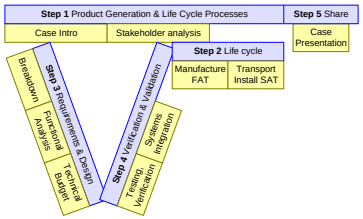
Supplier Systems Engineering Course

by *Gerrit Muller* USN-SE
e-mail: gaudisite@gmail.com
www.gaudisite.nl

Abstract

This course focuses on systems engineering in companies that are supplying to an OEM company.

March 3, 2024
status: draft
version: 0.5



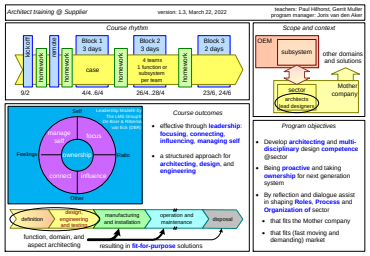
Supplier Systems Engineering Course; Course Info

by *Gerrit Muller* USN-SE
e-mail: gaudisite@gmail.com
www.gaudisite.nl

Abstract

This course focuses on systems engineering in companies that are supplying to an OEM company. This presentation shows the overview, format, and flow of the course.

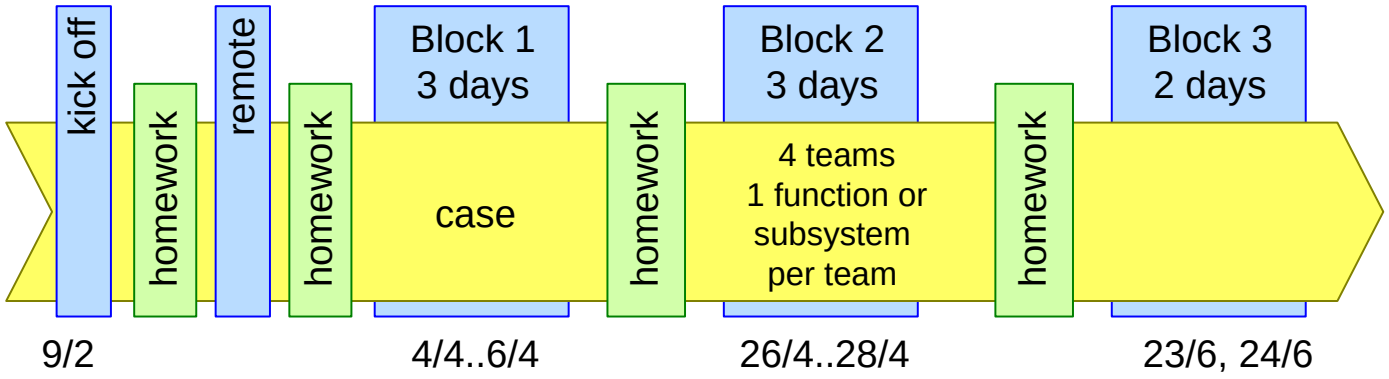
March 3, 2024
status: draft
version: 0.1



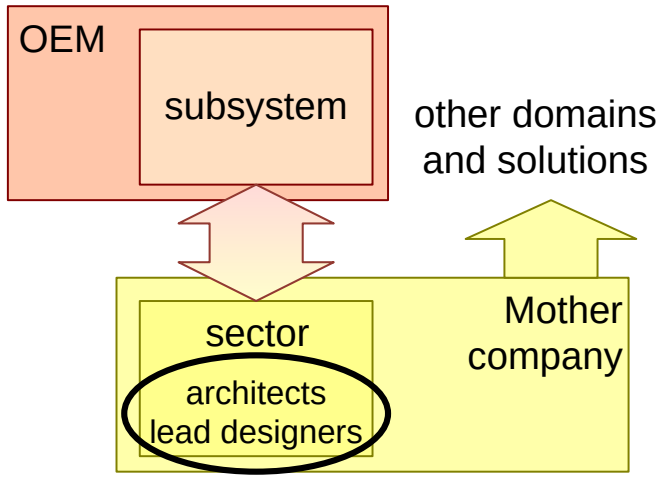
Architect training @ Supplier version: 1.3, March 22, 2022

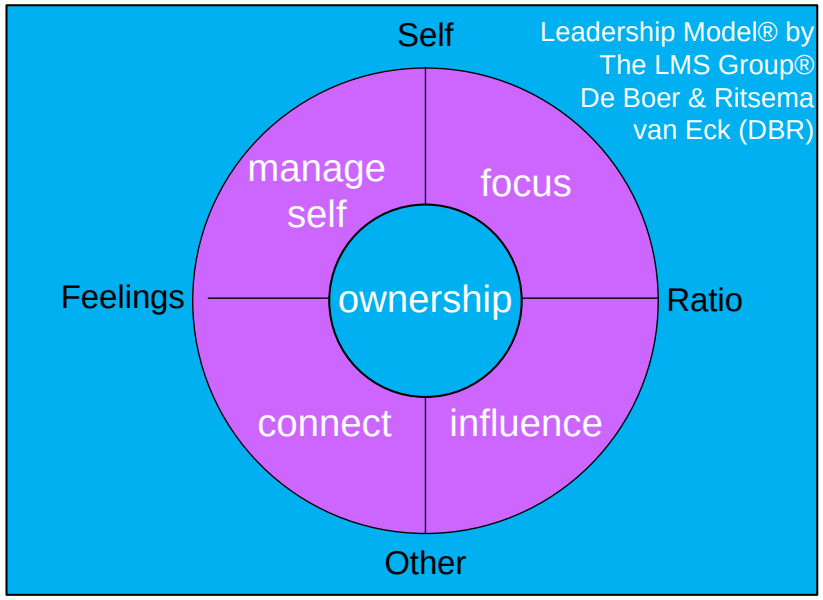
teachers: Paul Hilhorst, Gerrit Muller
program manager: Joris van den Aker

Course rhythm



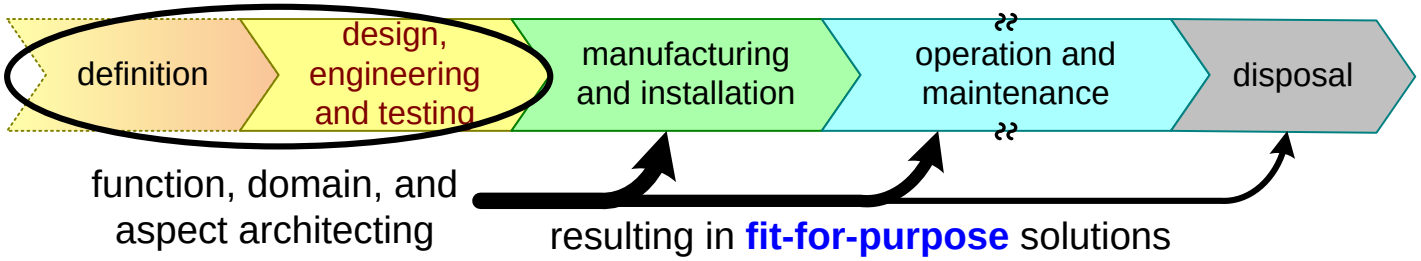
Scope and context





Course outcomes

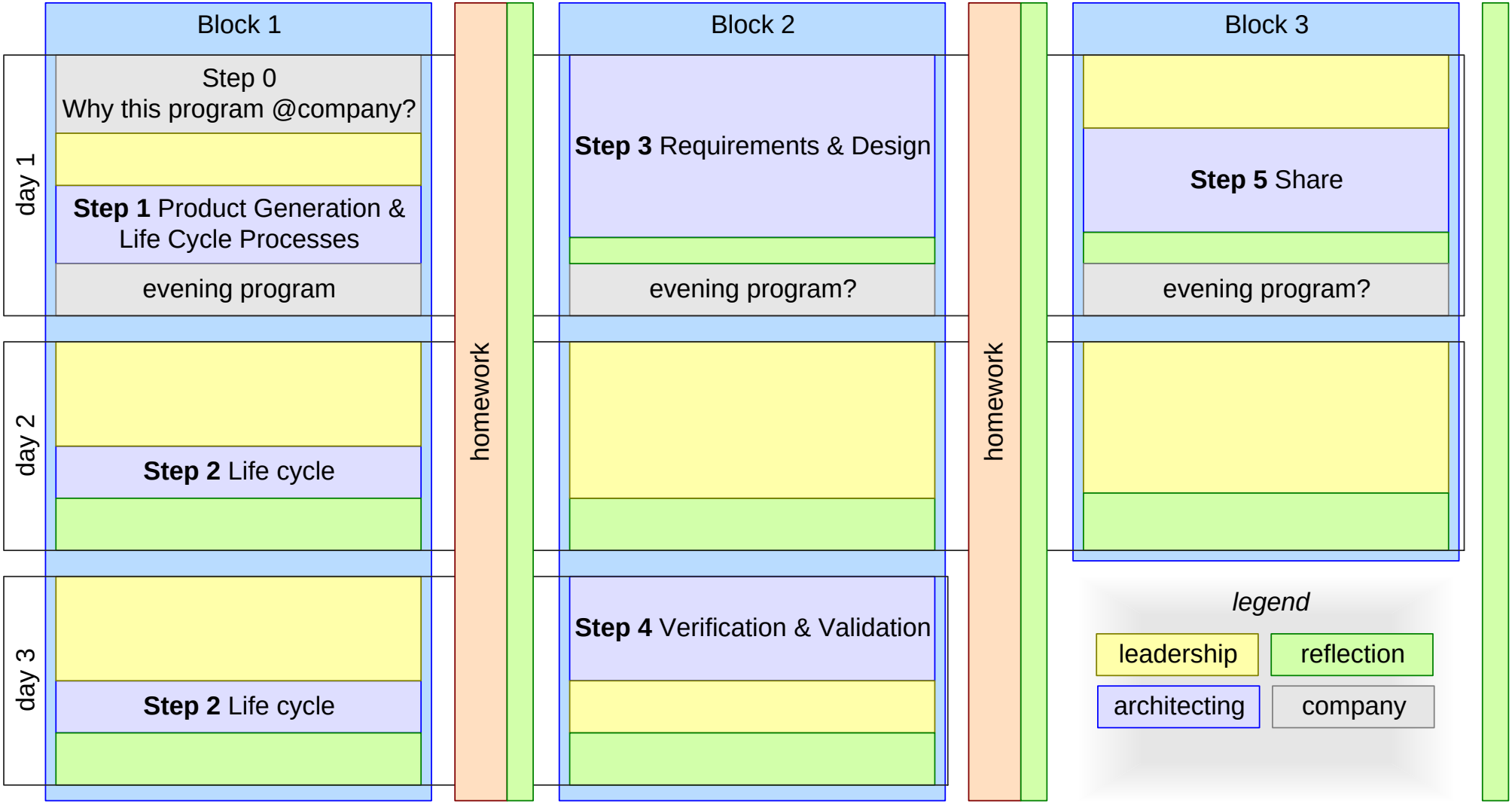
- effective through **leadership**: **focusing**, **connecting**, **influencing**, **managing self**
- a structured approach for **architecting**, **design**, and **engineering**



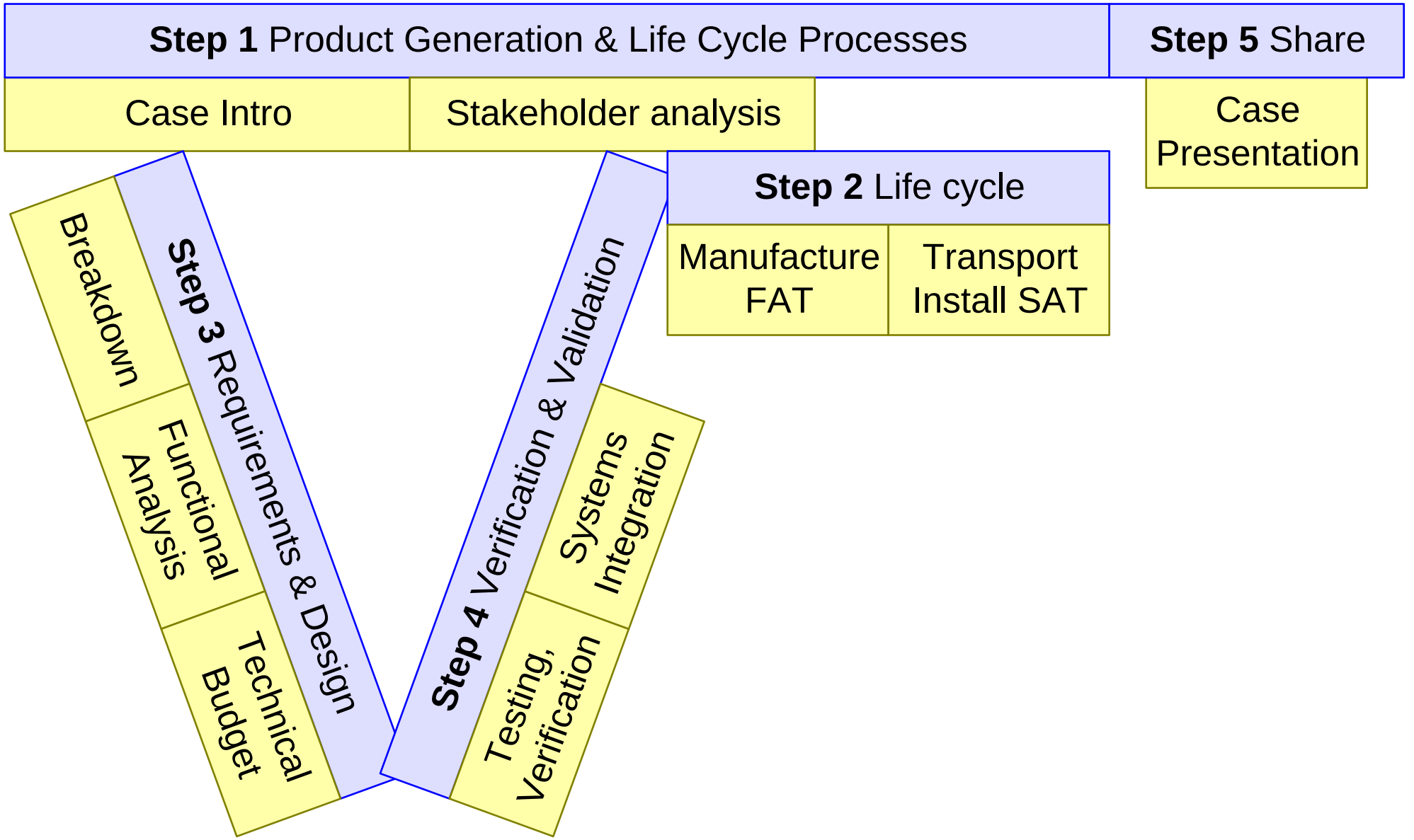
Program objectives

- Develop **architecting** and **multi-disciplinary** design **competence** @sector
- Being **proactive** and taking **ownership** for next generation system
- By reflection and dialogue assist in shaping **Roles**, **Process** and **Organization of** sector
  - that fits the Mother company
  - that fits (fast moving and demanding) market

Program Blocks



Course Flow


Step 1 Product Generation & Life Cycle Processes
Step 5 Share
Case Intro
Stakeholder analysis
Case Presentation
Step 2 Life cycle
Manufacture FAT
Transport Install SAT
Breakdown
Step 3 Requirements & Design
Functional Analysis
Technical Budget
Step 4 Verification & Validation
Systems Integration
Testing, Verification

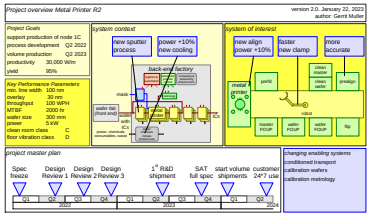
Project Overview How To

by *Gerrit Muller* USN-SE
e-mail: gaudisite@gmail.com
www.gaudisite.nl

Abstract

A project overview shows the overview of a project on a single slide or sheet. The overview helps the team to share the same understanding of scope, objectives, and timeline.

March 3, 2024
status: draft
version: 0.2



Project Overview Canvas

Project Title

meta information, e.g. version, date
author, owner

Project Goals

- specific and quantified

Key Performance Parameters

- specific and quantified

system context

- visualization (drawing, block diagram, 3D model, or photo) of the system context
- indication of changes in the context

system of interest

- visualization (drawing, block diagram, 3D model, or photo) of the system
- indication of changes in the system of interest

project master plan with timeline

- timeline with 5 to 10 milestones, especially deliverables
- specific and quantified

optional information, e.g.

