

# What is the relation between Architecting and Model-Based working?

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## Abstract

Architecting is the activity to create and maintain an architecture. An architecture description captures the why, what and how of ways to create solutions for a given problem. An architecture relates the customer value proposition (desirability) and the business and life cycle proposition (viability) to the system definition to the design and technology choices (feasibility). Architects make use of a rich palette of models. In the past decades, researchers have proposed many forms of formal modeling to support specific design challenges. In Systems Engineering, there are high expectations of Model Based Systems Engineering (MBSE). What is the relation between architecting and MBSE?

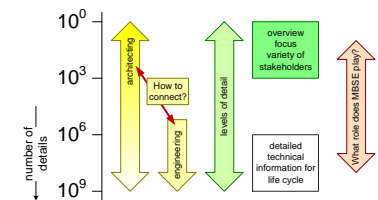
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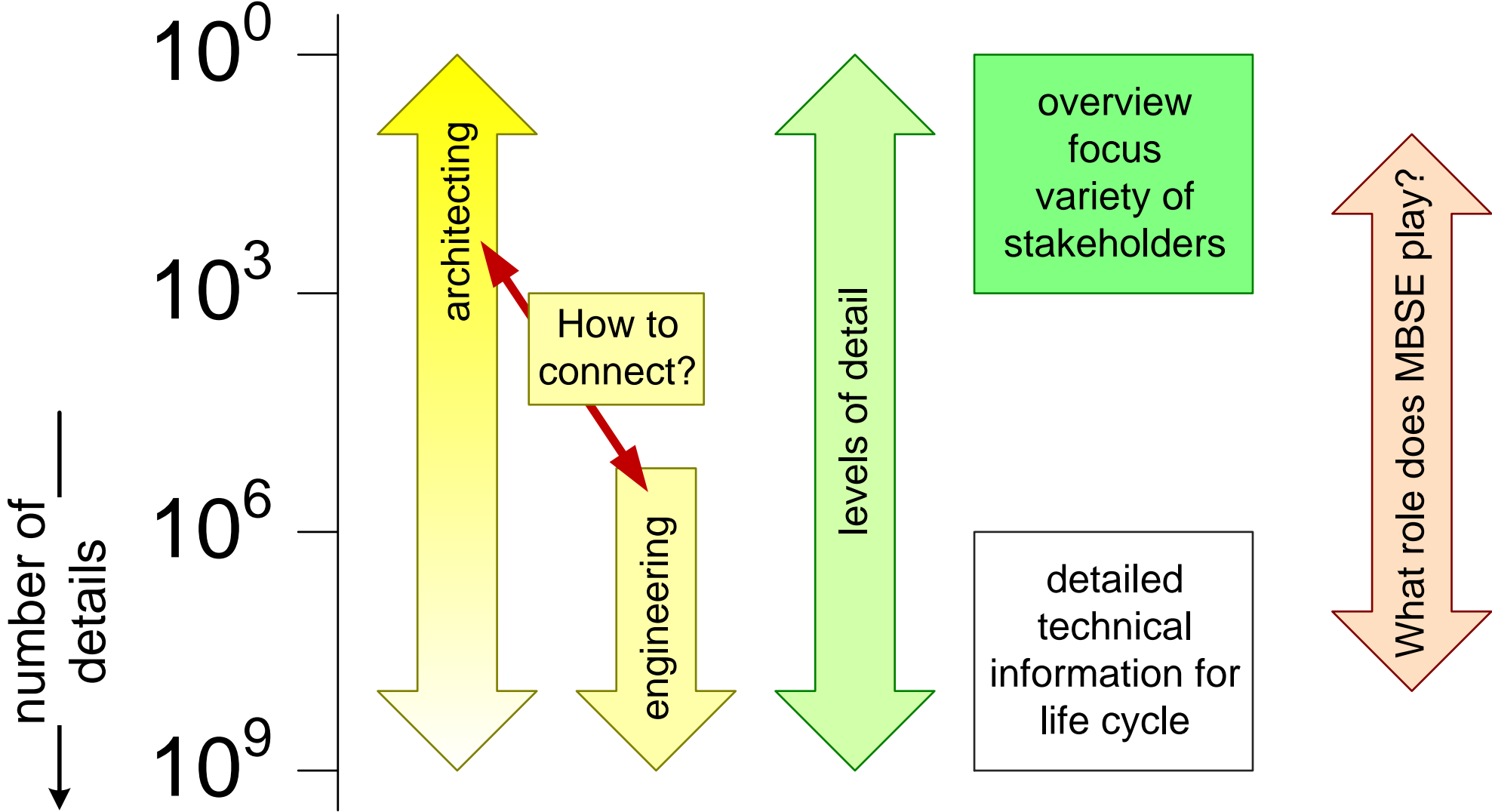
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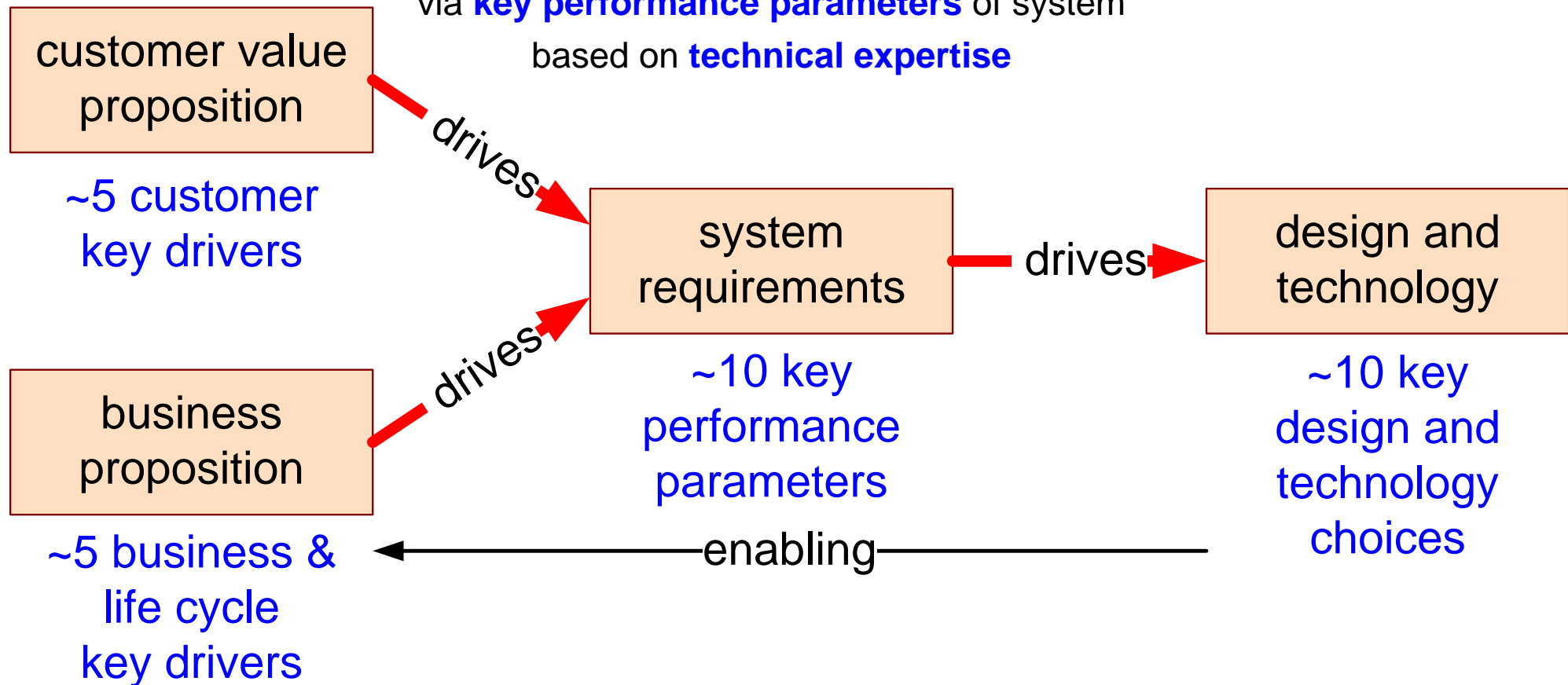
# Figure of Content



