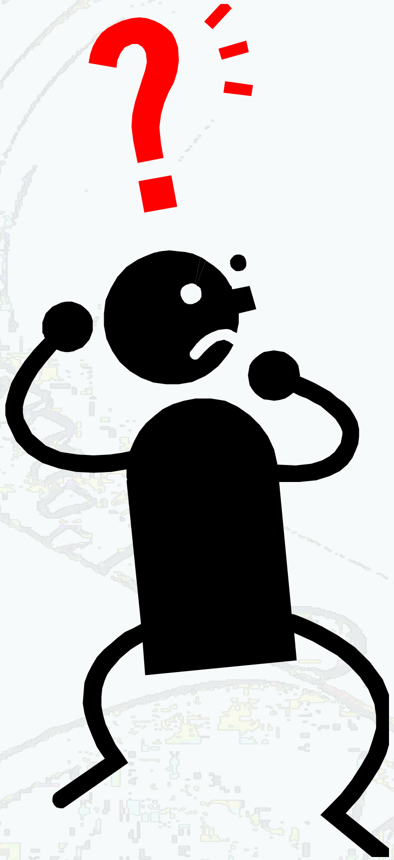
- Can help capture the performance aspect of the system
- Communicated the functional and performance aspect better than requirement specification documents
- Does not communicate requirements well
- Does not provide input to system requirement specification
- Does not help them discover performance requirements in future projects
- Eight requirements where derived using the method

Conclusions

Survey participants view on compact system description A3s

- Communicate the most important aspects of the system well
- Makes it easier to understand single viewpoints of the system when shown together with other system viewpoints
- Makes it easier to provide feedback compared with requirement specification documents
- Graphical models communicate the system architecture better than text descriptions

Questions



Future Research

Representation of the Use case combined with NFRs diagram

Measure requirement changes due to gained knowledge from using the method

Evaluate method communicated with other mediums