- enabling systems
- stakeholders
- external or internal interfaces
- constraints, e.g. applicable legislation

Example Project Overview

Project overview Metal Printer R2

version 2.0. January 22, 2023
author: Gerrit Muller

Project Goals

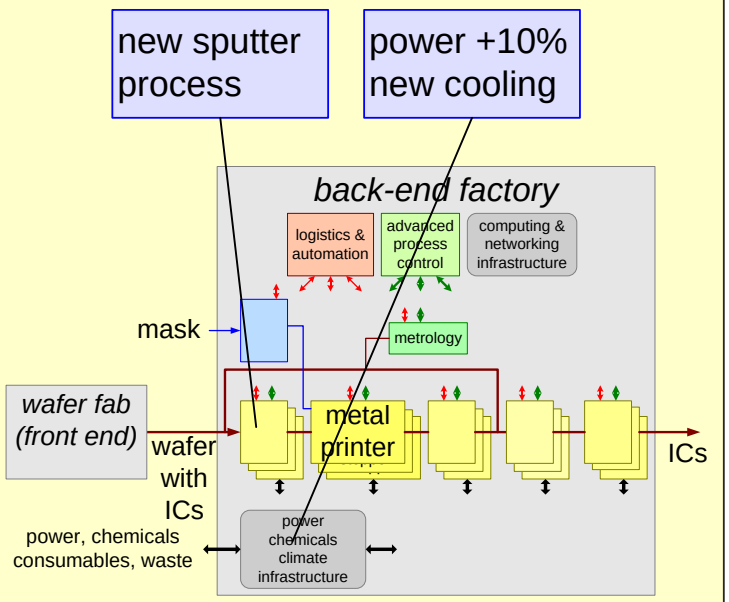
support production of node 1C

process development	Q2 2022
volume production	Q2 2023
productivity	30,000 W/m
yield	95%

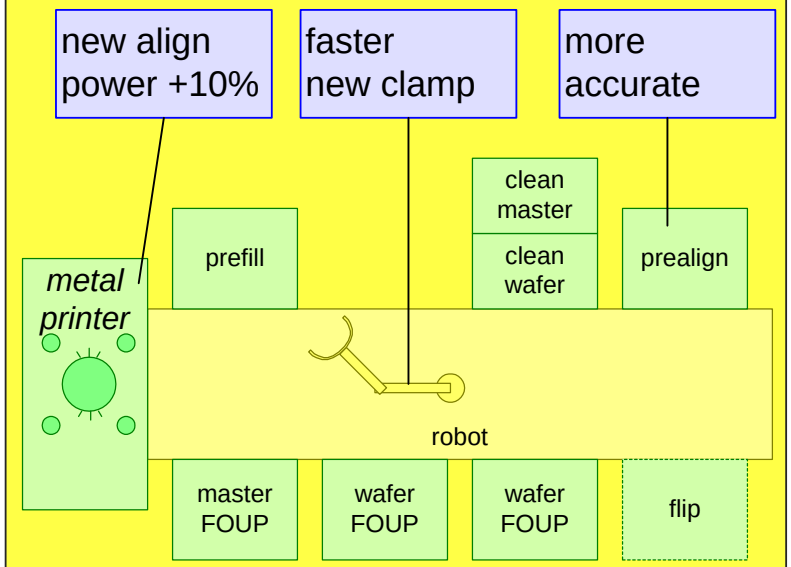
Key Performance Parameters

min. line width	100 nm
overlay	30 nm
throughput	100 WPH
MTBF	2000 hr
wafer size	300 mm
power	5 kW
clean room class	C
floor vibration class	D

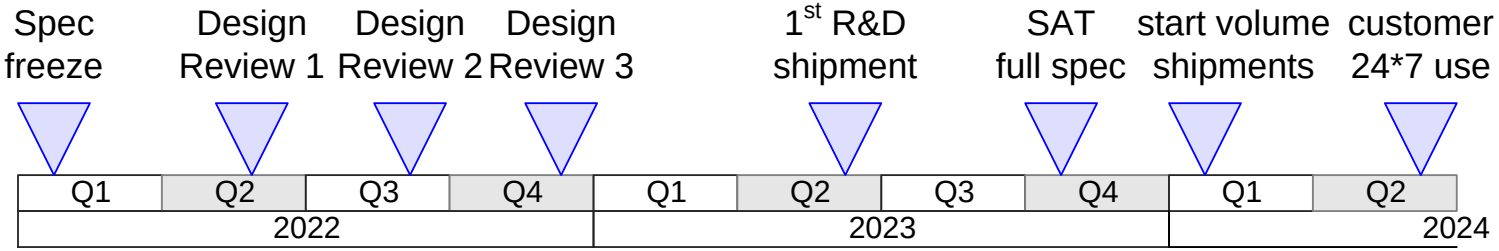
system context



system of interest



project master plan



changing enabling systems

conditioned transport

calibration wafers

calibration metrology

Project Overview Canvas

Project Title

meta information, e.g. version, date
author, owner

Work Breakdown Structure

- visualization
- *builds upon the Product Breakdown Structure*

Project Master Plan

- PERT plan with major milestones

project organization

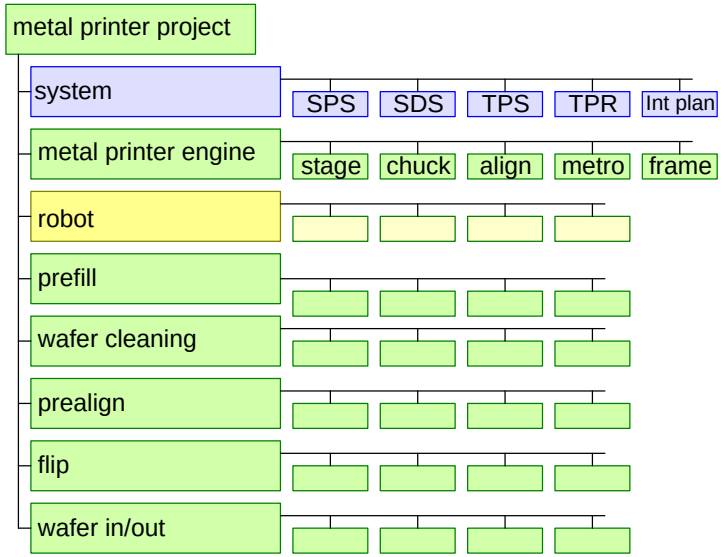
- allocation of roles
- specific additions or deviations

Example Project Overview

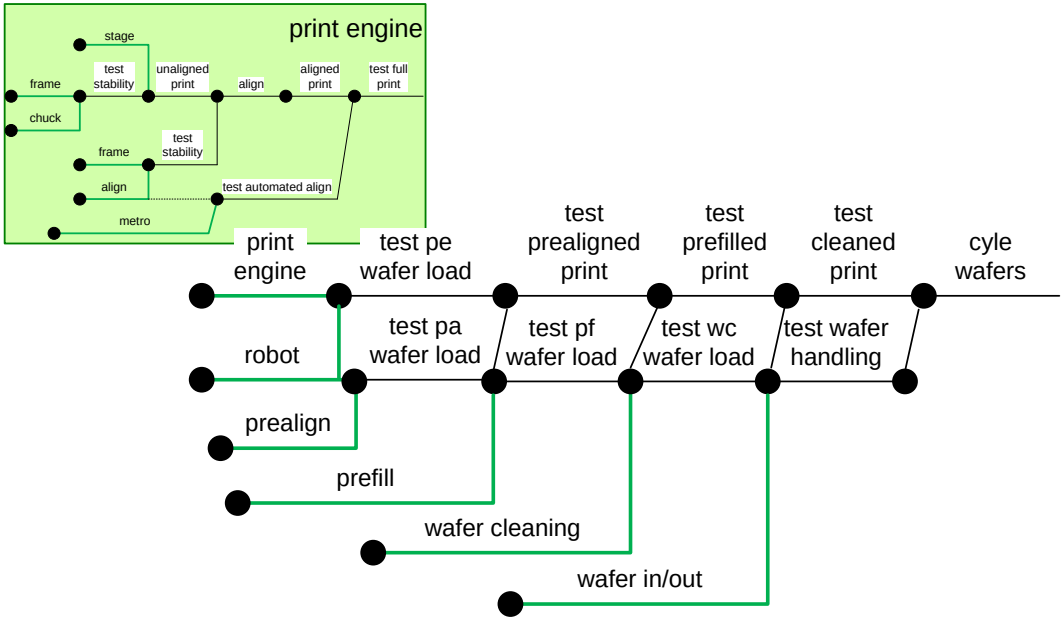
Metal Printer

version 0.1, 2023-02-11
author: Gerrit Muller

Work Breakdown Structure



Project Master Plan



project organization

Project Leader: P.L. Eader

Product Manager: P.M. Anager

Architect: Archie Tect

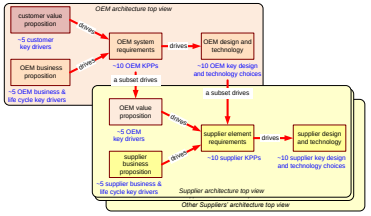
Supplier Systems Engineering Course; OEM View

by *Gerrit Muller* USN-SE
e-mail: gaudisite@gmail.com
www.gaudisite.nl

Abstract

This course focuses on systems engineering in companies that are supplying to an OEM company. This presentation elaborates the development process and the various roles in that process.

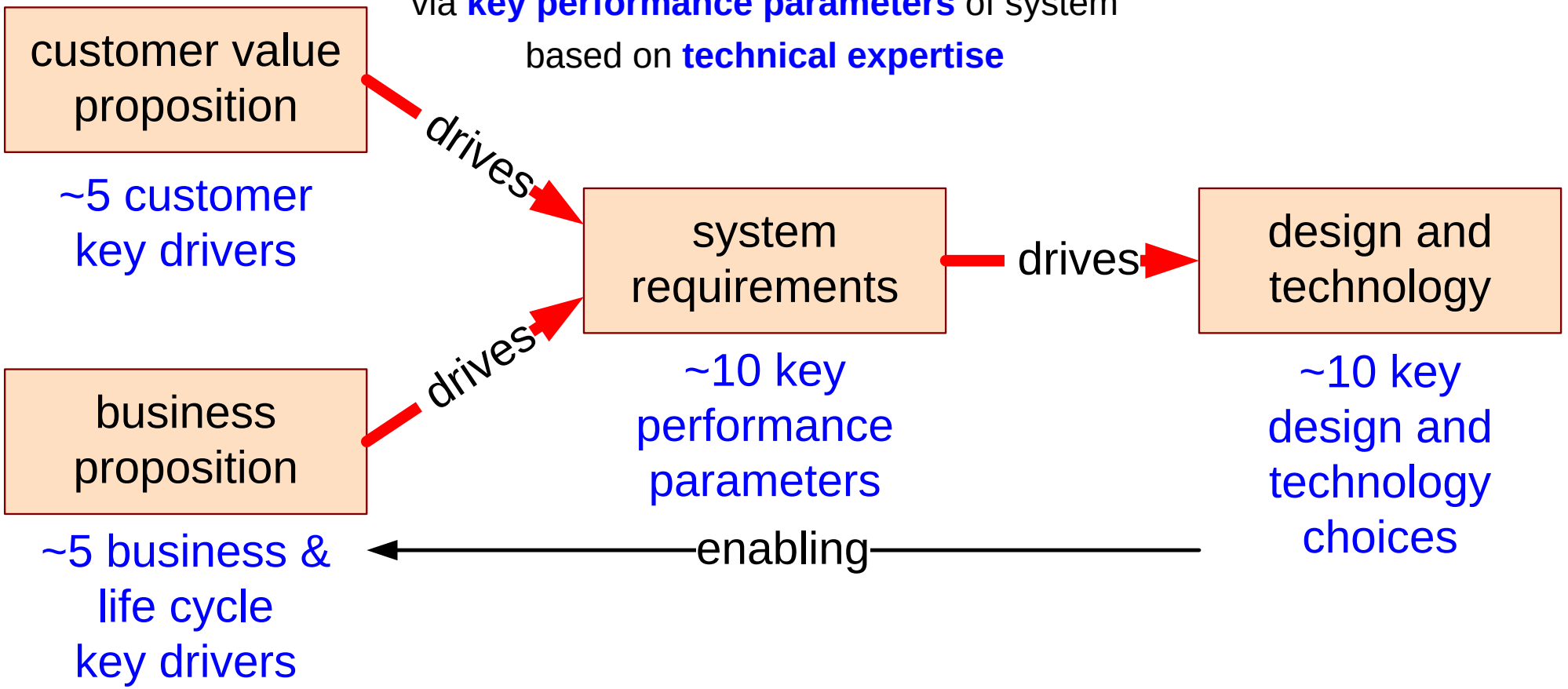
March 3, 2024
status: preliminary draft
version: 0



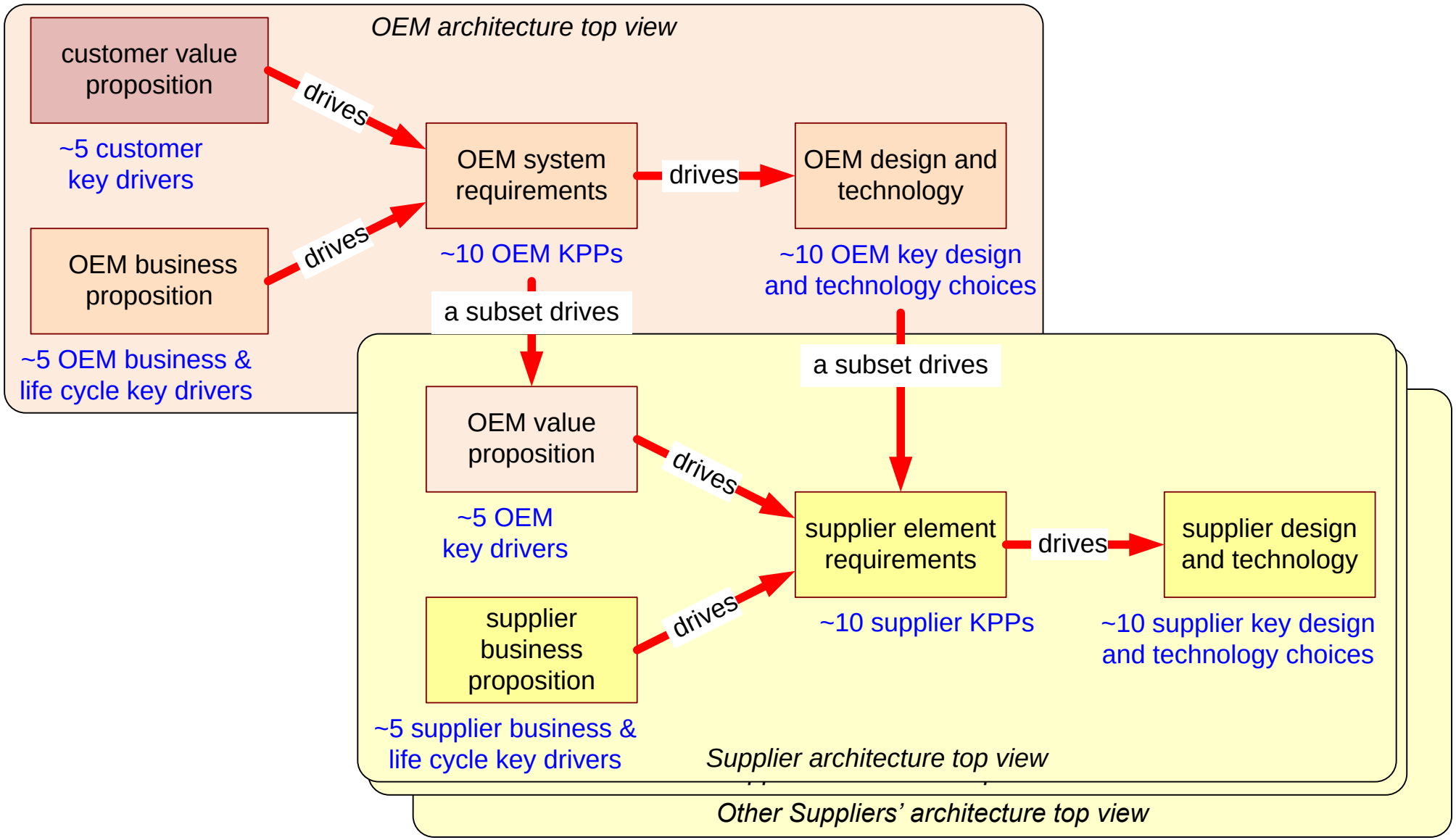
Architecture Top View

Systems Engineering: ***Fitness-For-Purpose***

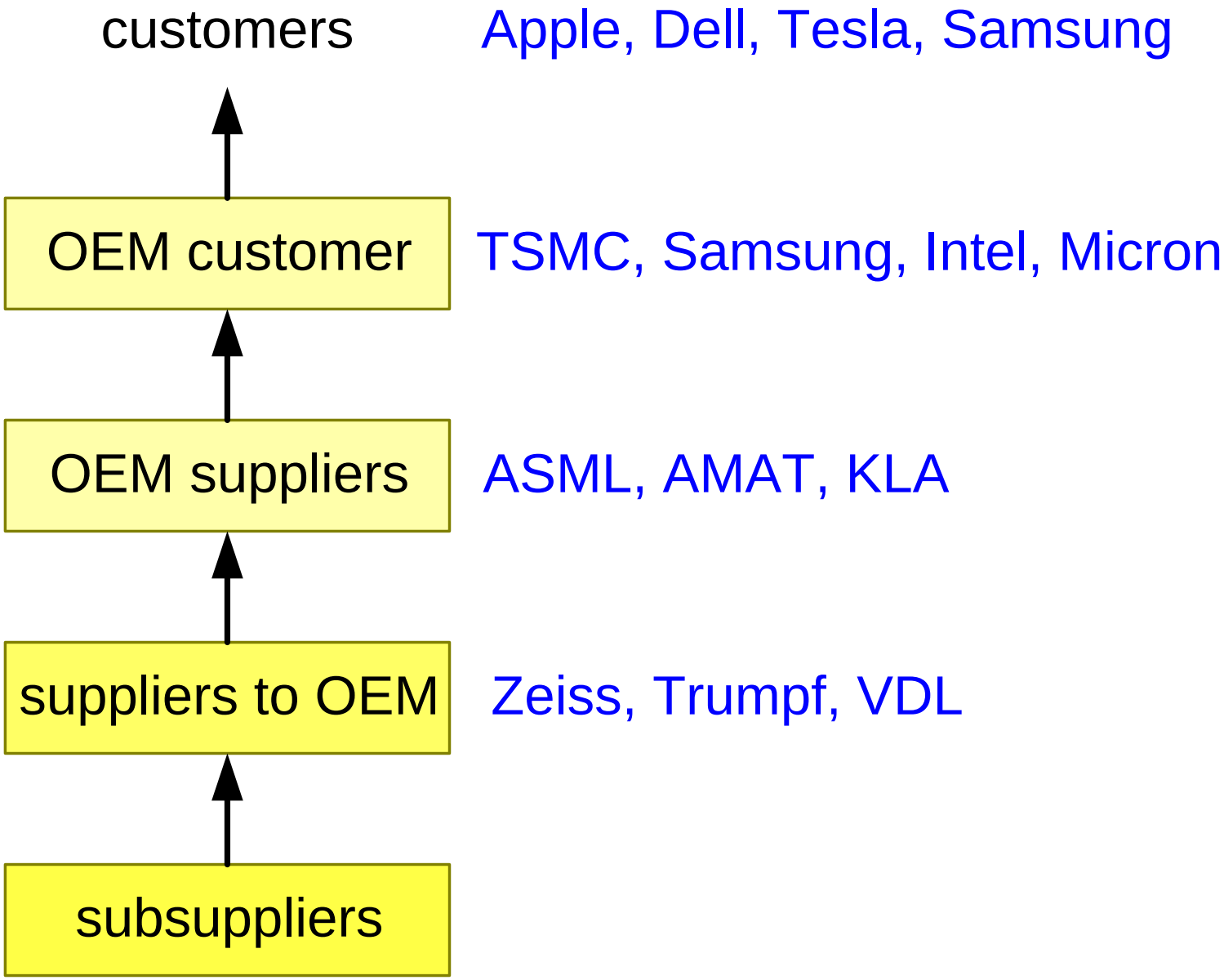
Achieving **customer** and **business key drivers**
via **key performance parameters** of system
based on **technical expertise**