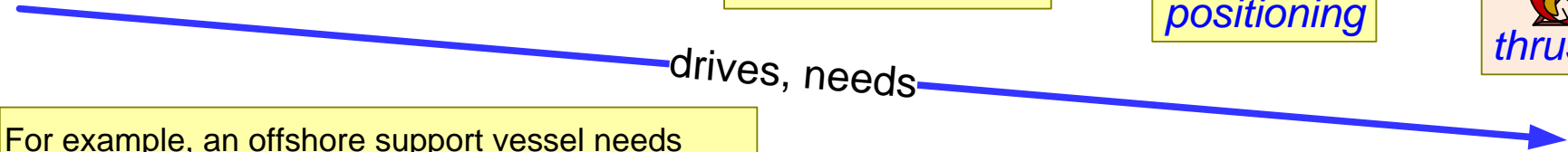
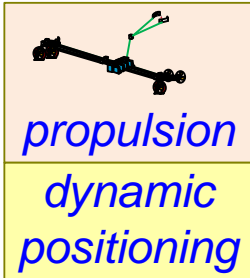
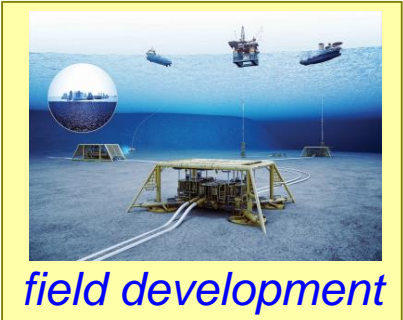
# Systems Architecting: delivering solutions that are fit for purpose

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

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



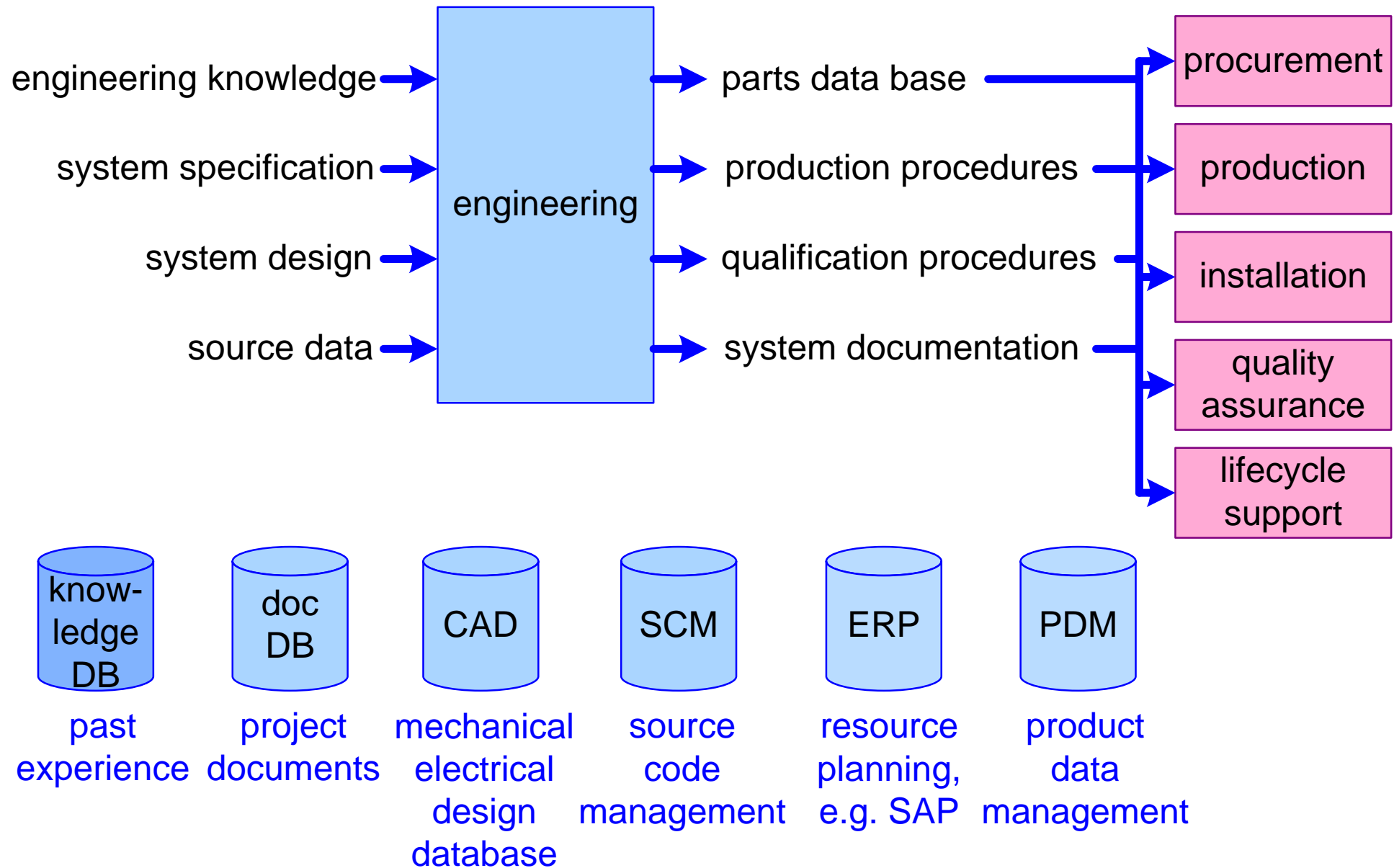
# System needs drive subsystem specification and design



For example, an offshore support vessel needs propulsion and dynamic positioning (sub)systems. The operations that the offshore vessel has to perform, e.g. anchor handling, determine the offshore vessel specs, which in turn drive the propulsion specs.

- concepts
- design
- technologies

# Engineering produces TPD: the How-to for the Life Cycle



# Complexity challenges require architecting and engineering

## *common problems*

- the project is **inefficient**
  - needs too many resources
- suffers from **delays, cost overruns**
  - late design changes
  - surprises during integration or deployment
- many “**manual**” transitions and operations
  - handovers increase risk
- long system **lifetime**
  - obsolescence
  - changing context
- **organizational complexity**
  - ecosystems, supply chains

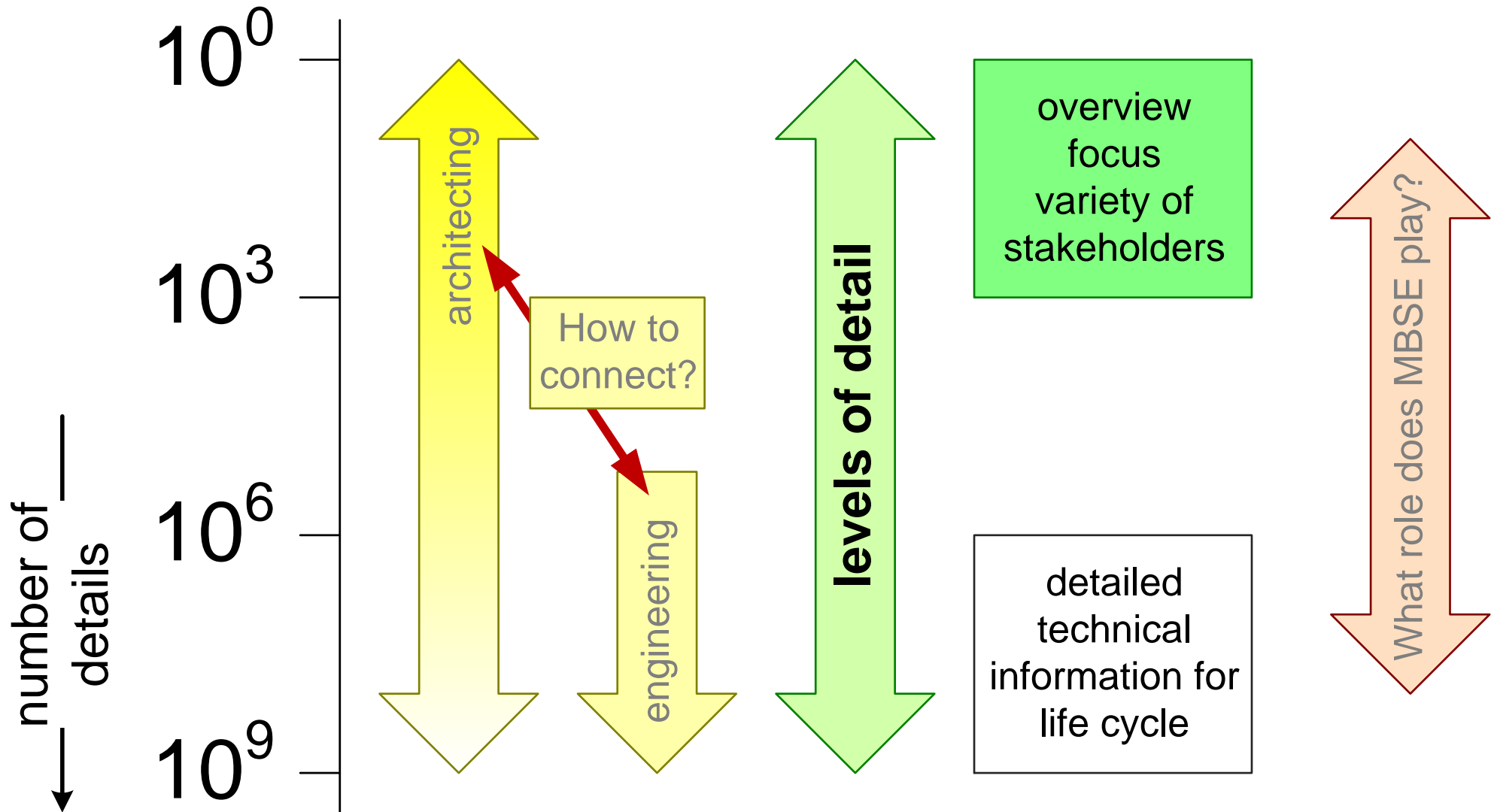
## *proposed architecting solutions*

- **overview**
  - compact information, A4, A3
  - connecting the dots
  - covering the dynamics
- **focus**
  - emphasis on key drivers, performance parameters and design decisions
- support for **communication** between **heterogeneous stakeholders**
  - visualization and conceptualization

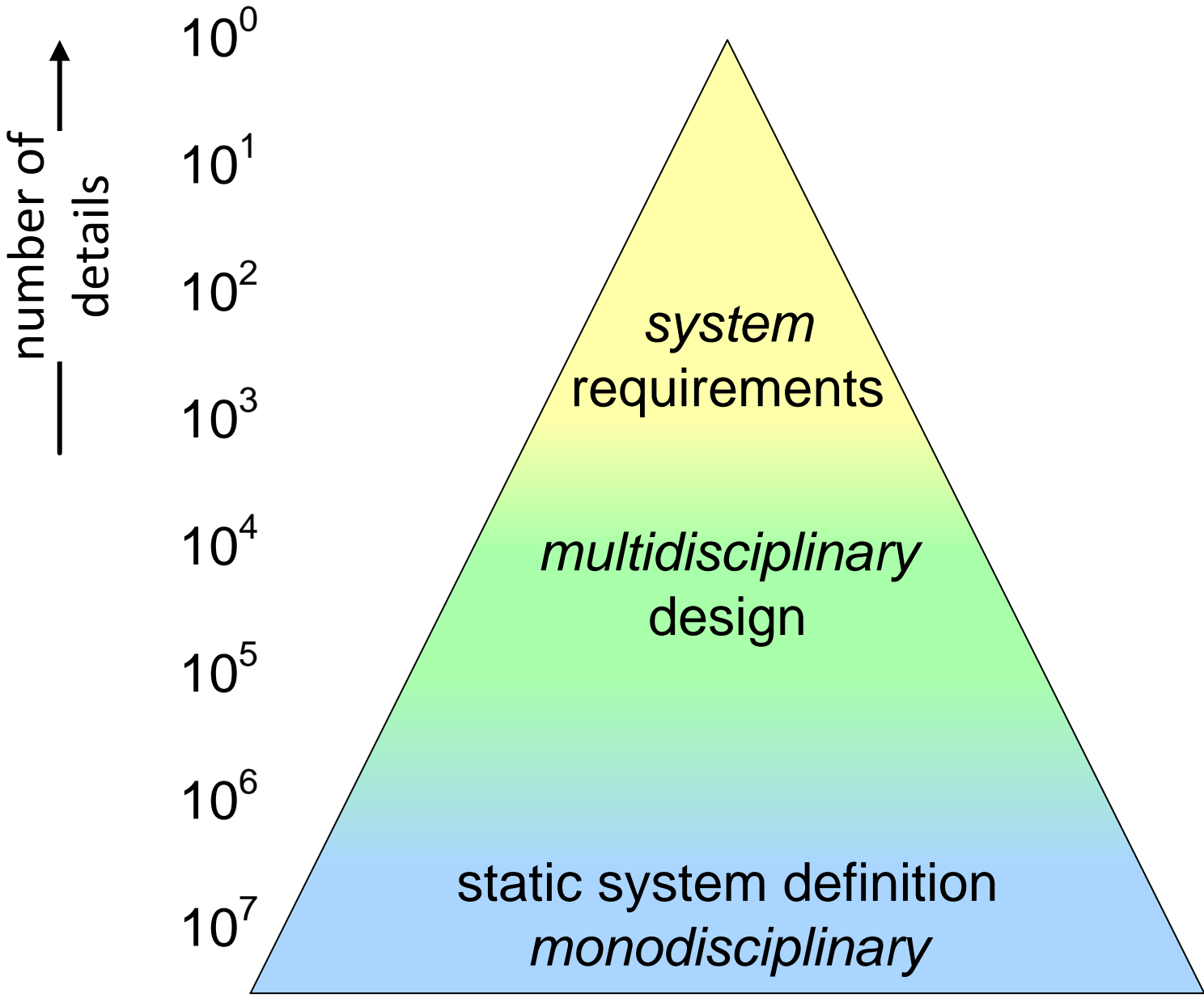
## *proposed engineering solutions*

- process and tooling support
- information models for interoperability
- “MBSE” + wide variety of IT tools