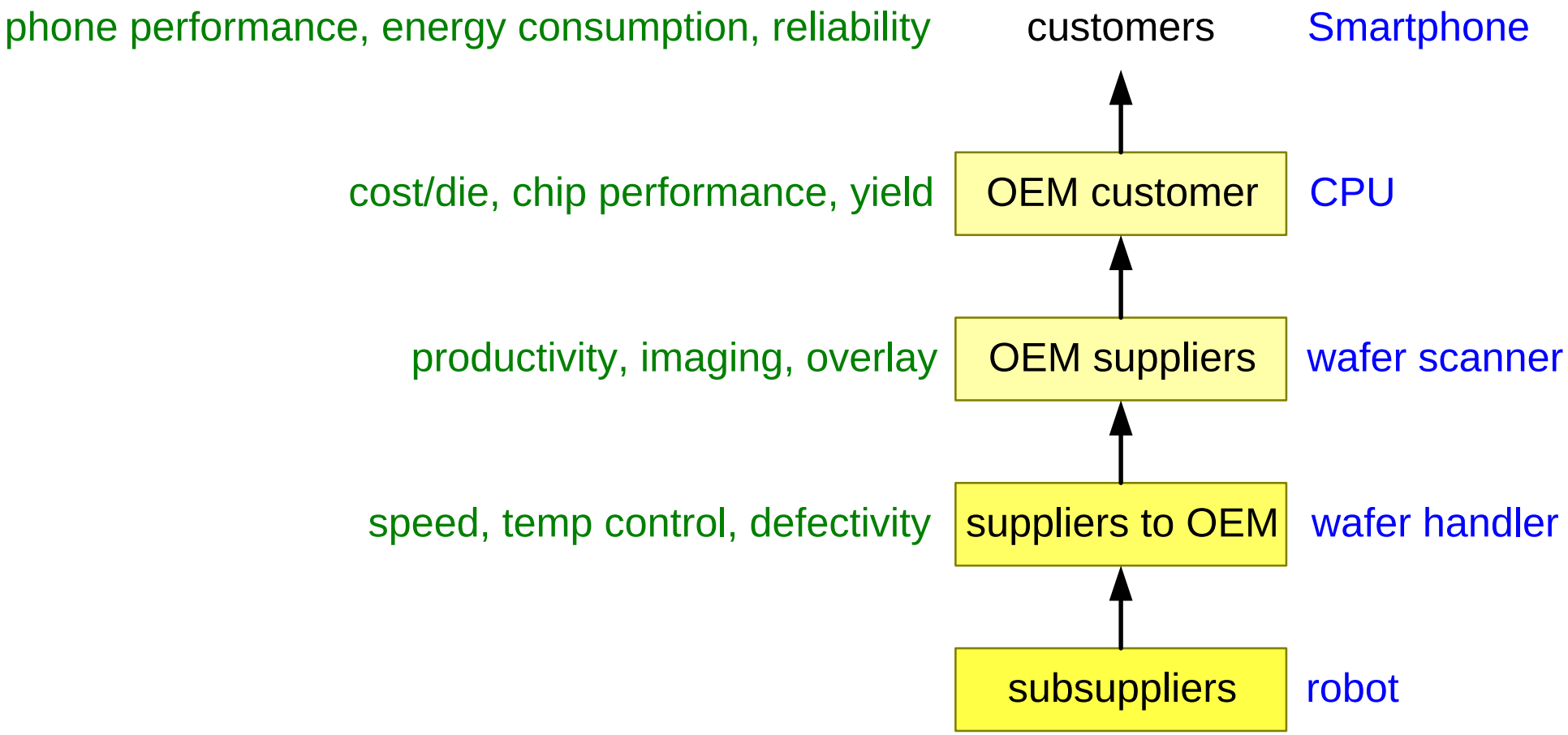
OEM and Supplier Architectures



Value Network



Changing Perspective



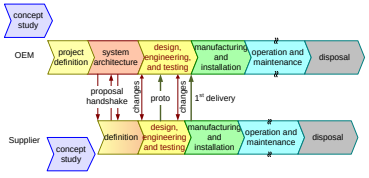
Supplier Systems Engineering Course; Life Cycle

by *Gerrit Muller* USN-SE
e-mail: gaudisite@gmail.com
www.gaudisite.nl

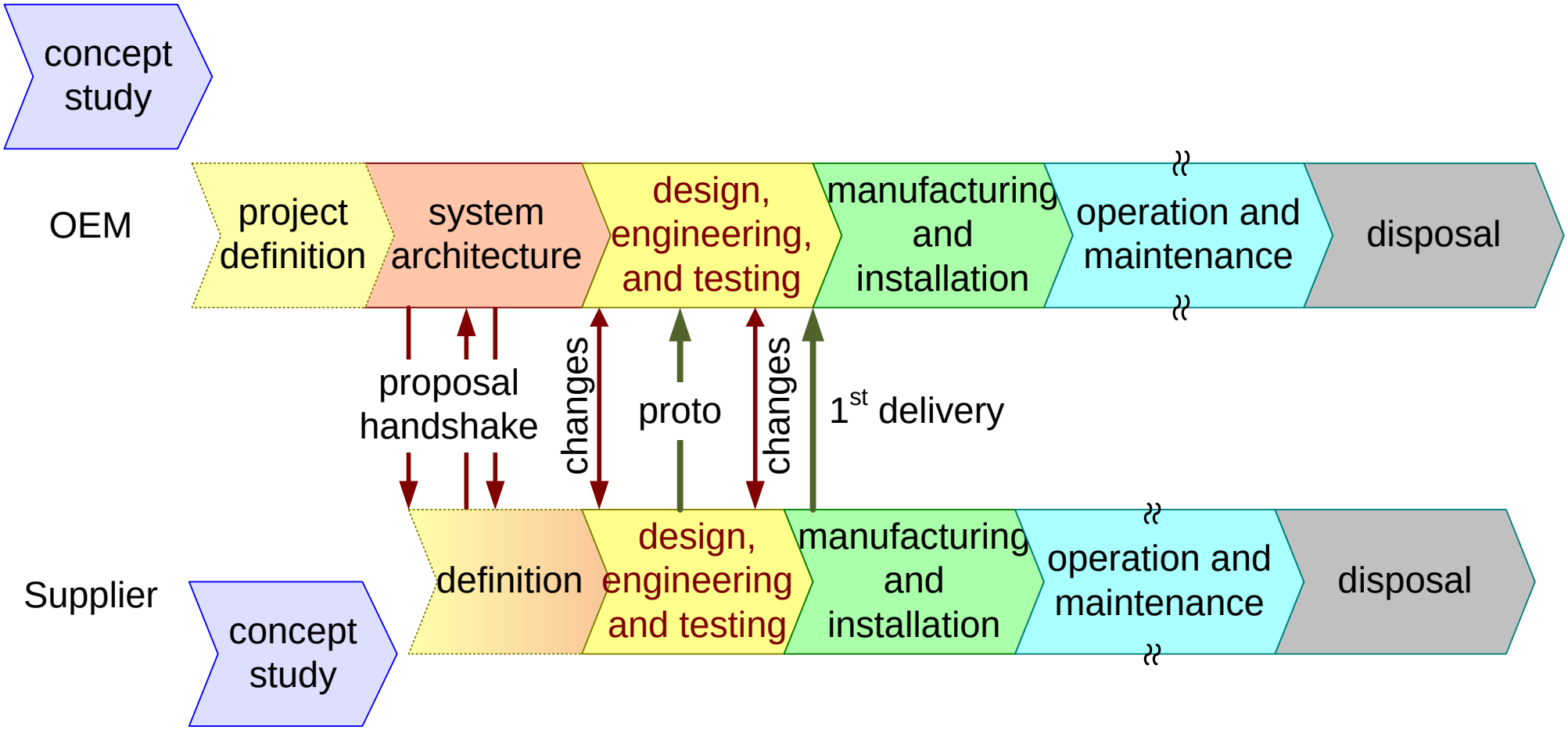
Abstract

The Development and Engineering effort has to result in a system that fits the stakeholders. Many stakeholders are active in the later part of the life cyle. This presentation elaborates the life cycle.

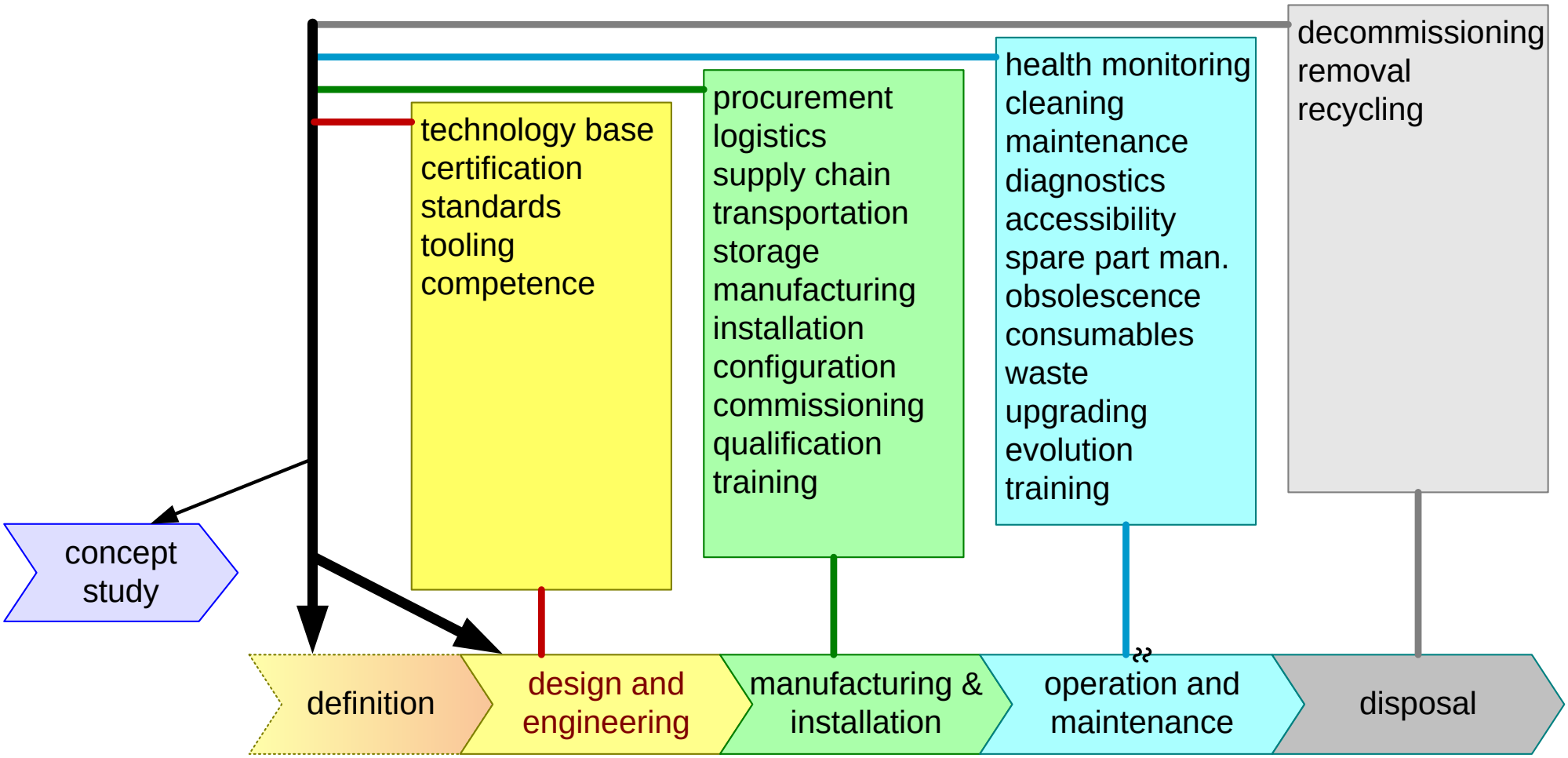
March 3, 2024
status: preliminary draft
version: 0



Project Life Cycles



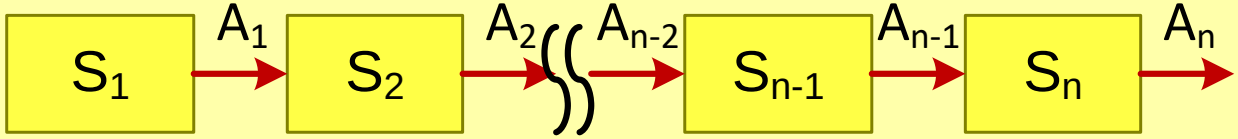
Life Cycle Inputs

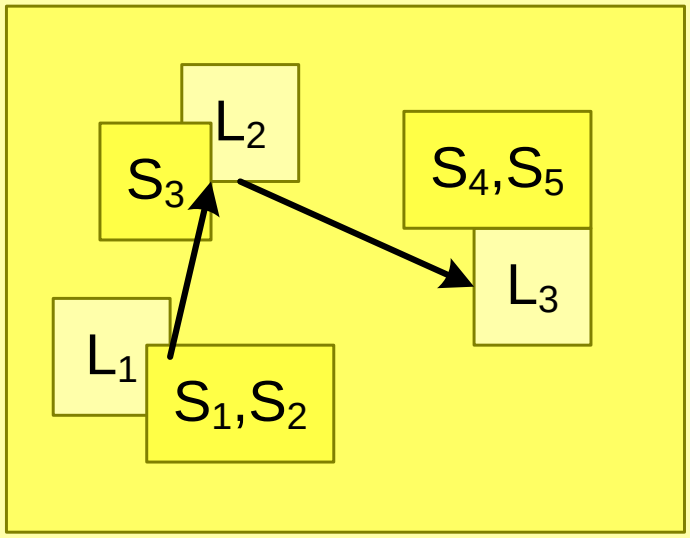


Concept of Operations (ConOps)

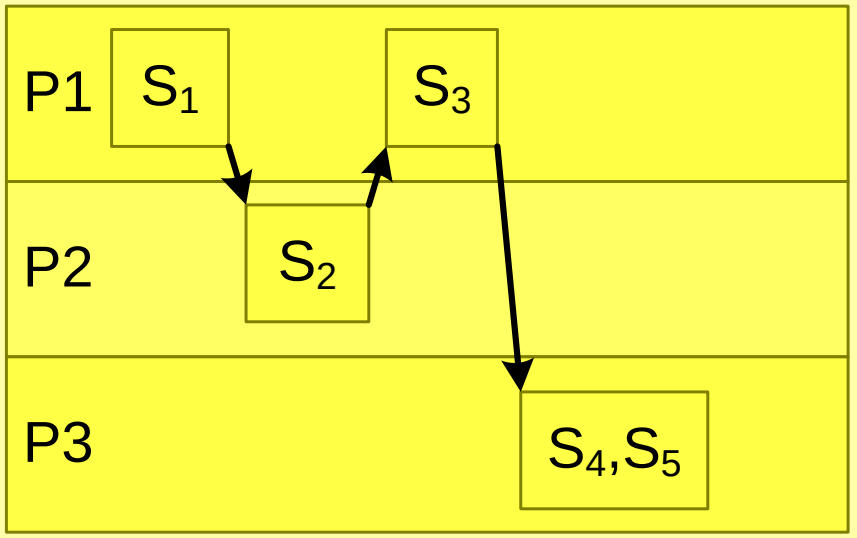
An envisioning of how the stakeholders will run their operation in relation to the system.

what (workflow)



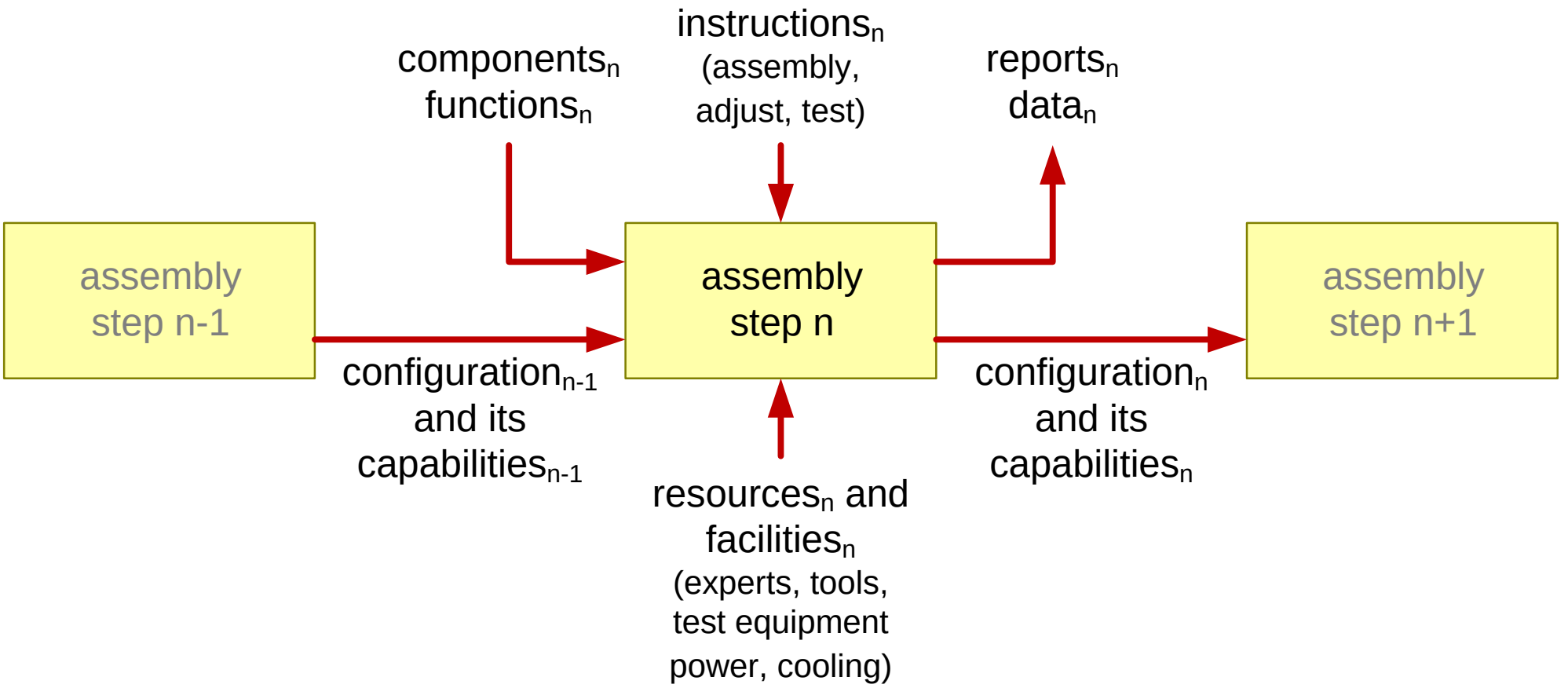


where (map)



who (swimming lanes)