# Levels of Detail

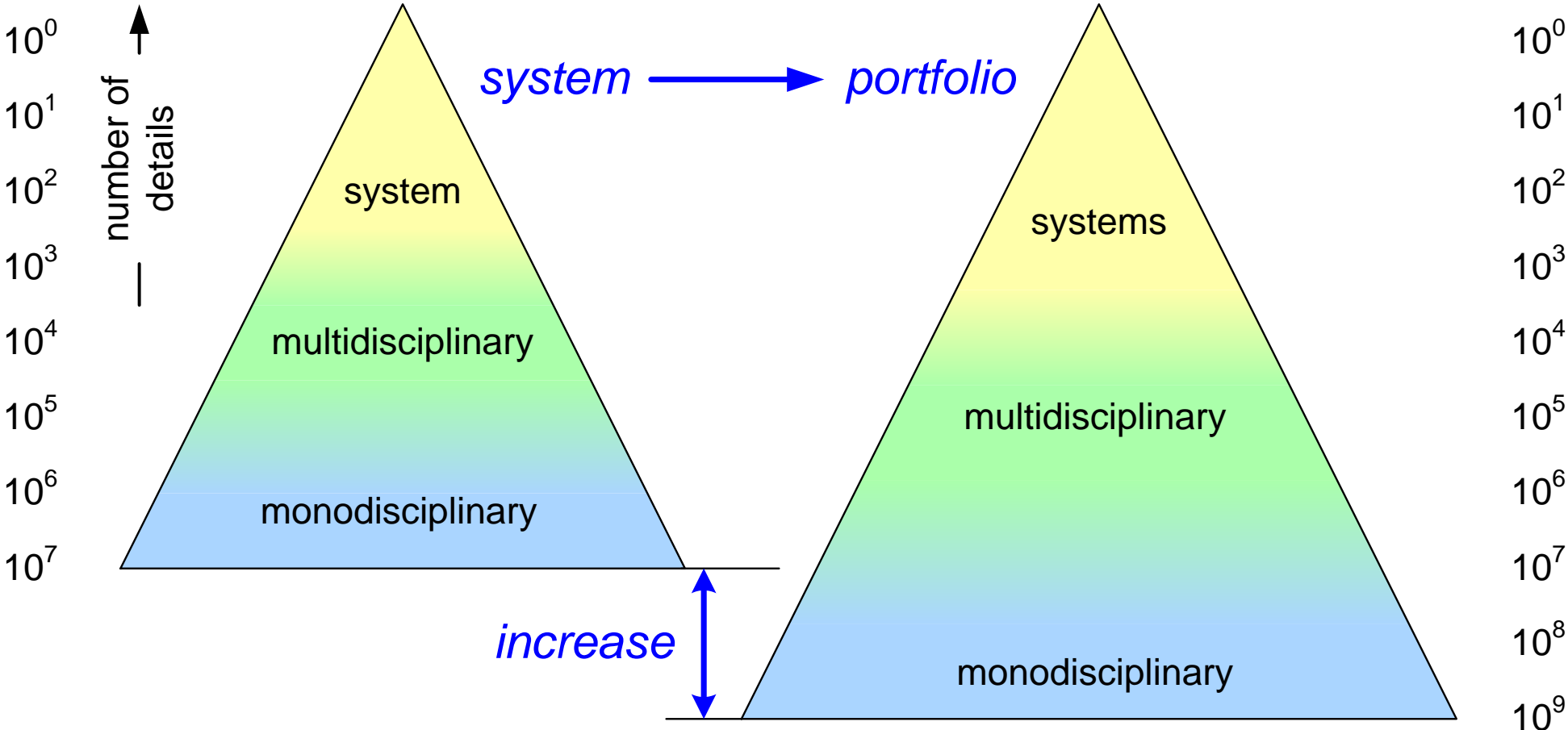


# Level of Abstraction Single System

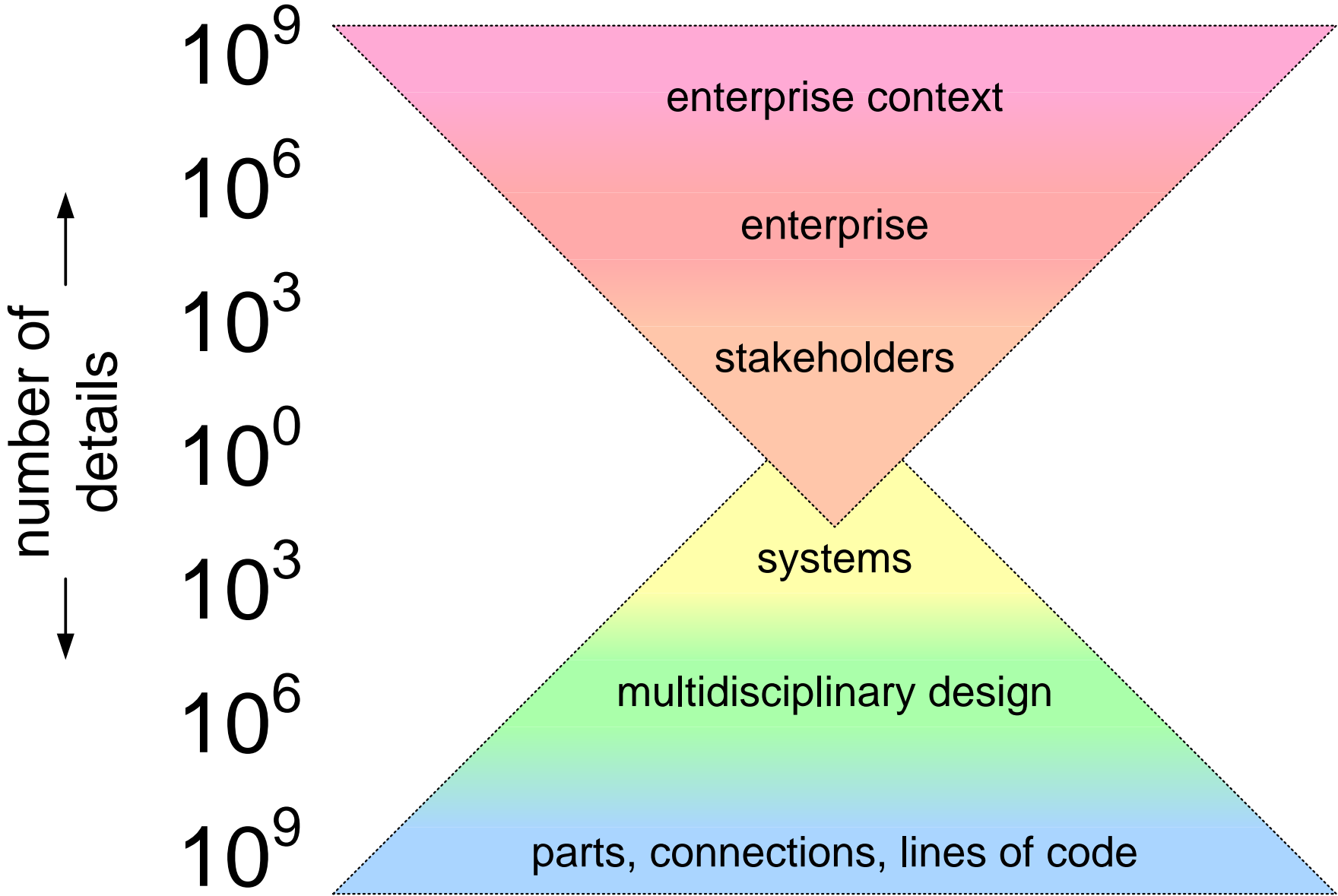




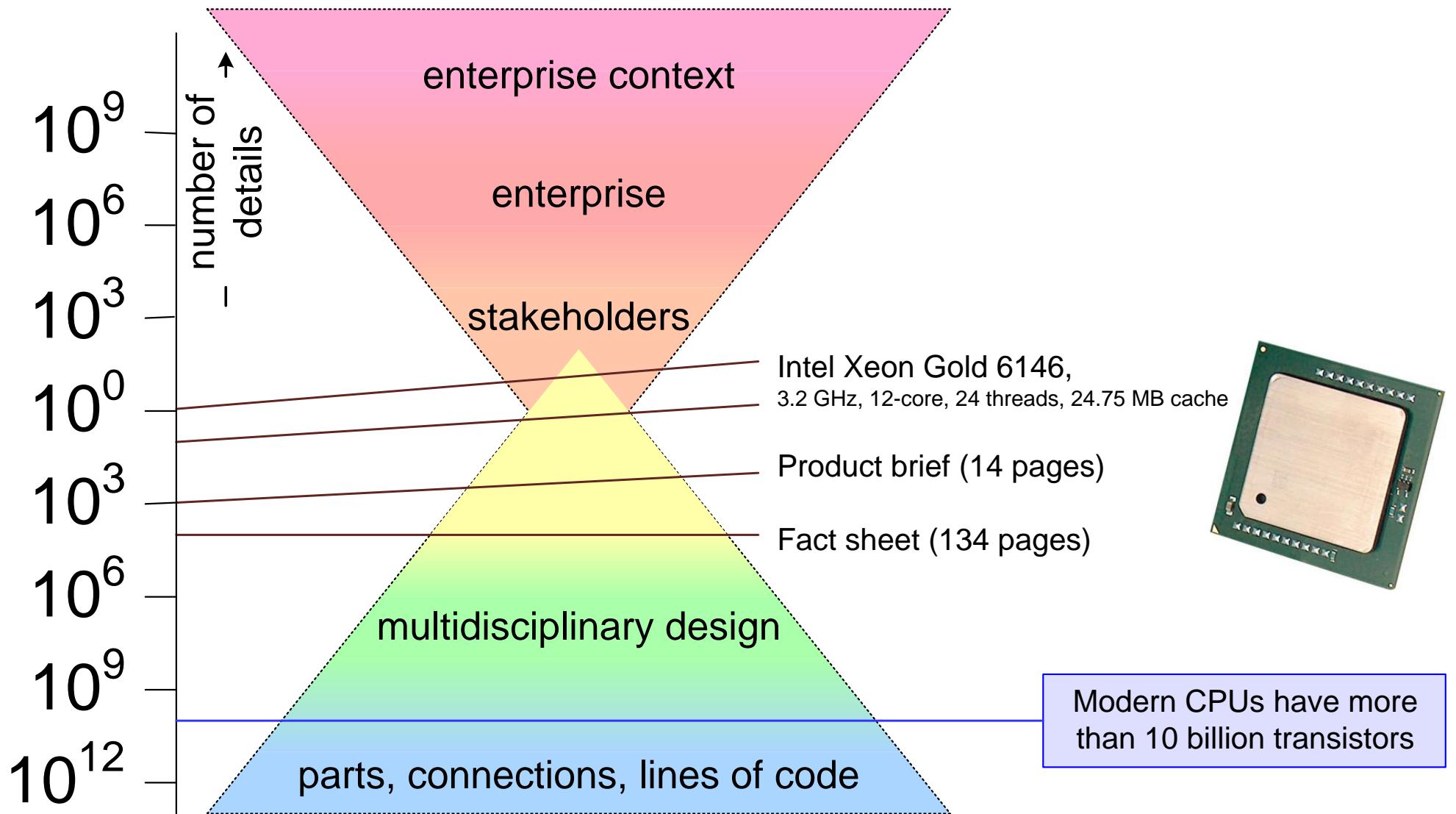
# From system to Product Family or Portfolio