Manufacuring ConOps



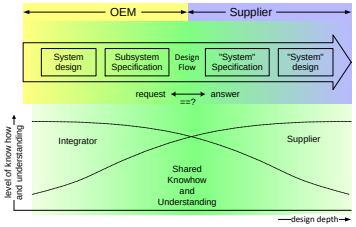
Supplier Systems Engineering Course; Process and Roles

by *Gerrit Muller* USN-SE
e-mail: gaudisite@gmail.com
www.gaudisite.nl

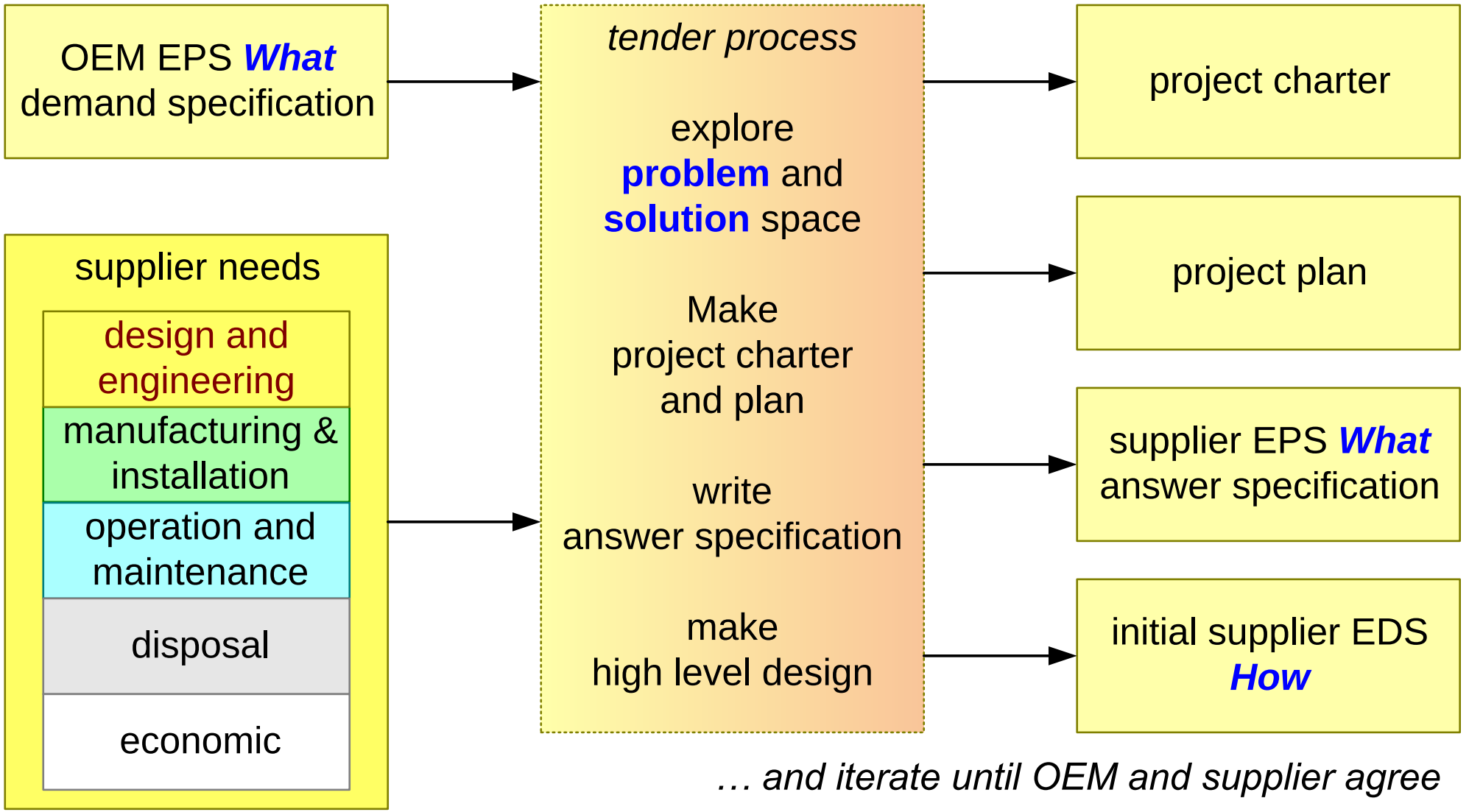
Abstract

This course focuses on systems engineering in companies that are supplying to an OEM company. This presentation elaborates the development process and the various roles in that process.

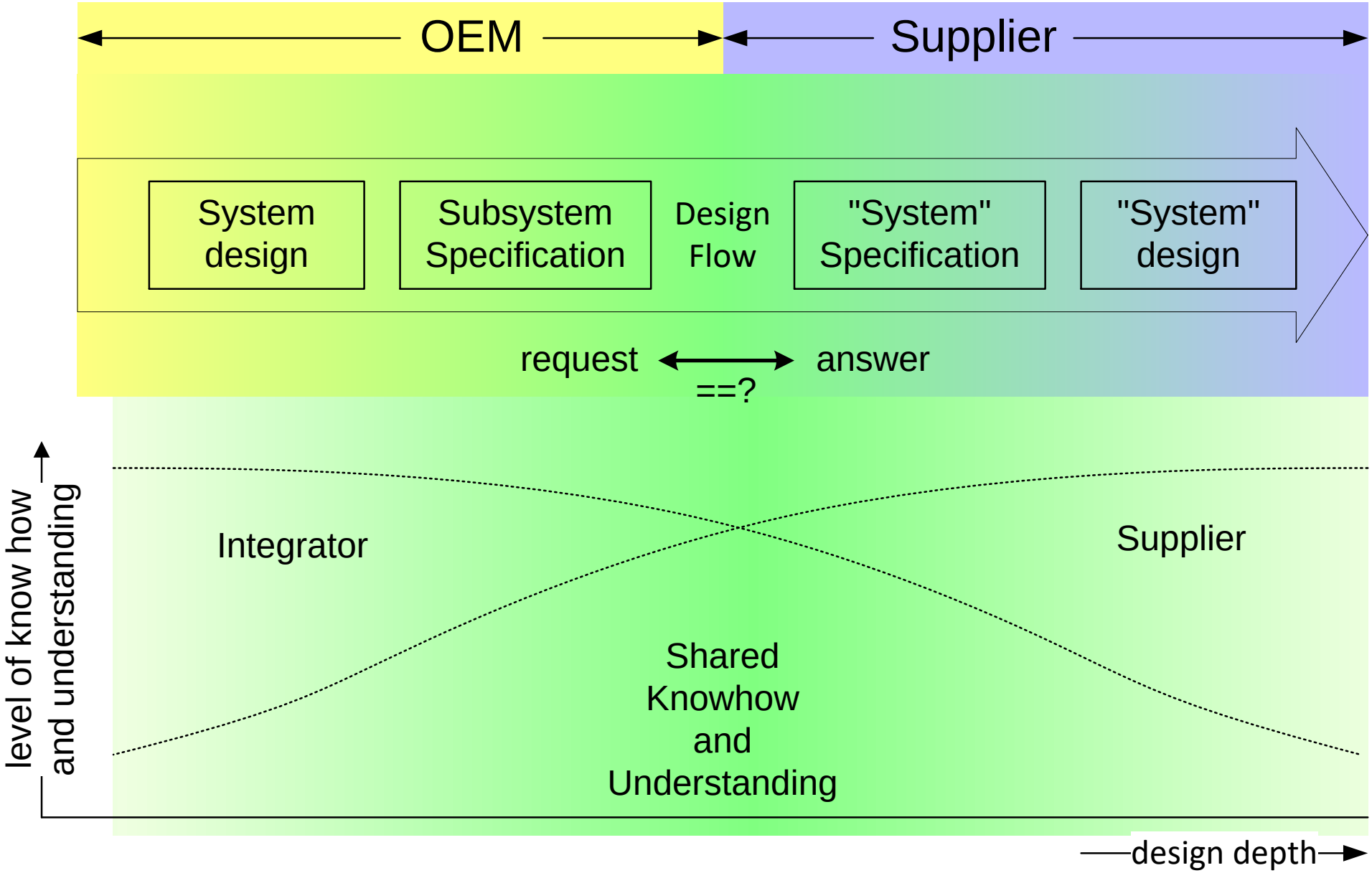
March 3, 2024
status: draft
version: 0.4



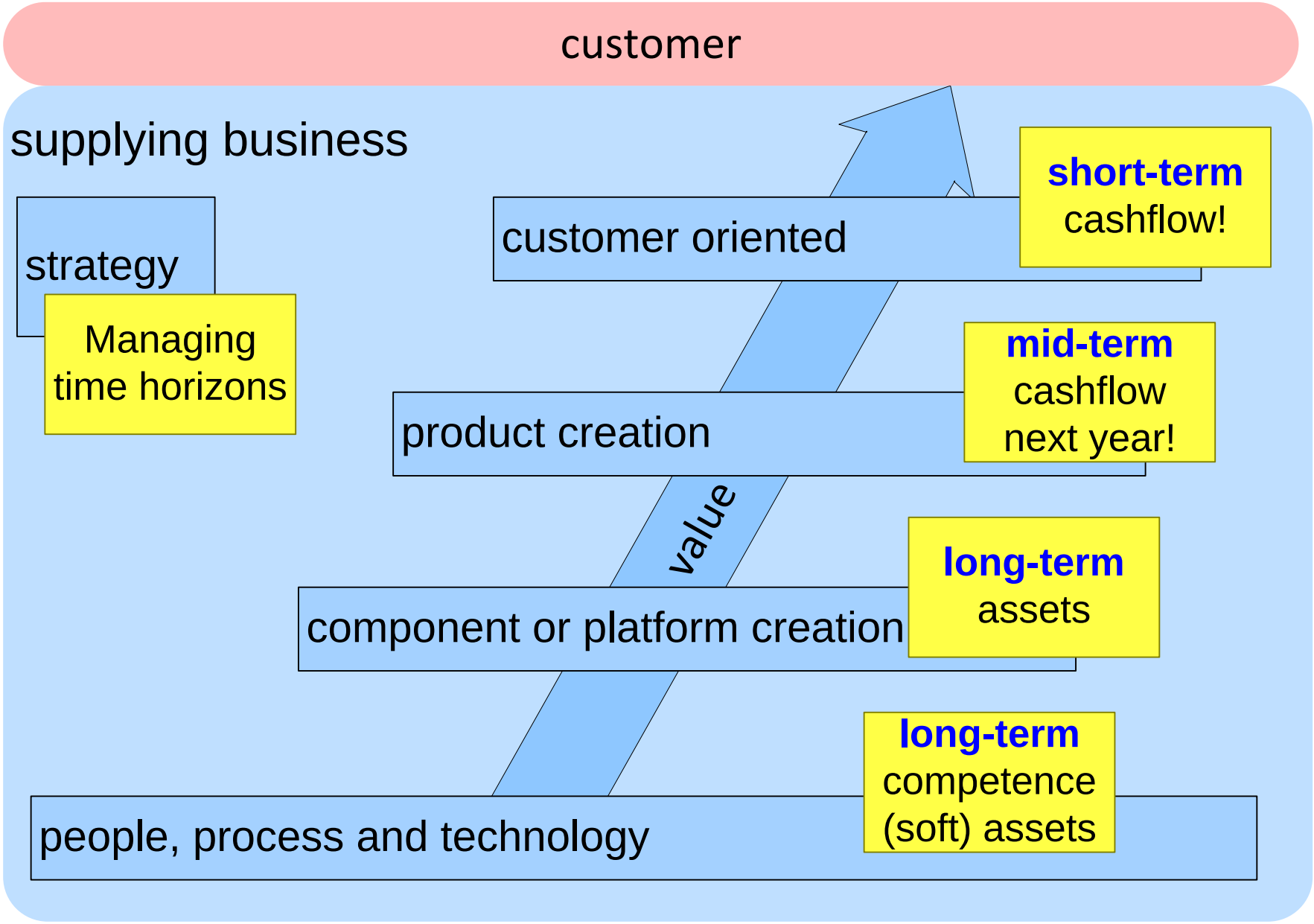
OEM and Supplier Tendering



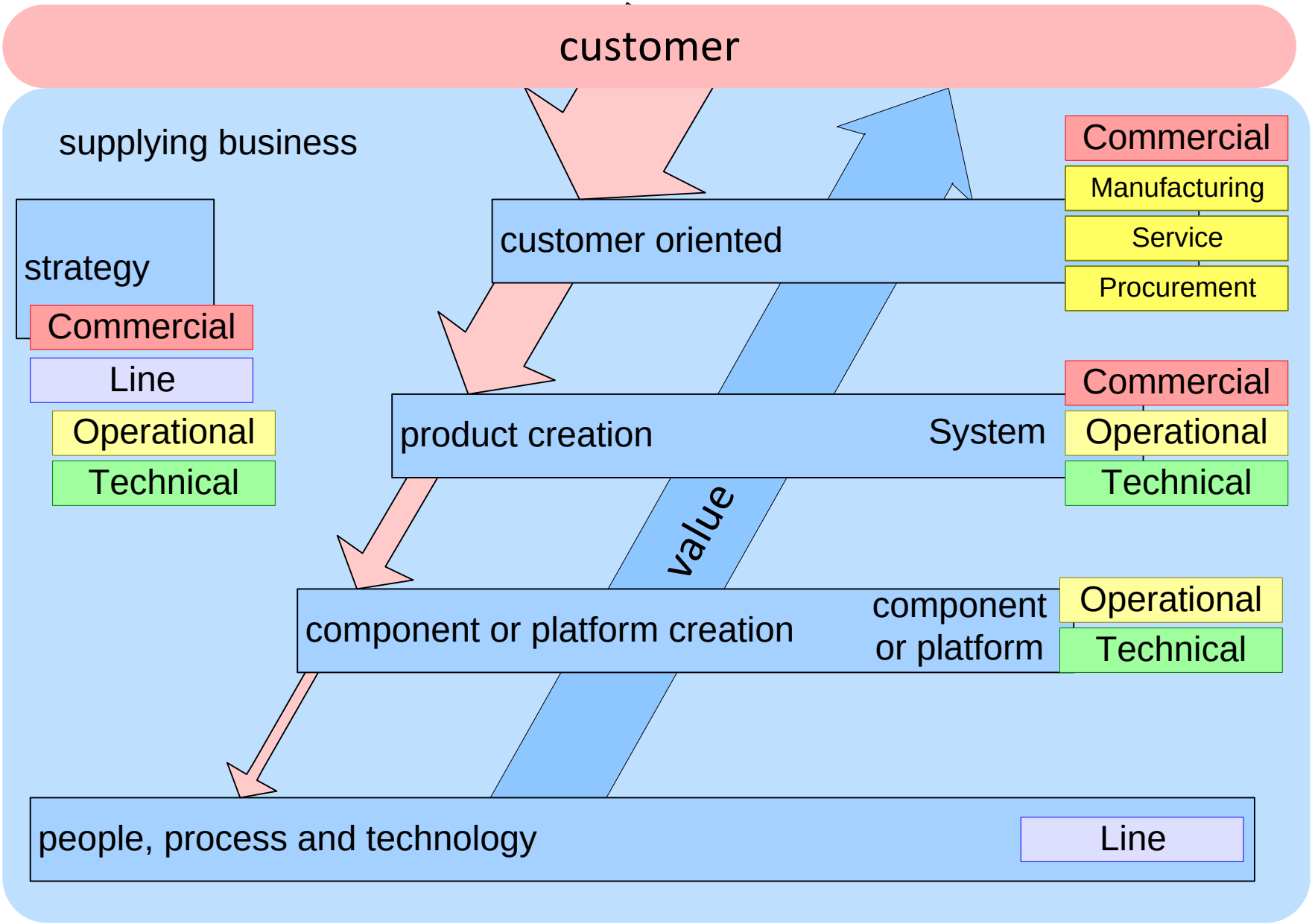
Required Overlap in Knowledge



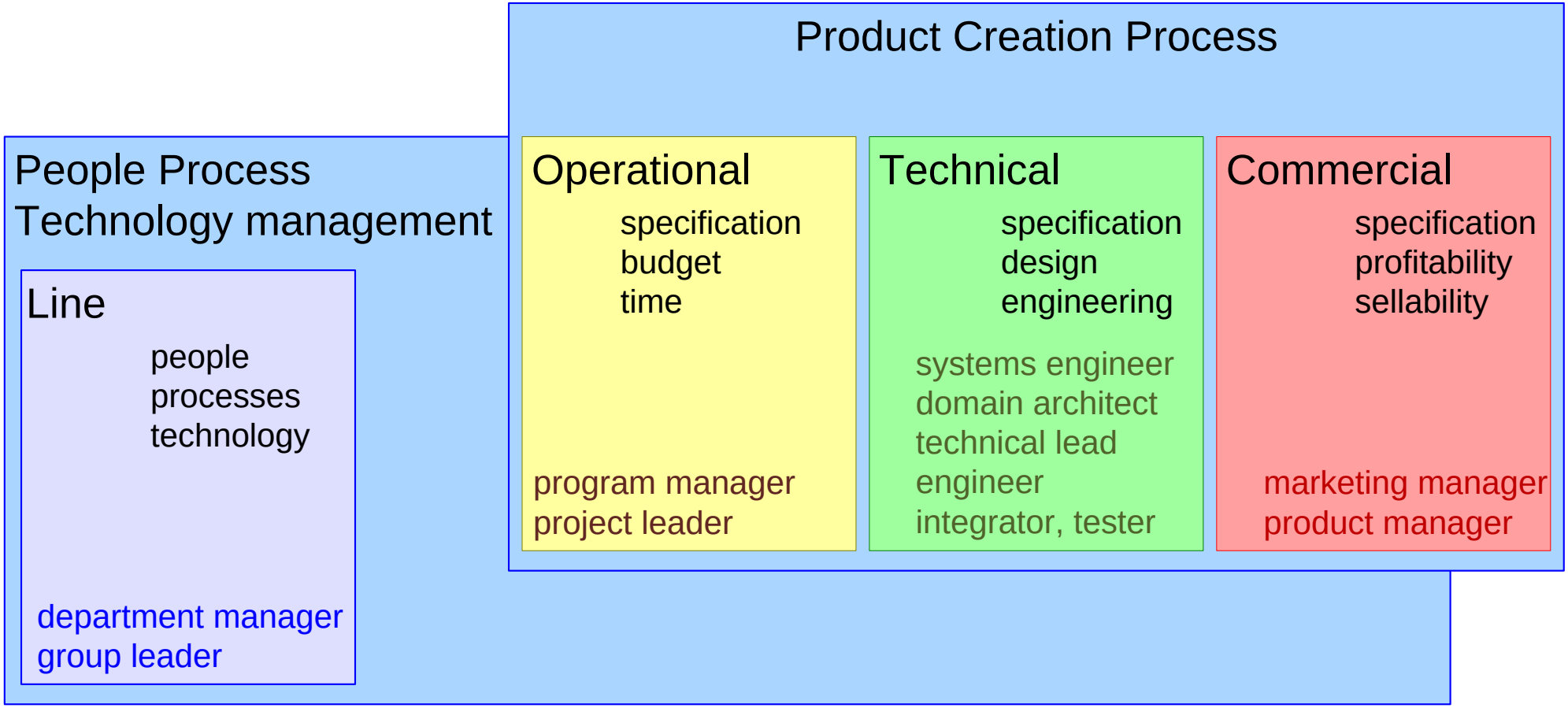
Process Decomposition and Time Dimension