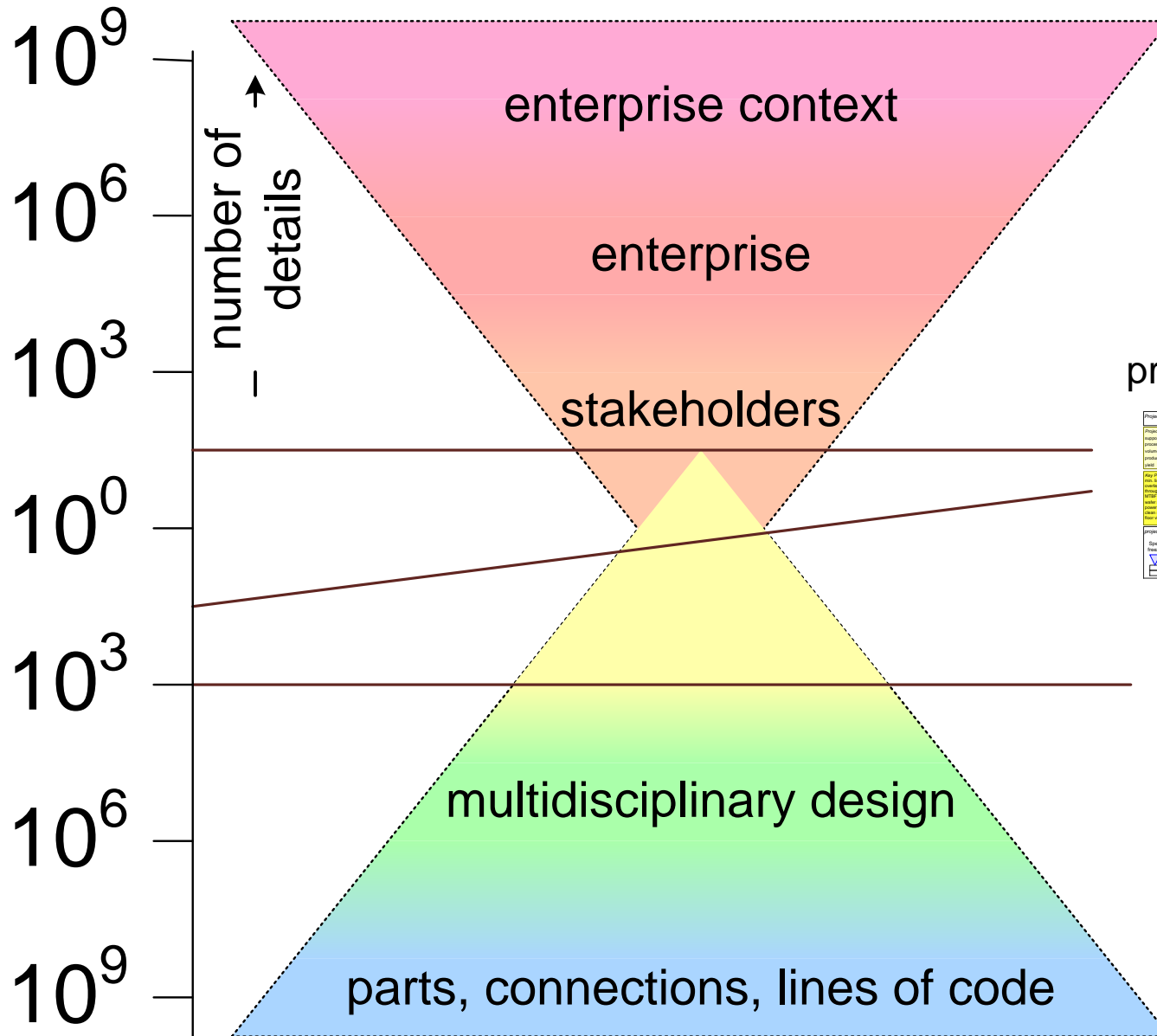
# Product Family in Context



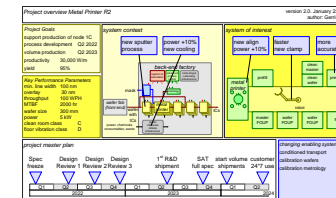
# Example for a CPU chip



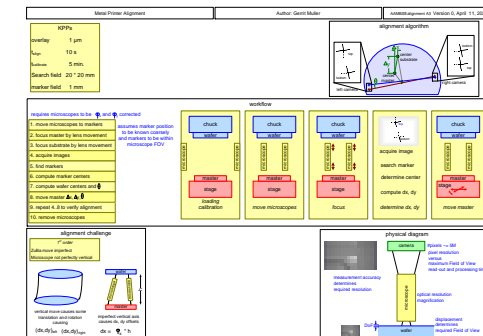
# Example for a Metal Printer



project overview A4



architecture overview A3



# A4 Project Overview brings overview and focus

Project overview Metal Printer R2

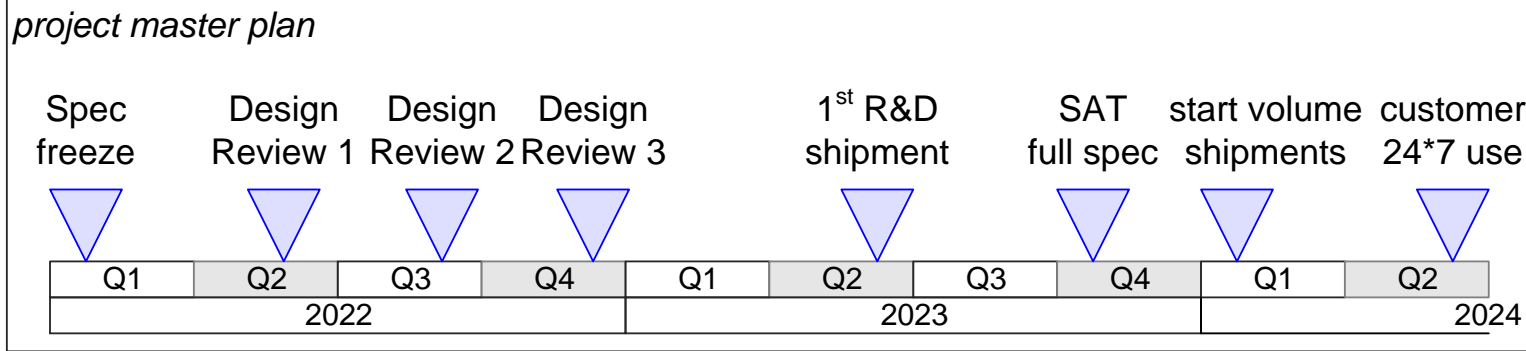
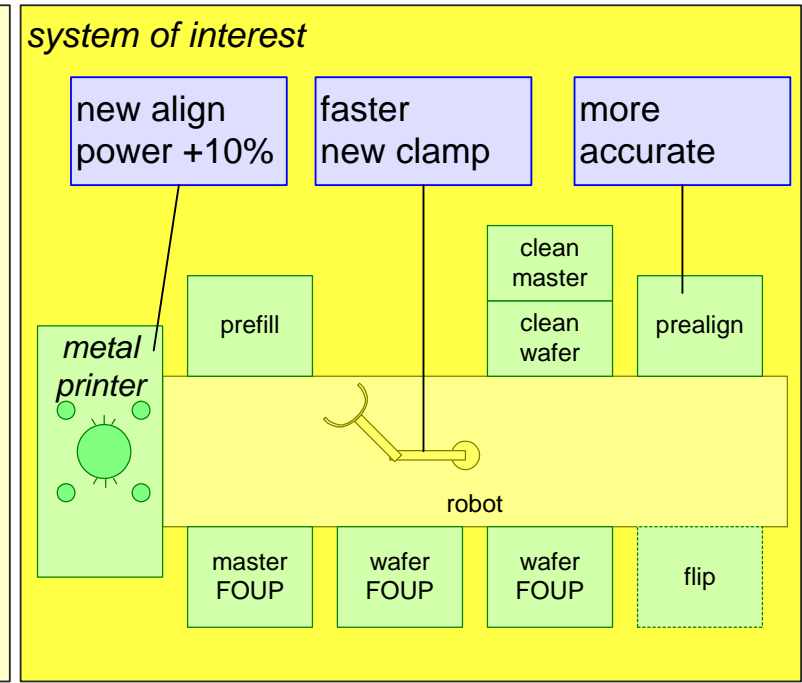
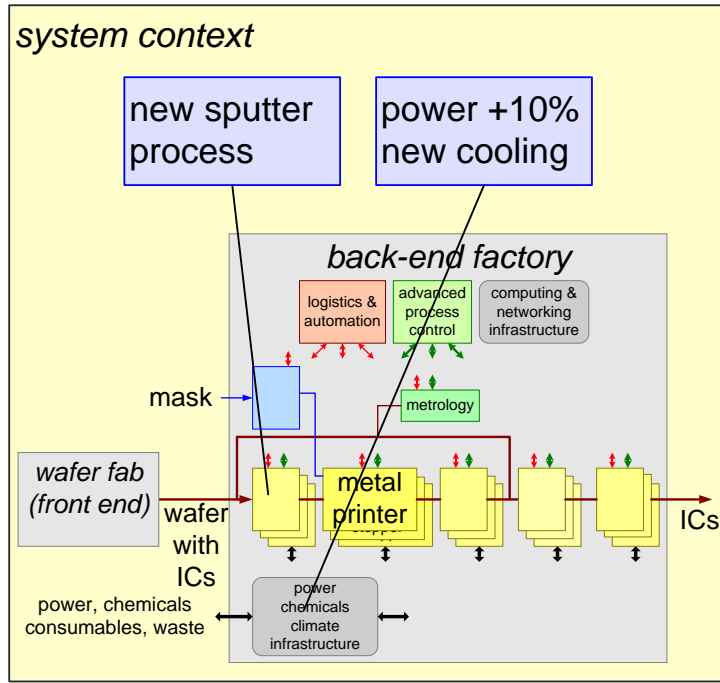
version 2.0. January 22, 2023  
author: Gerrit Muller

**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**

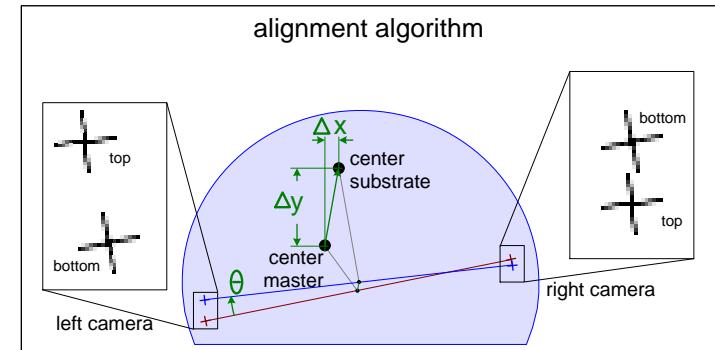
- min. line width 100 nm
- overlay 30 nm
- throughput 100 WPH
- MTBF 2000 hr
- wafer size 300 mm
- power 5 kW
- clean room class C
- floor vibration class D



**changing enabling systems**

- conditioned transport
- calibration wafers
- calibration metrology

KPPs	
overlay	1 $\mu\text{m}$
$t_{\text{align}}$	10 s
$t_{\text{calibrate}}$	5 min.
Search field	20 * 20 mm
marker field	1 mm

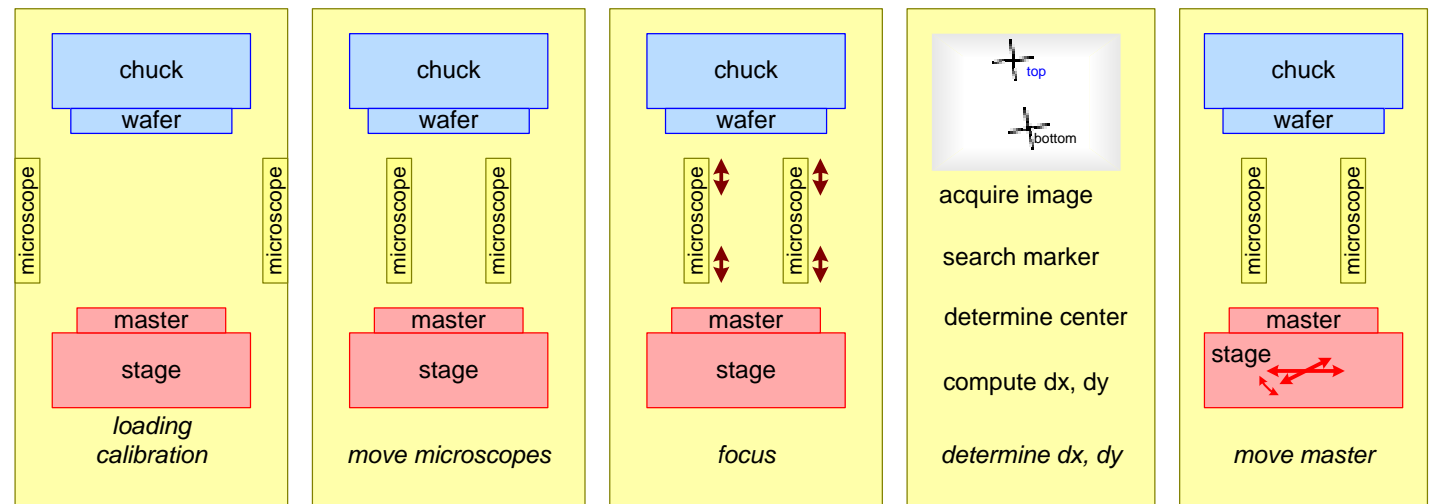


requires microscopes to be  $\varphi_x$  and  $\varphi_y$  corrected

1. move microscopes to markers
2. focus master by lens movement
3. focus substrate by lens movement
4. acquire images
5. find markers
6. compute marker centers
7. compute wafer centers and  $\theta$
8. move master  $\Delta x, \Delta y, \theta$
9. repeat 4..8 to verify alignment
10. remove microscopes

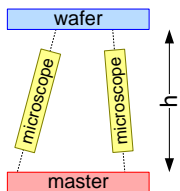
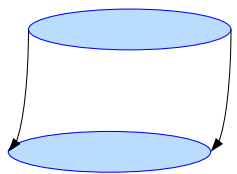
assumes marker position to be known coarsely and markers to be within microscope FOV

workflow



alignment challenge

1<sup>st</sup> order  
ZuBa move imperfect  
Microscope not perfectly vertical



vertical move causes some translation and rotation causing

imperfect vertical axis causes dx, dy offsets

$$(dx, dy)_{\text{left}} \quad (dx, dy)_{\text{right}}$$

$$dx = \varphi_x * h$$

physical diagram



camera #pixels  $\approx$  5M  
pixel resolution versus maximum Field of View read-out and processing time