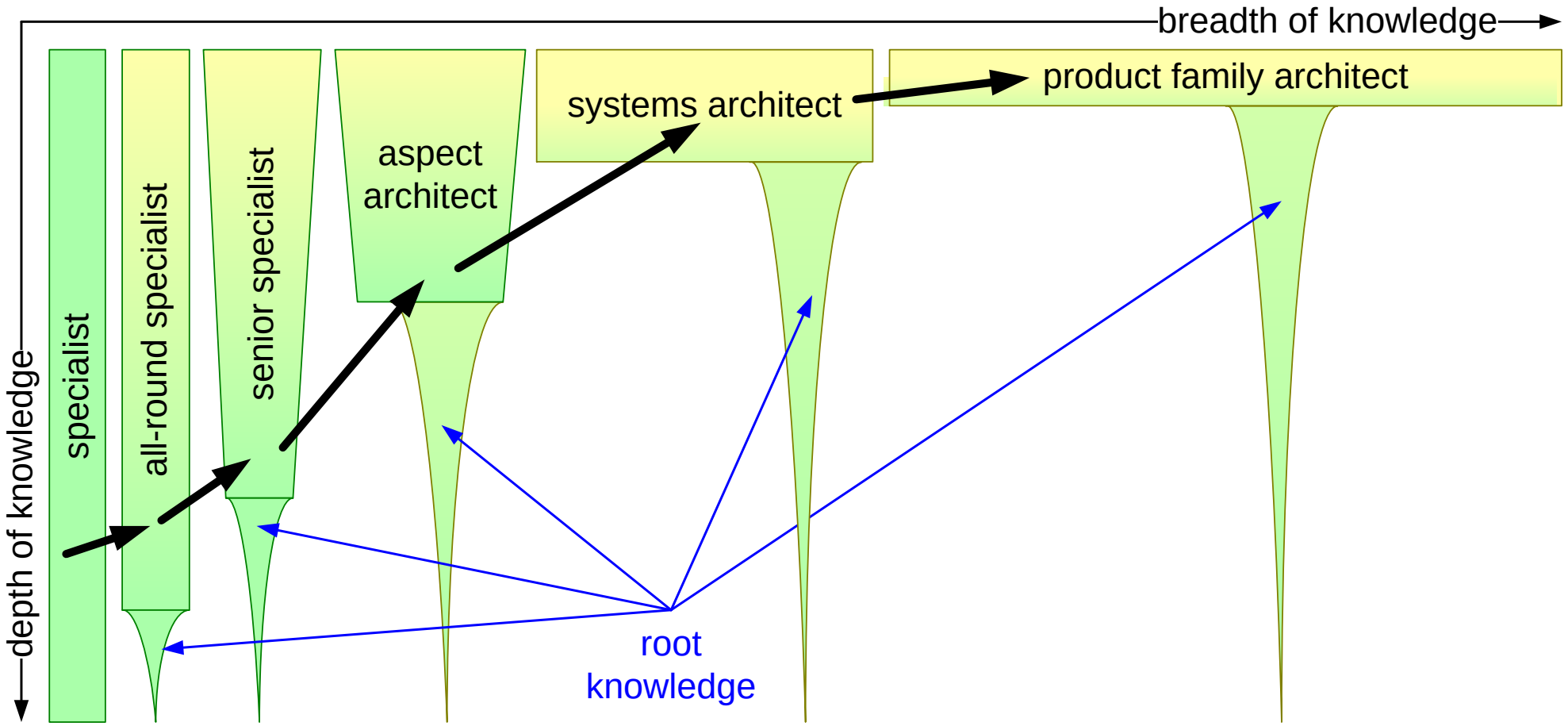
Process Decomposition and Roles



Roles in System Development



Evolution from Specialist to Architect



Supplier Systems Engineering Course; Development Flow

by *Gerrit Muller* USN-SE
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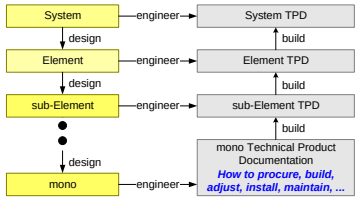
www.gaudisite.nl

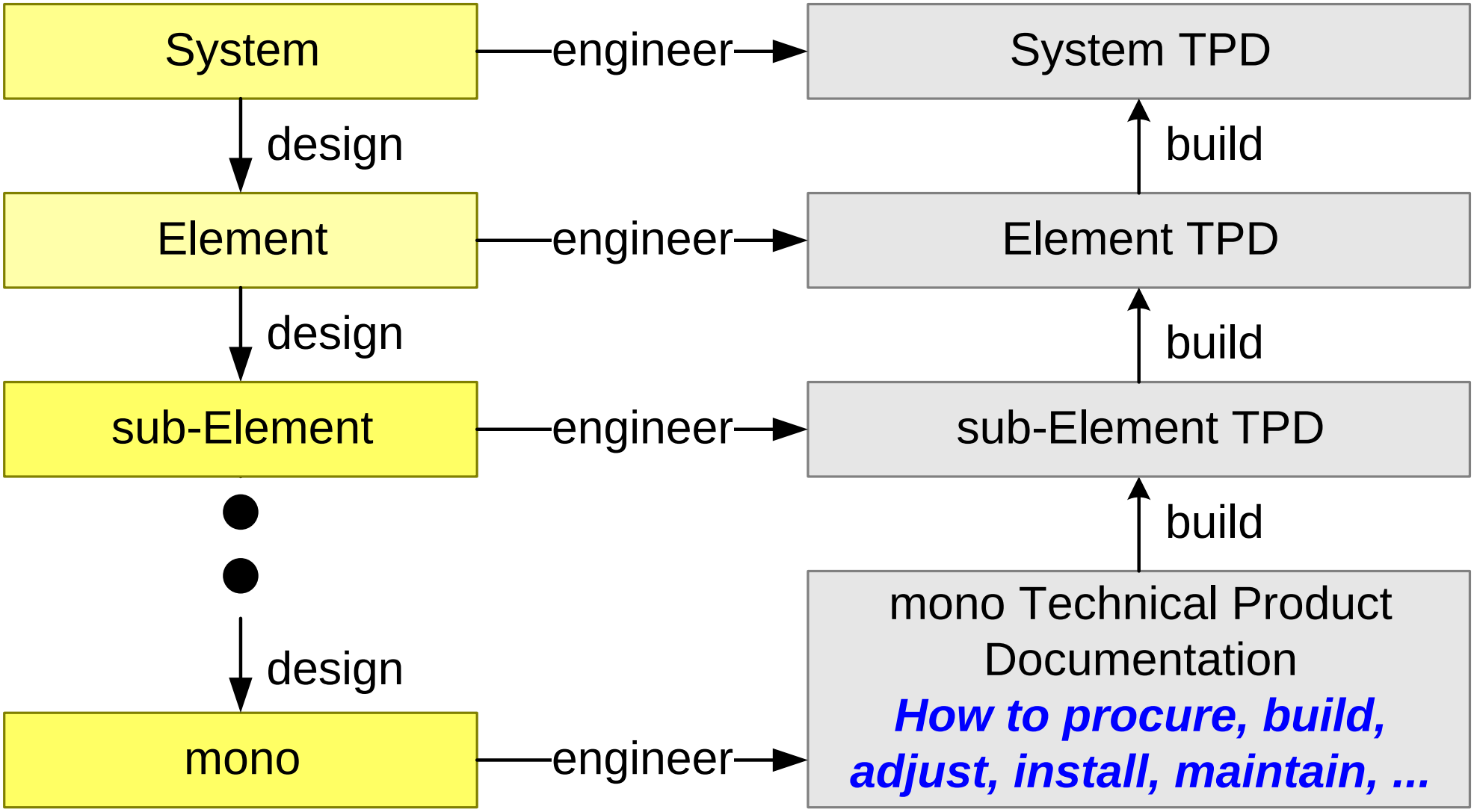
Abstract

The development flow follows the V-model. This presentation shows how the dvelopment documents and the technical product documentation evolve recursively from system to monodisciplinary level.

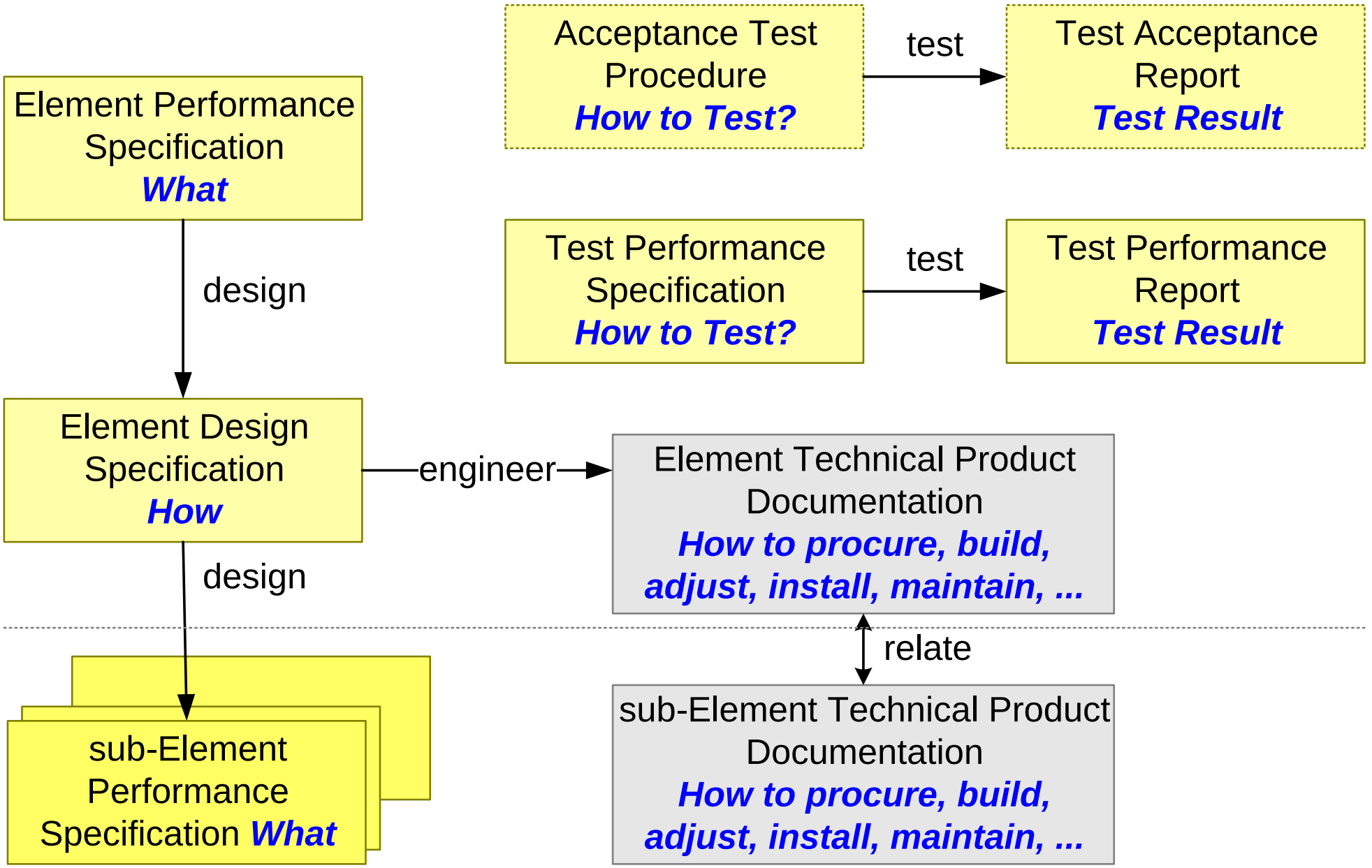
March 3, 2024
status: preliminary draft
version: 0.2



System Breakdown Hierarchy



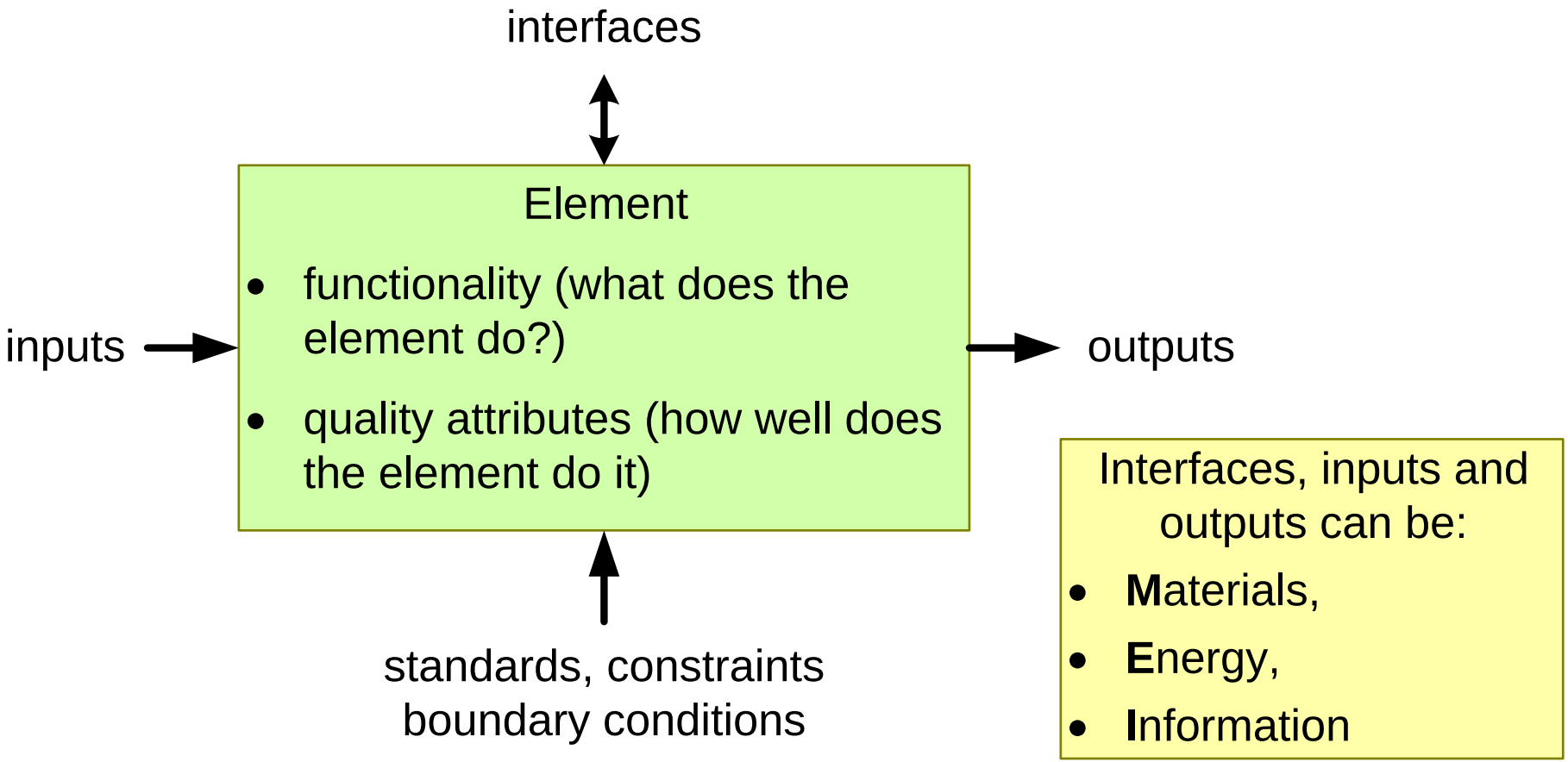
Specifications per Element



Performance Specification: What

an Element Performance Specification (EPS) specifies an element as a black box: *What* the element should be able to do, not *How* it should work.

An EPS specifies the requirements of the element “from the outside”

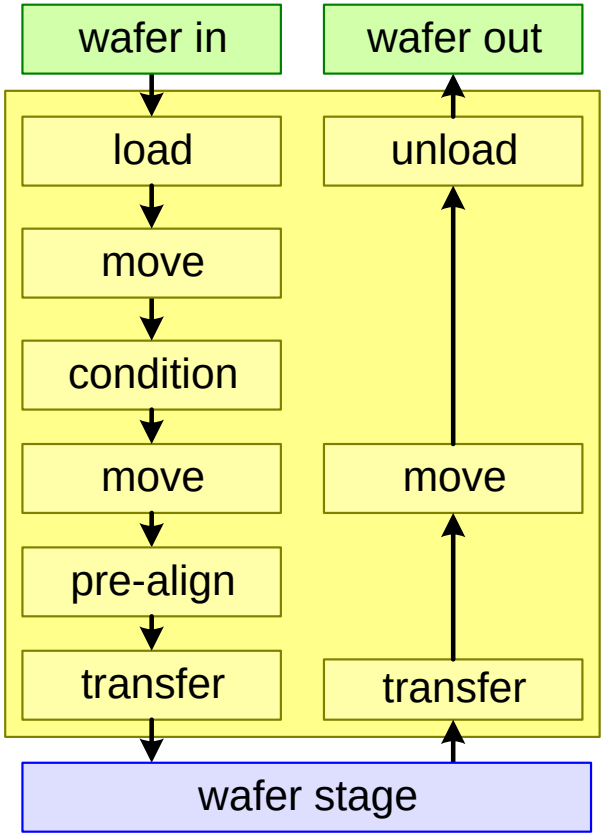


Design Specification: How

an Element Design Specification (EDS) specifies the design of an element, e.g. the inside of the box: ***How*** the element will realize the specified functionality and quality attributes.

An EDS specifies the **functional design**, the **breakdown** into sub-elements, the internal **interfaces**, the **allocation** of functions to sub-elements, and the **allocation** of contributions to the **quality attributes** to functions and sub-elements.

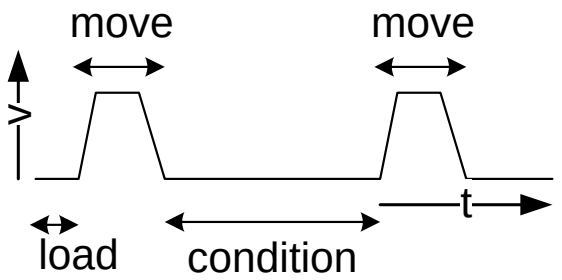
functional design



breakdown in sub-elements

load port	controller
gripper	handlers
robot	flow control
conditioner	conditioning
aligner	align
unload port	calibrate
cables	infra
cabinets	OS
frame	tools

allocations of quality attributes to functions and sub-elements

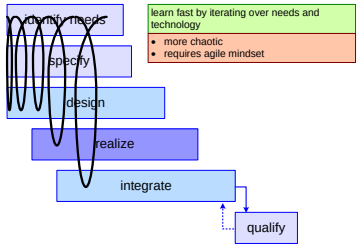


Mastering Systems Integration; Early Validation

by *Gerrit Muller* TNO-ESI, University of South-Eastern Norway]
e-mail: gaudisite@gmail.com
www.gaudisite.nl

Abstract

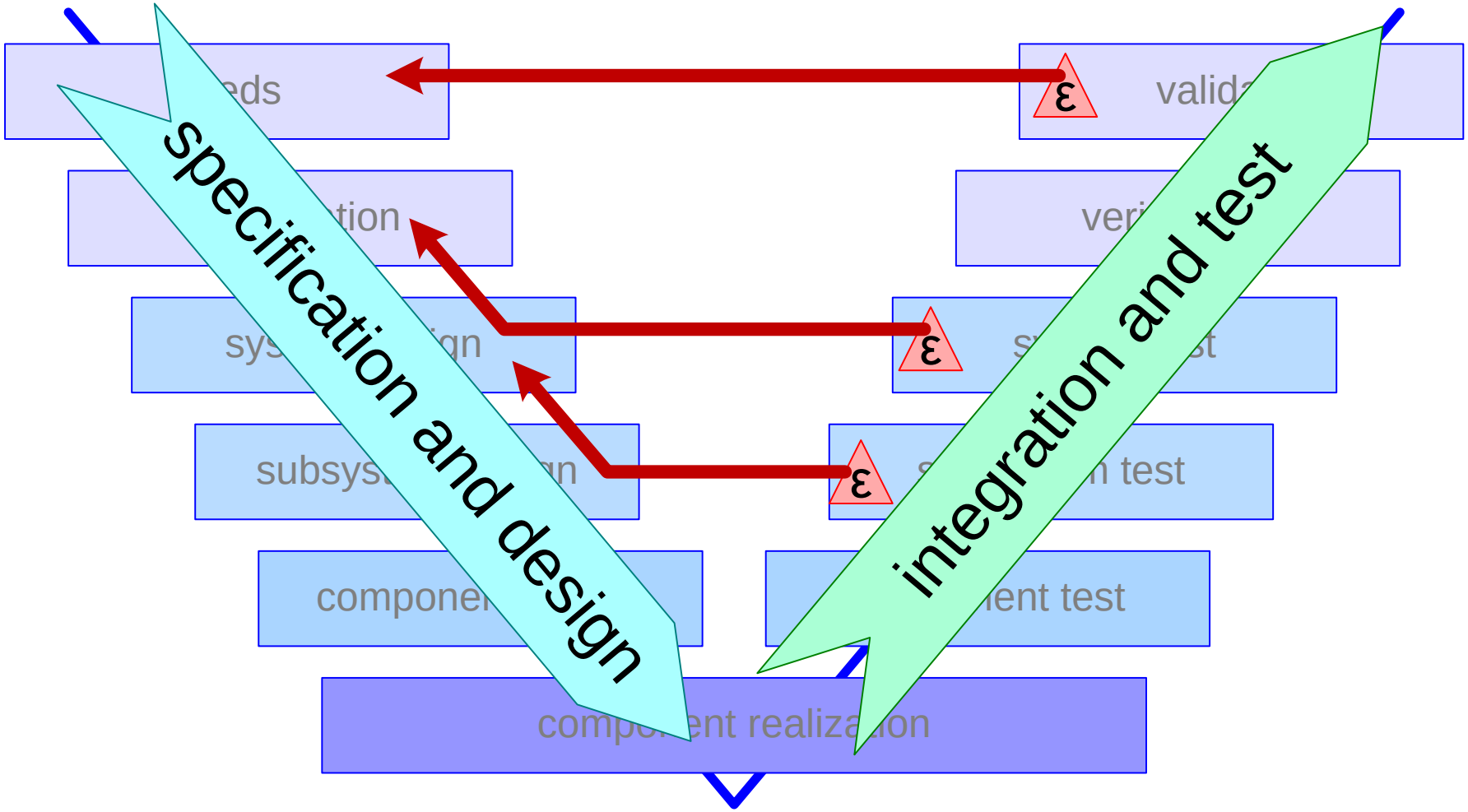
The core principle of systems integration is early validation; are the assumptions of the needs, specifications and design decisions valid? it is better to fail early, then to hit faulty assumptions, unknowns, or uncertainties late in development.



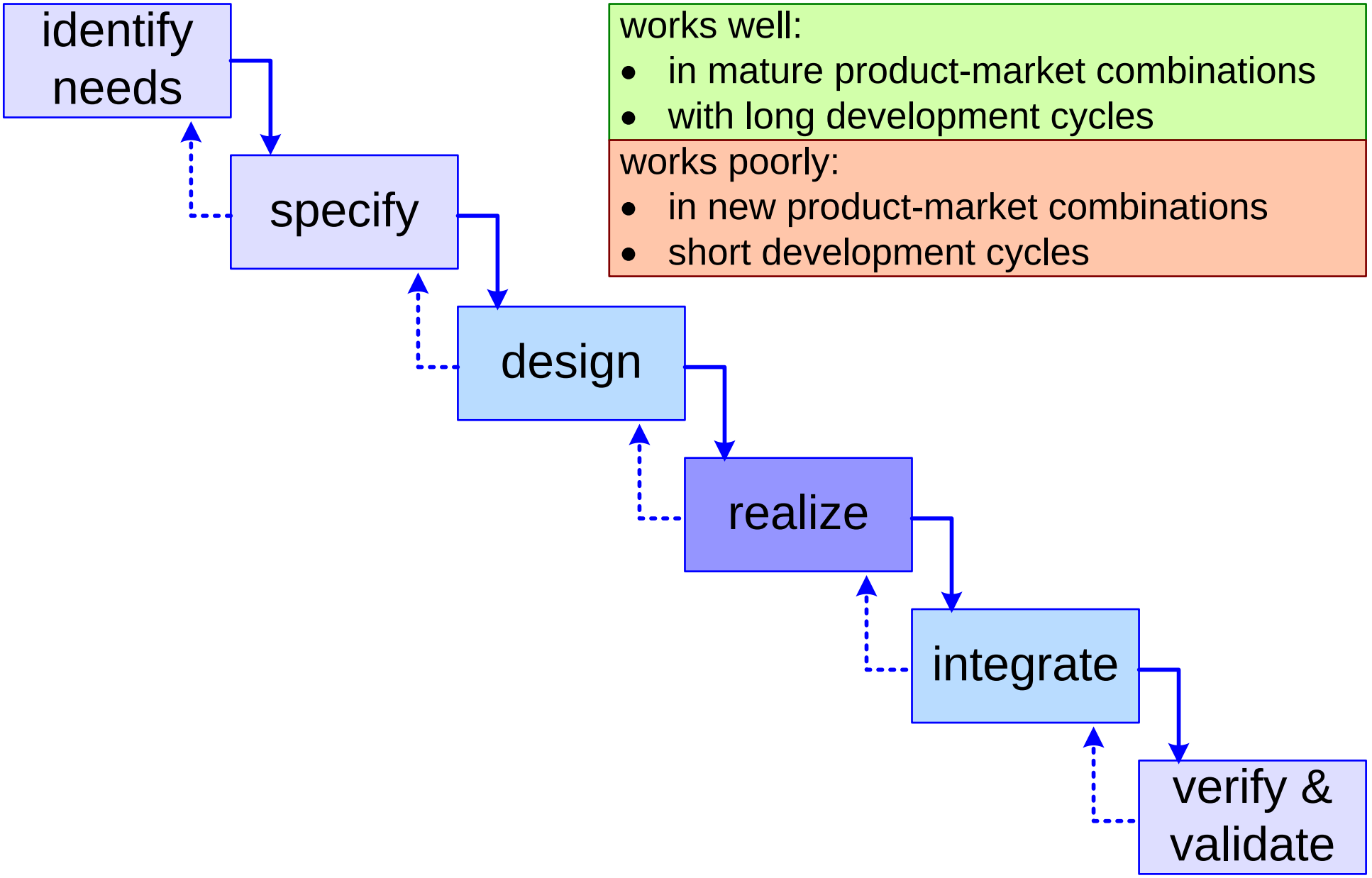
March 3, 2024
status: planned
version: 0.5

Most Problems are Found Late

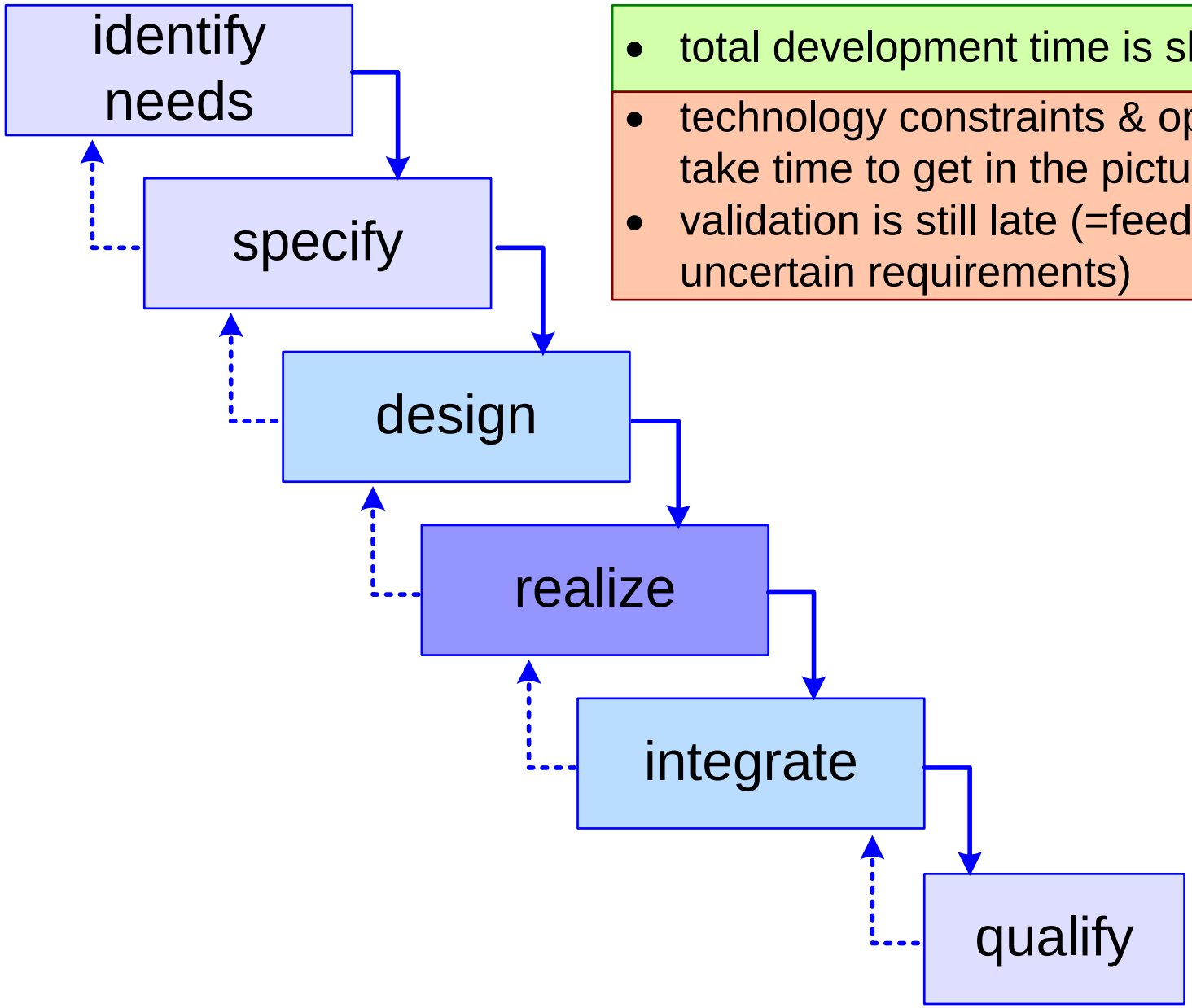
failures found during integration and test can be traced back to ***unknowns***, ***unforeseens***, and ***wrong assumptions***



Waterfall model

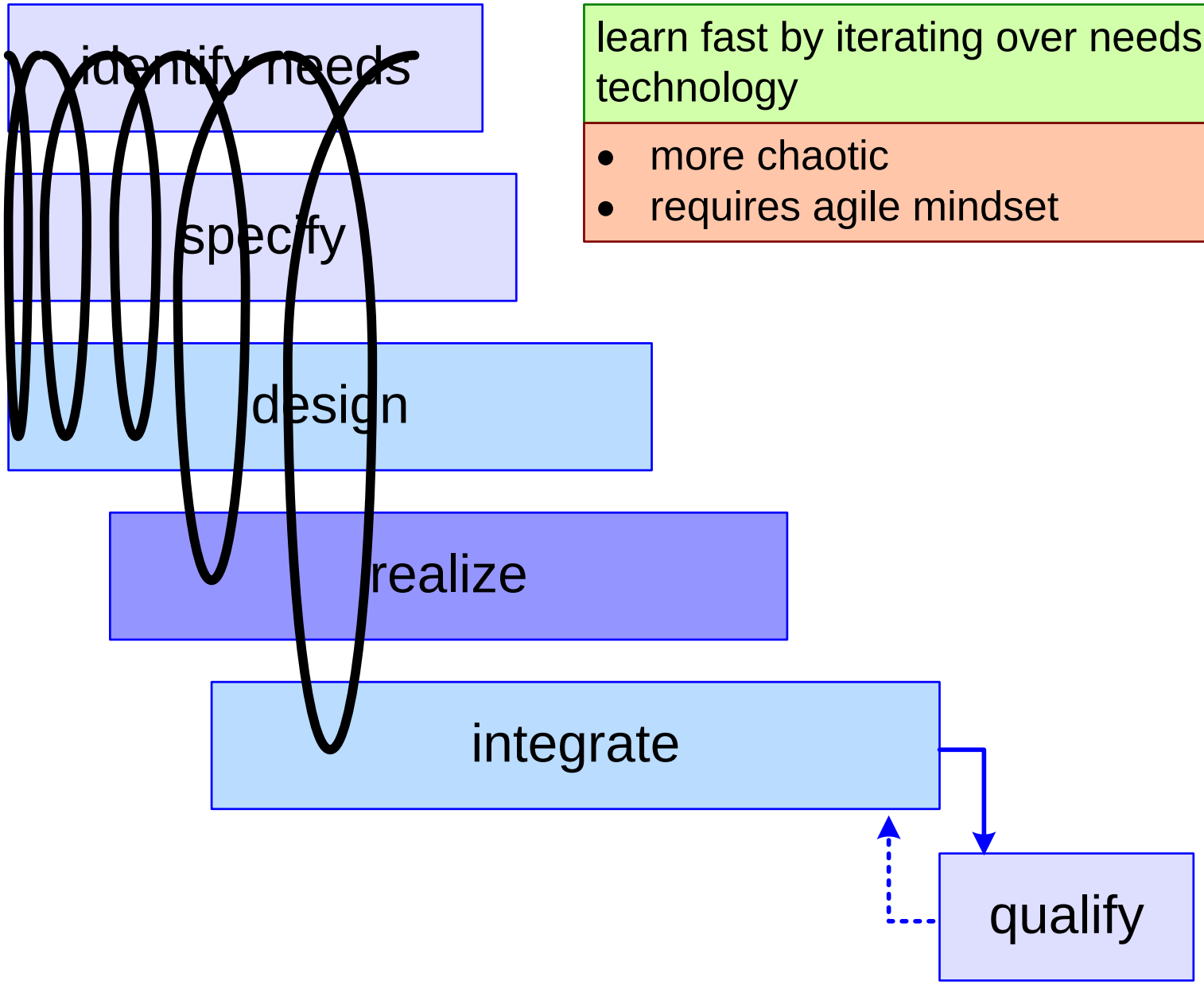


Concurrent Engineering



- total development time is shorter
- technology constraints & opportunities take time to get in the picture
- validation is still late (=feedback on uncertain requirements)