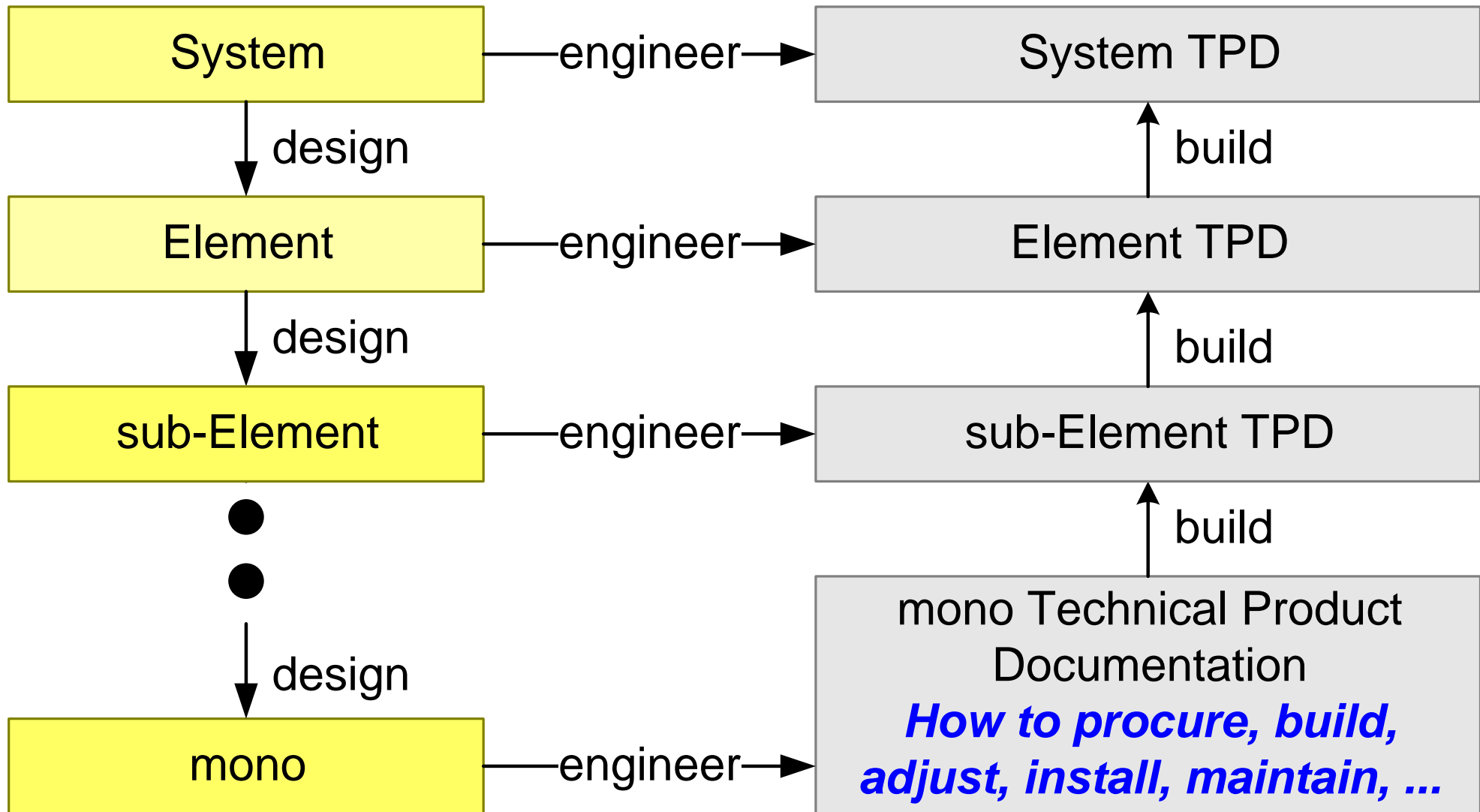
measurement accuracy determines required resolution