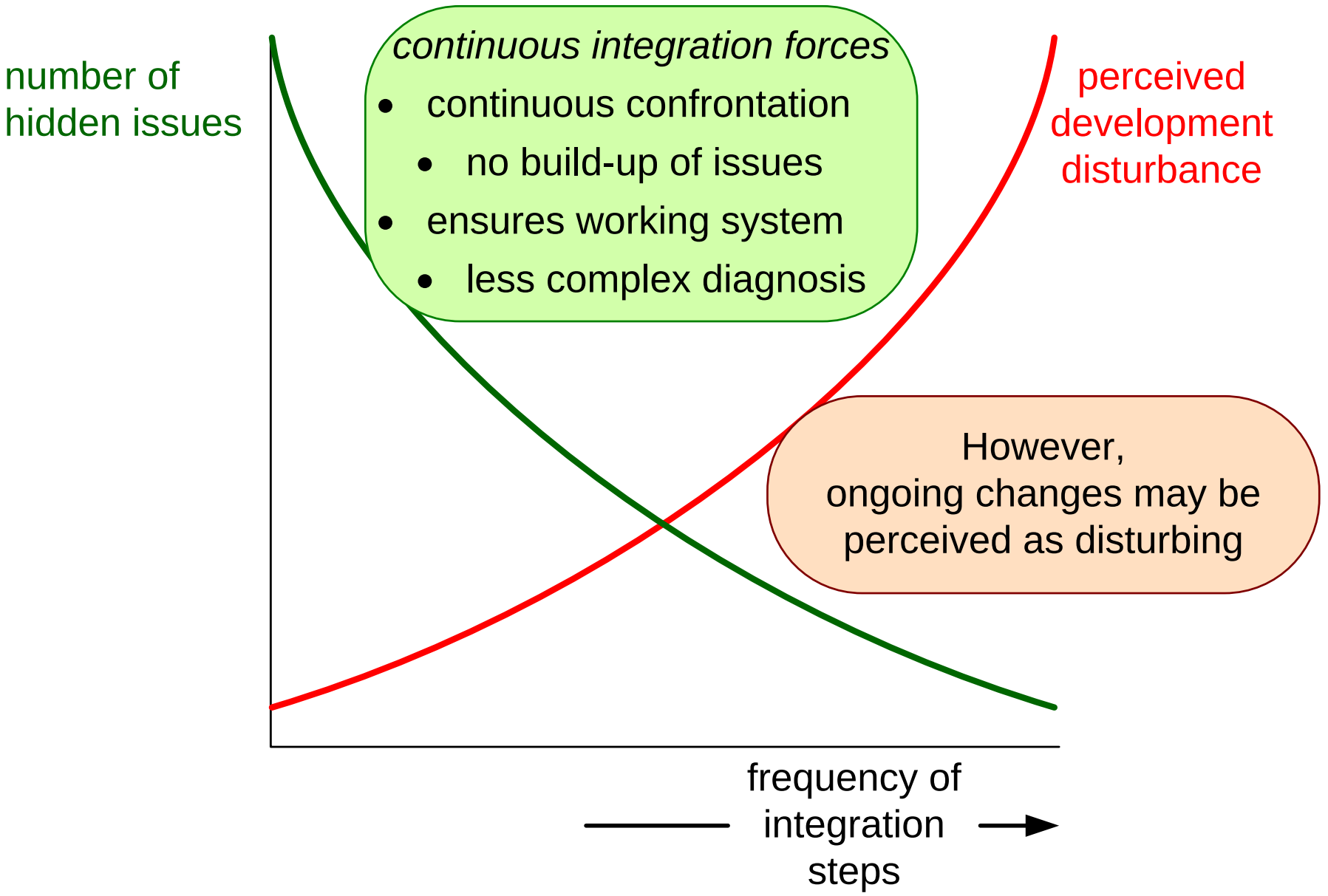
Iterative Approach



learn fast by iterating over needs and technology

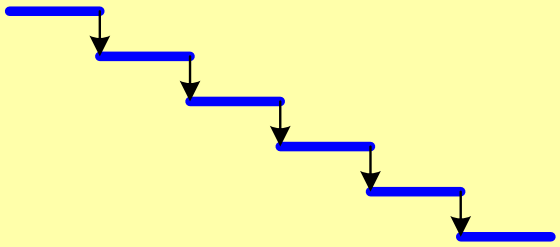
- more chaotic
- requires agile mindset

Continuous Integration



Development Processes From Waterfall to Agile

waterfall

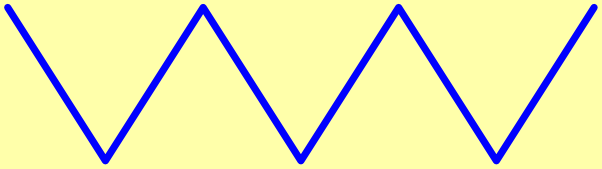


triple-V

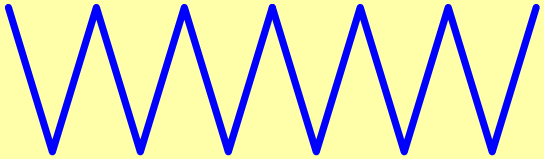
M1 functional model

M2 prototype

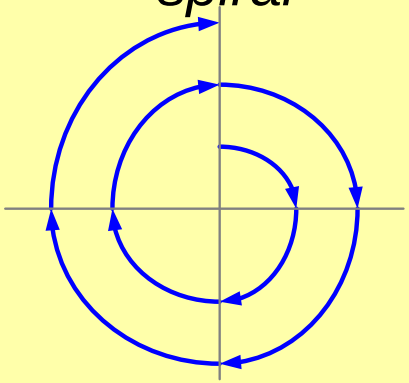
M3 product



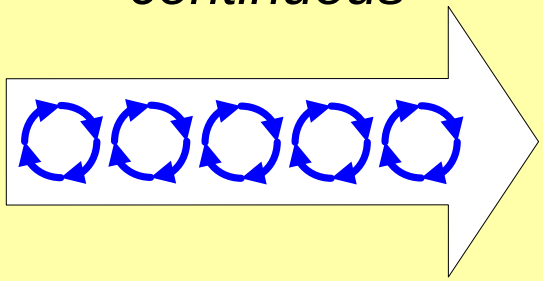
many Vs



spiral



agile/incremental/ continuous



and all kinds of hybrids

Supplier Systems Engineering Course; Assignments

by *Gerrit Muller* USN-SE
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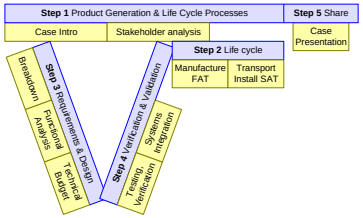
Abstract

This course focuses on systems engineering in companies that are supplying to an OEM company. The assignments use a case and guide the participants through the V-Model for that case.

March 3, 2024
status: draft
version: 0.3



Create a Project Overview of the Case

Create a Project Overview for your case

Project Title

meta information, e.g. version, date, author, owner

Project Goals

- 3 to 5 specific and quantified objectives

Key Performance Parameters

- 5 to 10 specific and quantified requirements

system context

- sketch the next generation system
- indicate changes compared to the current generation system

system of interest

- sketch your next generation subsystem, module, or function
- indicate changes compared to the current generation subsystem

project master plan with timeline

- first light, prototype shipment, 1st SAT @OEM, 1st SAT @OEM's customer, start volume production

other relevant project infomation

Homework; Discuss and Update Case Overview

Contact the project and team leaders.

Have a dialogue on the case overview.

Adjust the case overview.

Annotate where uncertainties are.

Create a Project Overview for your case

Project Title — meta information, e.g. version, date, author, owner

system context

- sketch the next generation system
- indicate changes compared to the current generation system

system of interest

- sketch your next generation subsystem, module, or function
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Project Goals

- 3 to 5 specific and quantified objectives

Key Performance Parameters

- 5 to 10 specific and quantified requirements

project master plan with timeline

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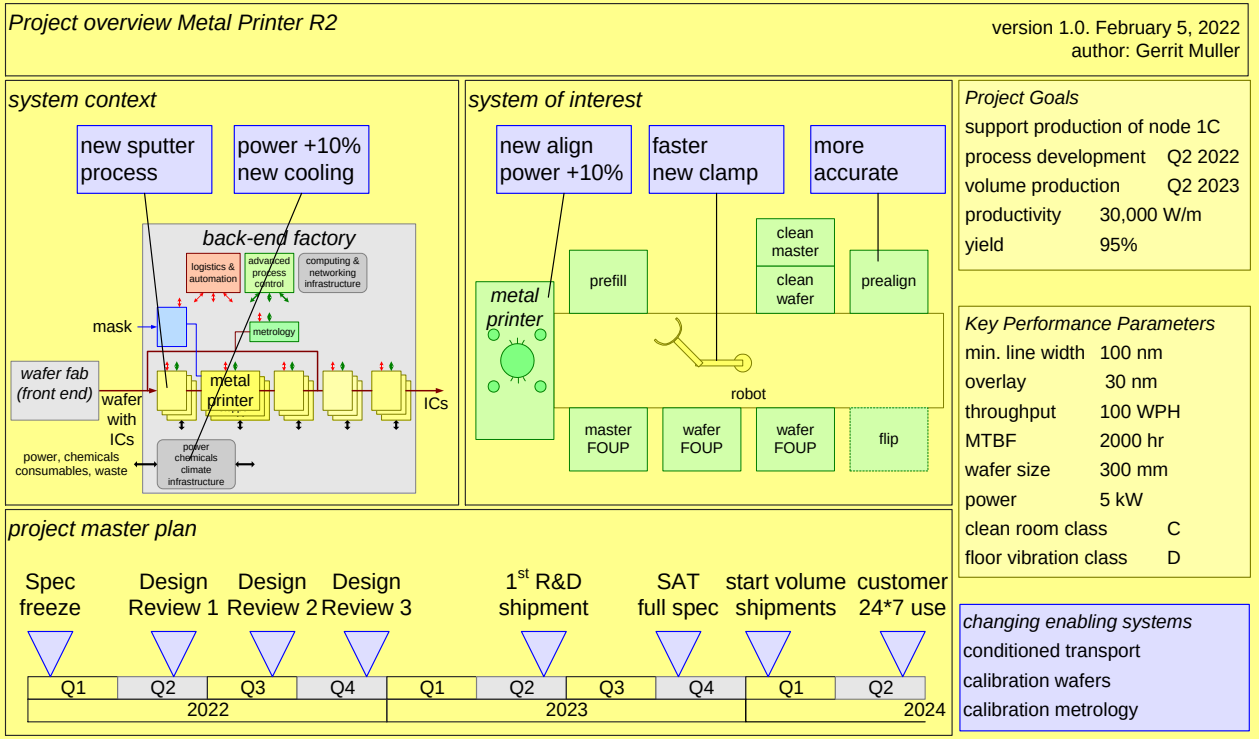
Case Introduction

Discuss the Project Overview

What are the most relevant project goals?

What are the main milestones and their timing?



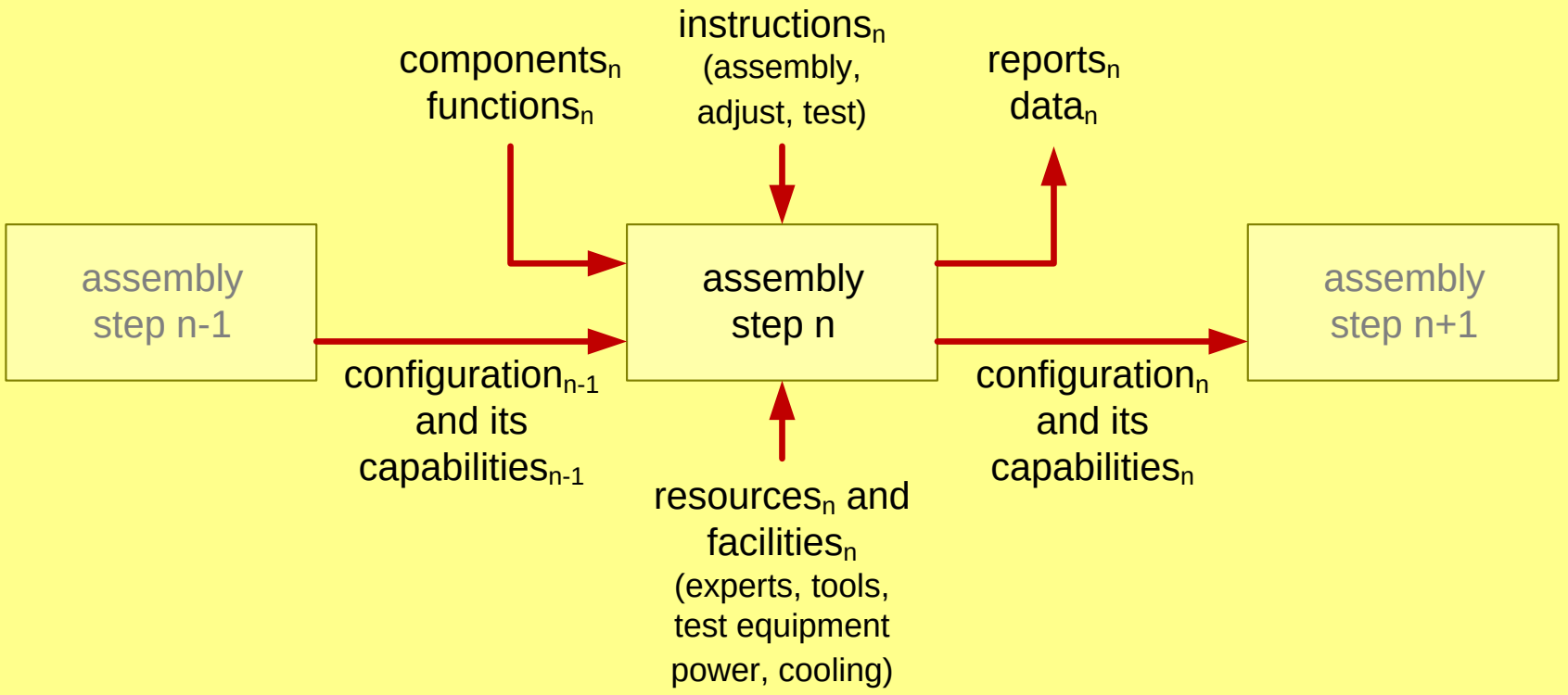
Stakeholder Analysis

Identify ~10 stakeholders of the project

Determine per stakeholder their ~3 main concerns

stakeholders	concerns
sales manager	price, margin, value proposition
purchaser	purchasing price, delivery date
project leader	delivery date, resources, budget
developer	
integrator	
operator	
maintainer	
…	

Sketch a manufacturing ConOps of the current system

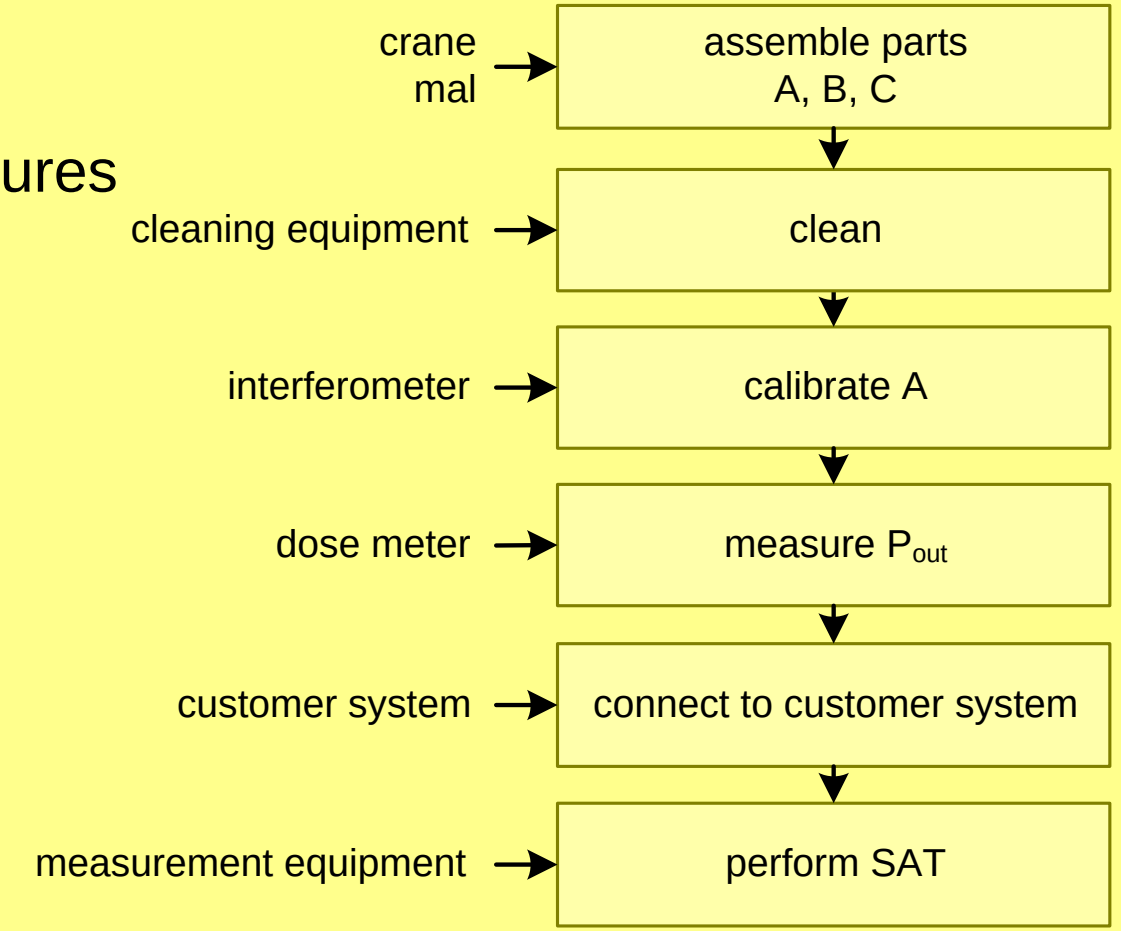


Transportation, Installation, and SAT

Sketch the installation workflow of the current system at the customer

Identify critical operations and

prerequisites like tools and fixtures



Homework; Elicit Needs from Stakeholders

Contact the major life cycle stakeholders in your company.

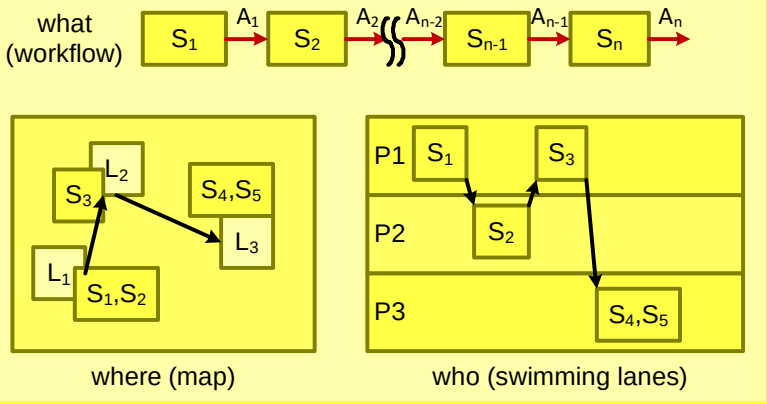
Have a dialogue on how they perform their role.

Capture their way of working in a ConOps.

Ask them for their main “pain” points.

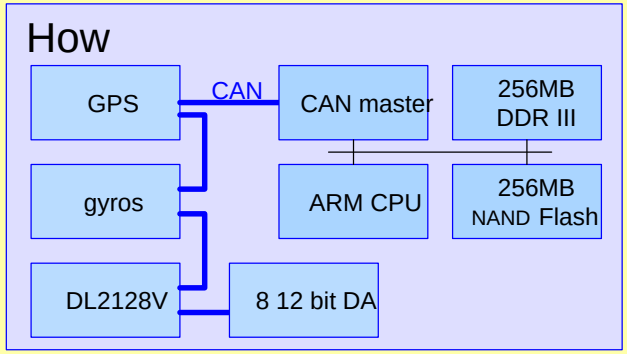
Concept of Operations (ConOps)

An envisioning of how the stakeholders will run their operation in relation to the system.

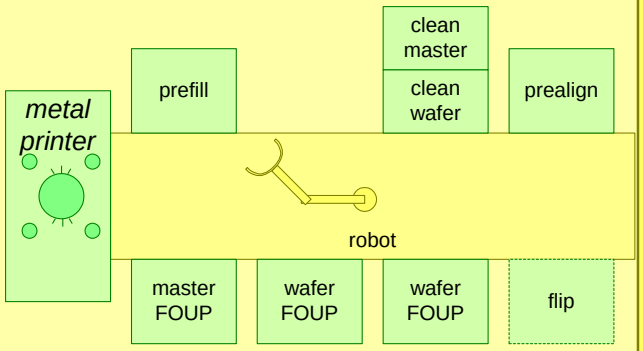


Breakdown

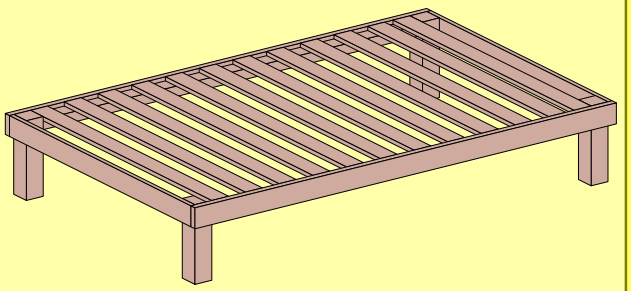
Make a breakdown of your system. Choose 1 representation from below



HW block diagram

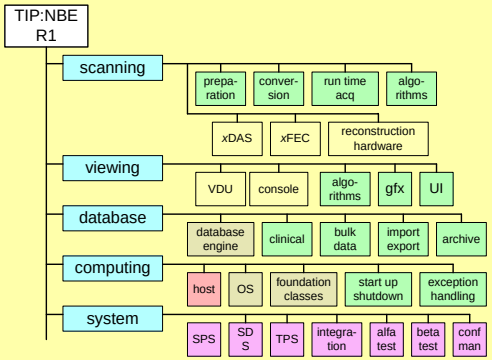


2D layout of system internals

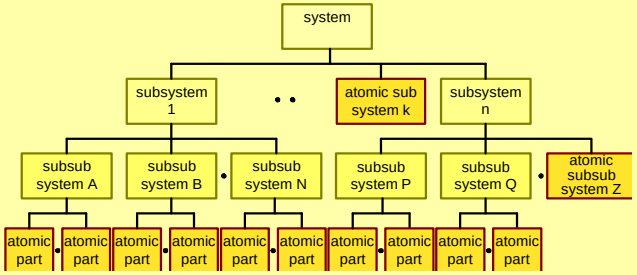


3D sketch of system internals

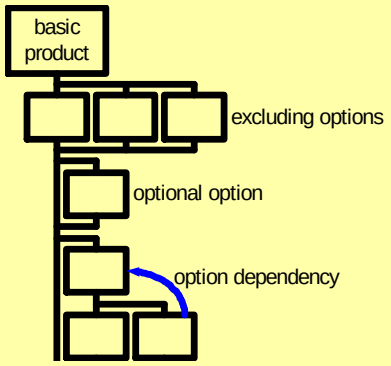
and select 1 representation from below



Work Breakdown Structure



System Breakdown

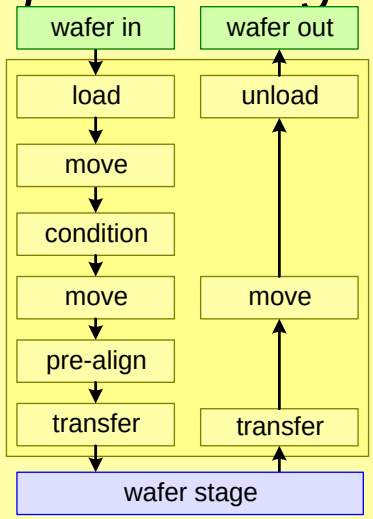


Product Configuration Tree

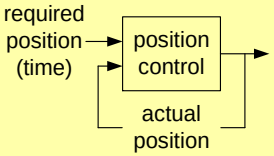
Functional Analysis

Make ~3 functional diagrams showing the behavior of part of the system

sequence diagram

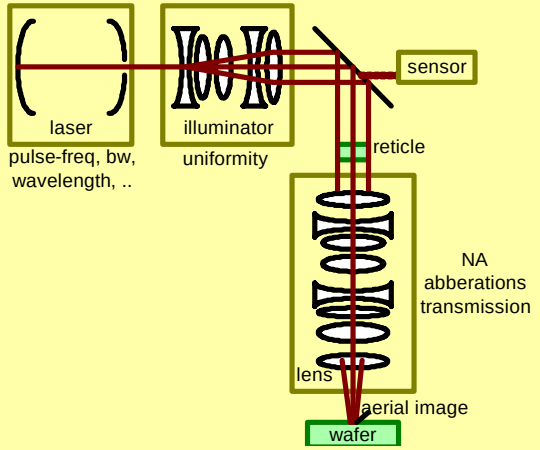


feedback control

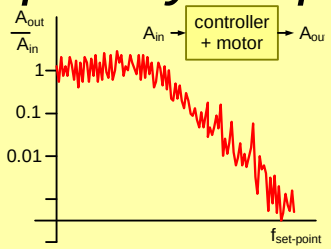


feedback frequency:
4 kHz (0.25 msec)

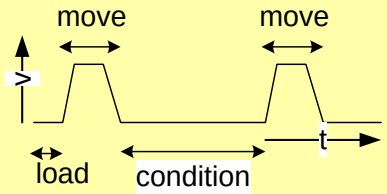
light path



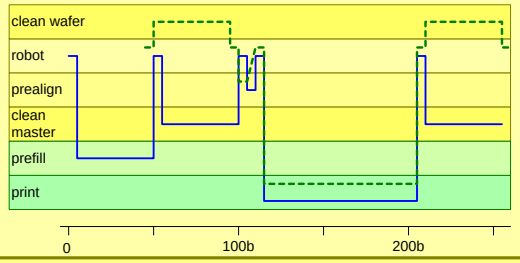
frequency response



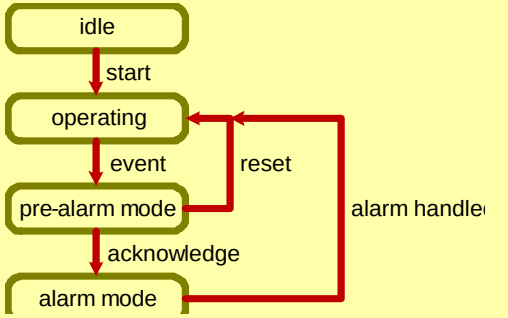
parameter as function of time



swimming lanes



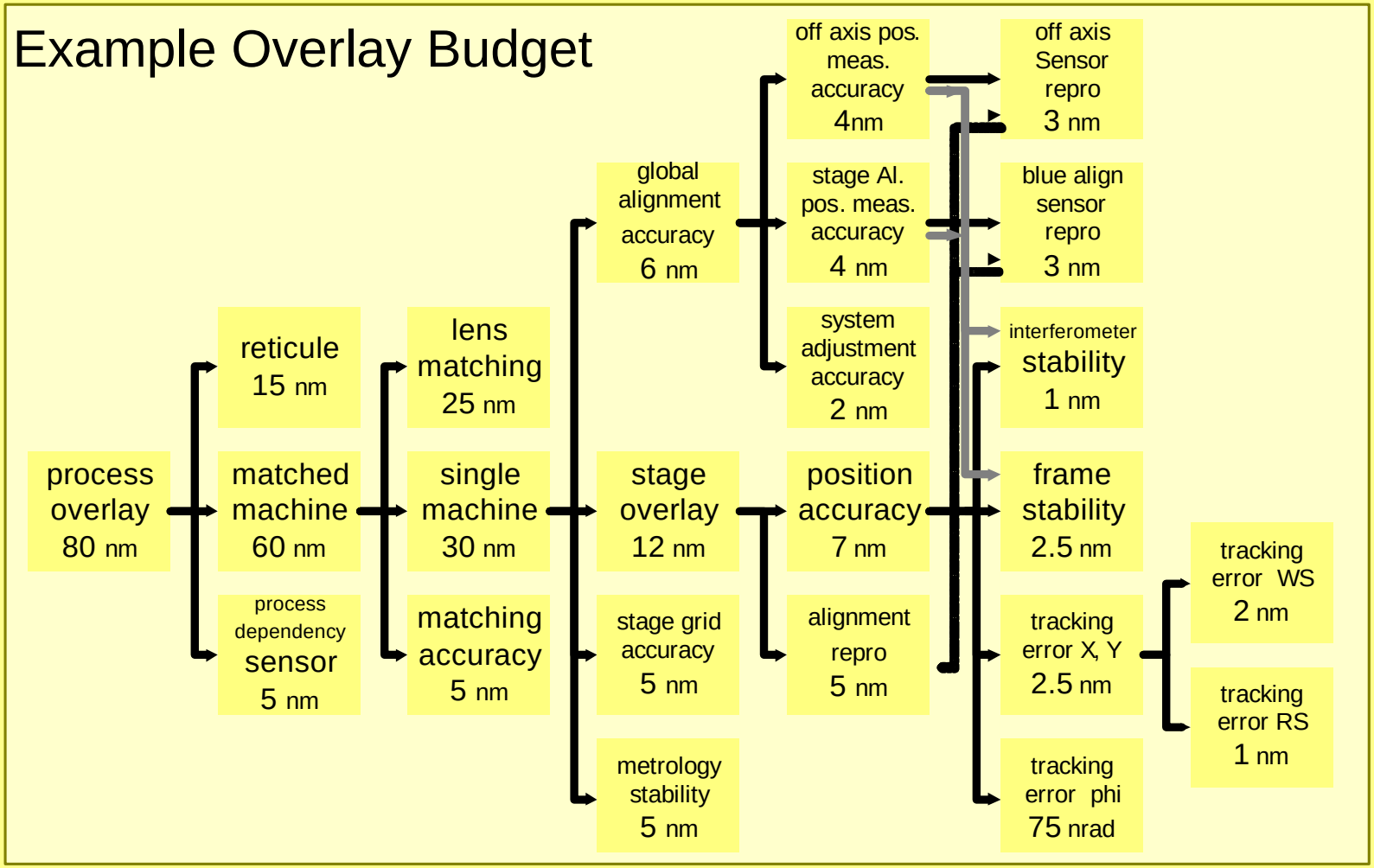
state diagram



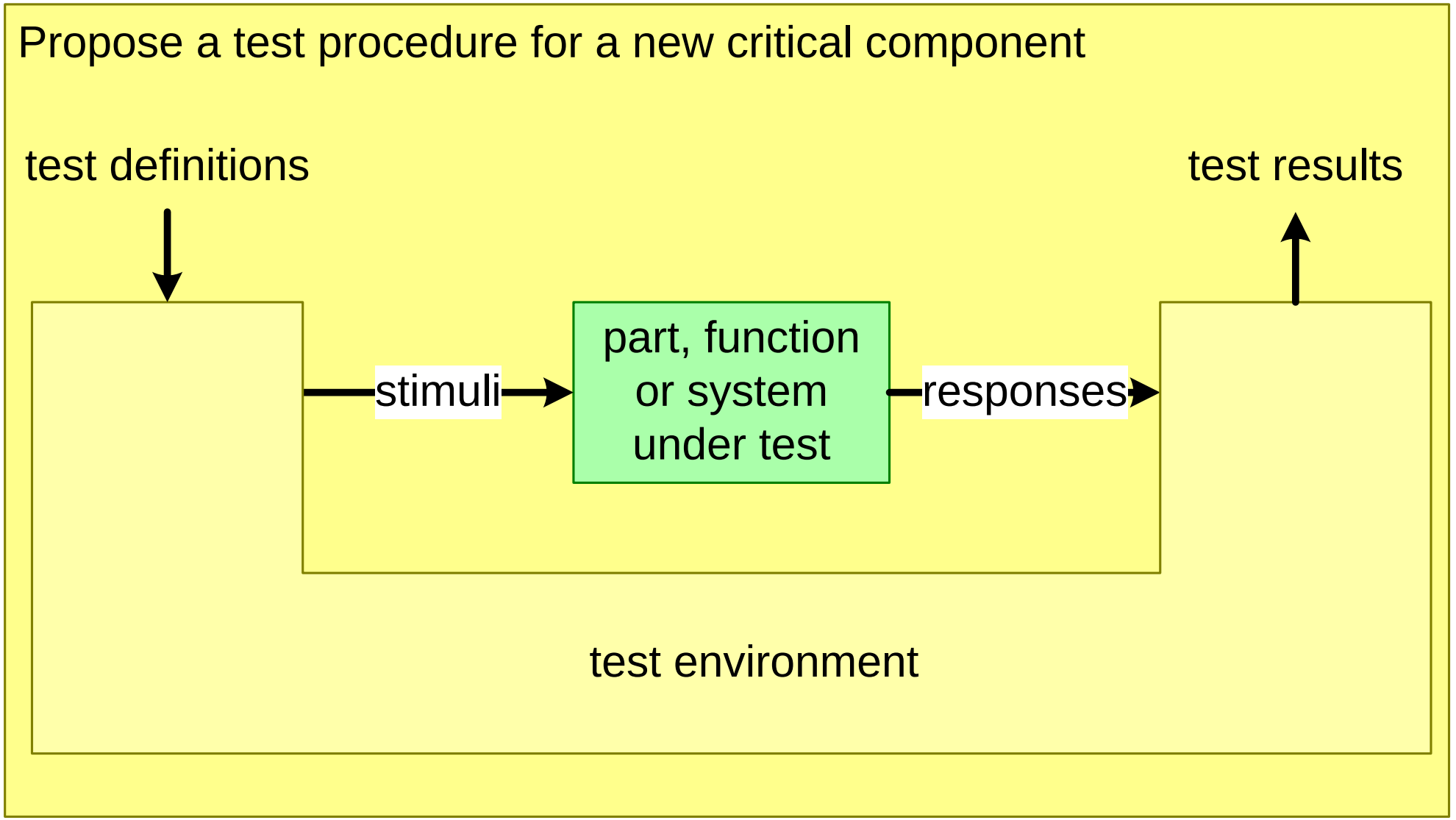
Technical Budget

Make a technical budget, a breakdown of contributions, for one KPP

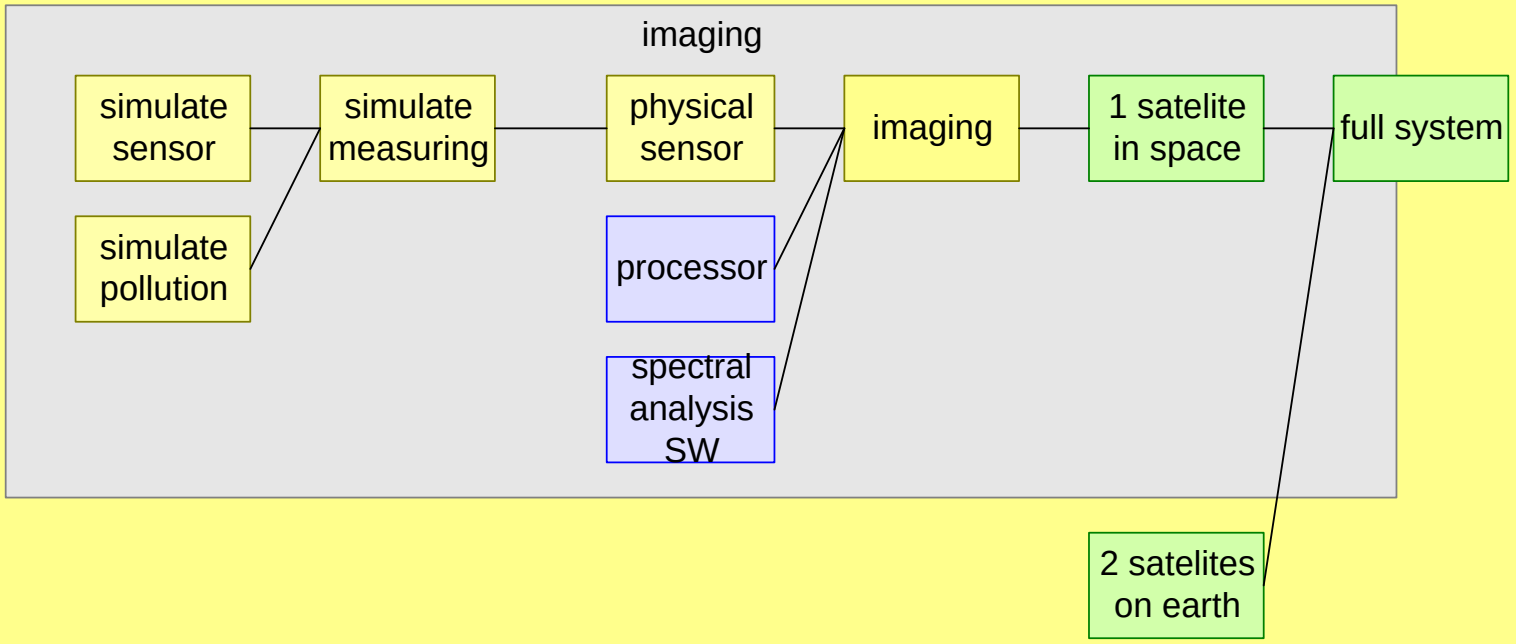
Example Overlay Budget



Testing and Verification



Propose an integration sequence that shows the KPP early



Homework; Consult Colleagues

Consult your colleagues to determine and construct:

- the top 3 Key Performance Parameters of your (sub)system
- 3 views on dynamic behavior; how does your (sub)system achieve the KPPs?

Case Presentation

Make a presentation for the Project Team to explain

- project overview
- master plan
- design
- verification & integration
- life cycle