optical resolution magnification

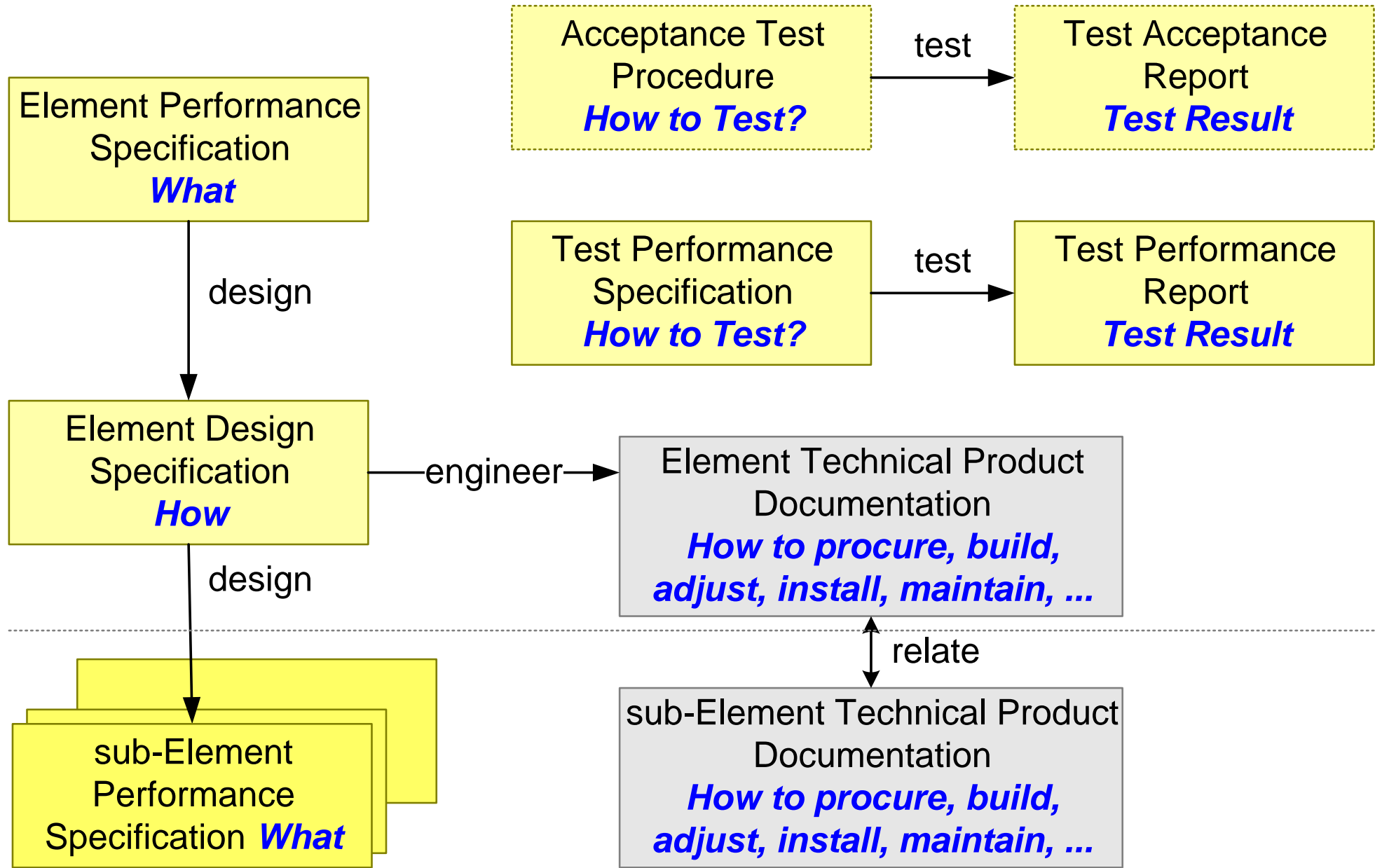


displacement determines required Field of View

# TPD translates design into life cycle instructions

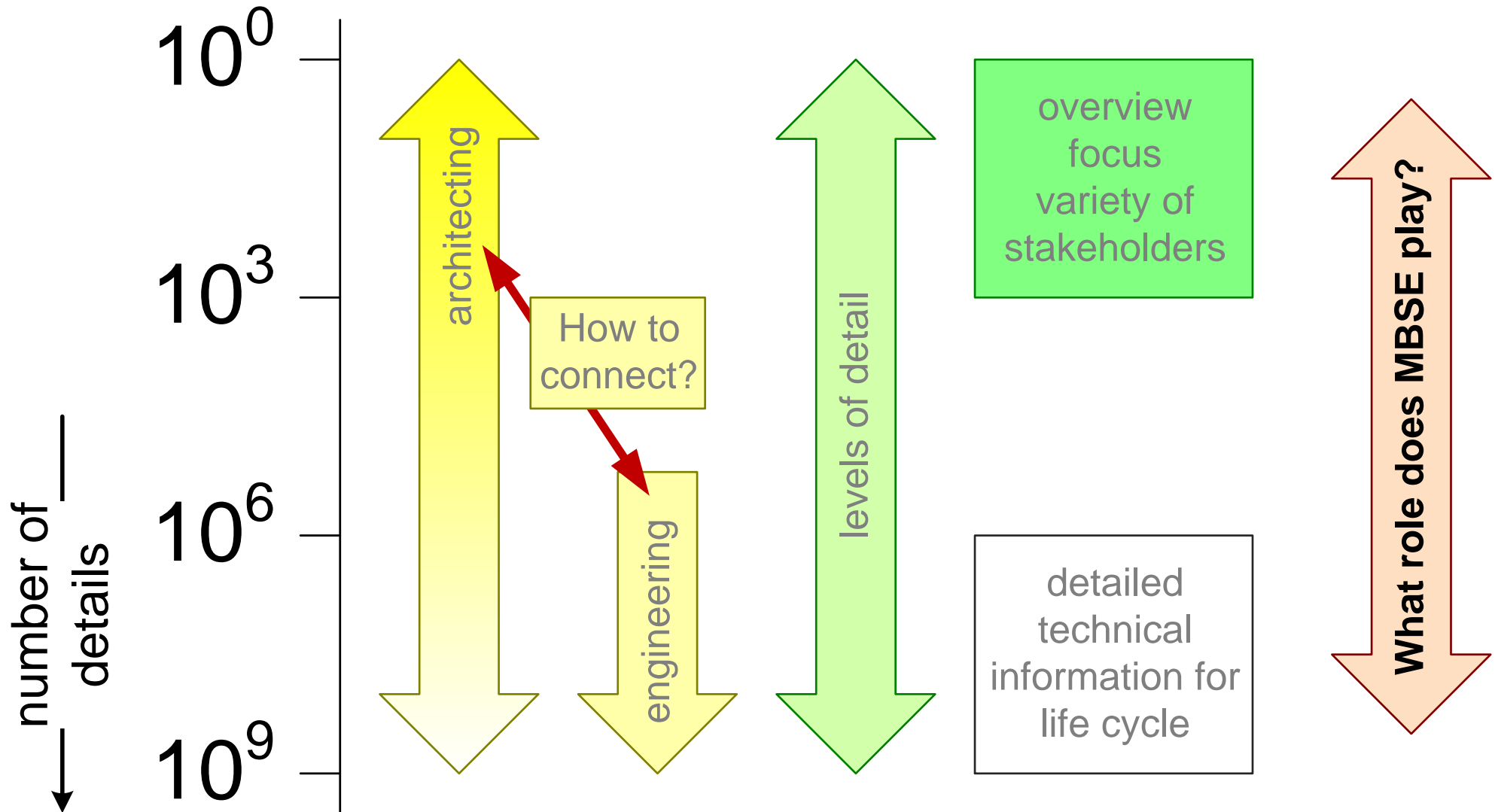


# Each Element needs information from specification to qualification





# What Role does MBSE Play?



# The definition of MBSE is broad and ambitious

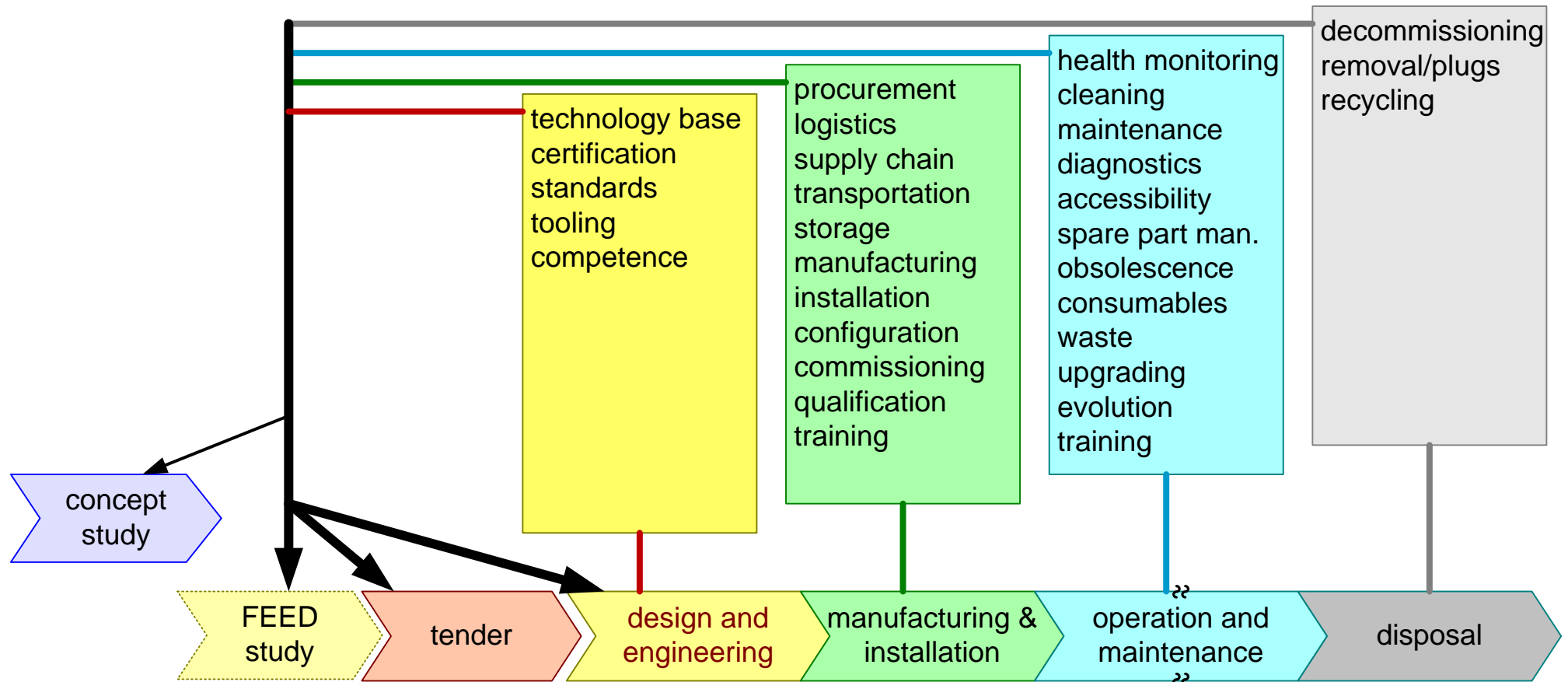
Model-based Systems Engineering [MBSE] is a paradigm that uses **formalized representations** of systems, known as models, **to support and facilitate** the performance of **Systems Engineering [SE] tasks throughout a system's life cycle**.

MBSE is frequently contrasted with legacy document-based approaches where systems engineering captures system design information via multiple independent documents in various non-standardized formats. MBSE consolidates system information in system design models, which provide primary SE artifacts. These system models, which are generally expressed in a standardized modelling language such as Systems Modeling Language [SysML®] express key system information in a **concise, consistent, correct,** and **coherent** format. When implemented properly, MBSE models permit the standardized consolidation and integration of system **knowledge** across engineering disciplines and subsystems and streamline key systems engineering tasks while also minimizing developmental risk.

From SEBoK:

[https://sebokwiki.org/wiki/Model-Based\\_Systems\\_Engineering\\_\(MBSE\)#:~:text=Model%2Dbased%20Systems%20Engineering%20%5BMBSE,throughout%20a%20system's%20life%20cycle.](https://sebokwiki.org/wiki/Model-Based_Systems_Engineering_(MBSE)#:~:text=Model%2Dbased%20Systems%20Engineering%20%5BMBSE,throughout%20a%20system's%20life%20cycle.)

# The life cycle has many information needs



# What is the real MBSE objective?

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- to support **reuse** or a platform based product strategy
  - to configure, generate, compose, validate
- to **automate** or generate
  - **tests, simulations**
- to **trace** needs, requirements, or quality attributes throughout the design and engineering
  - especially regulated qualities like **safety**
- to function as **knowledge base** for development and engineering
- to **access component-data** based on the field configuration (digital shadow)
- to populate and update **PLM** systems, e.g. ERP (digital thread)