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

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

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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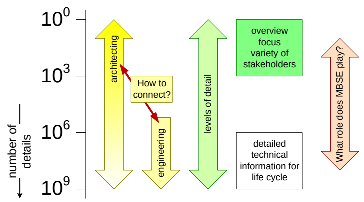
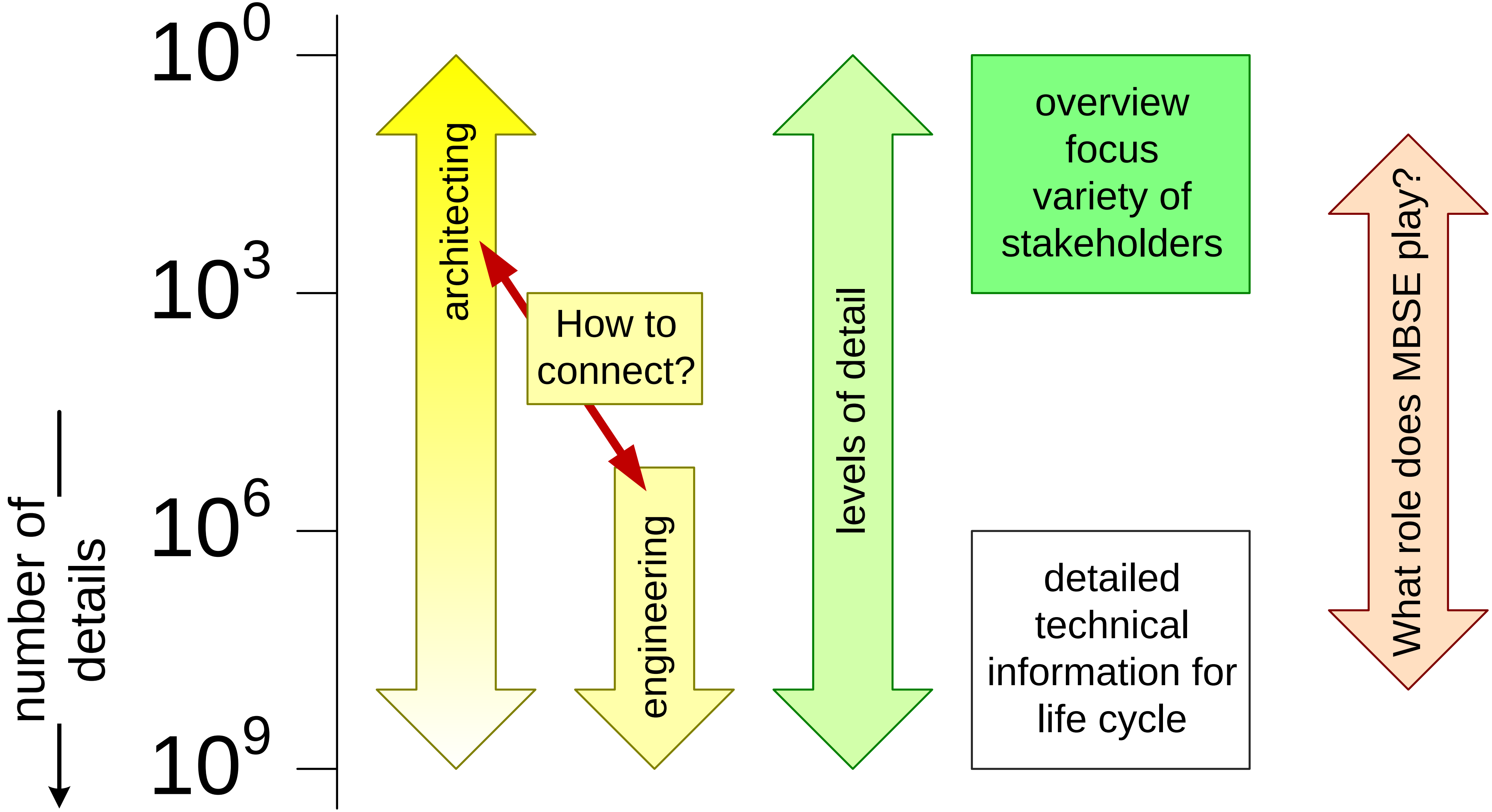


Figure of Content



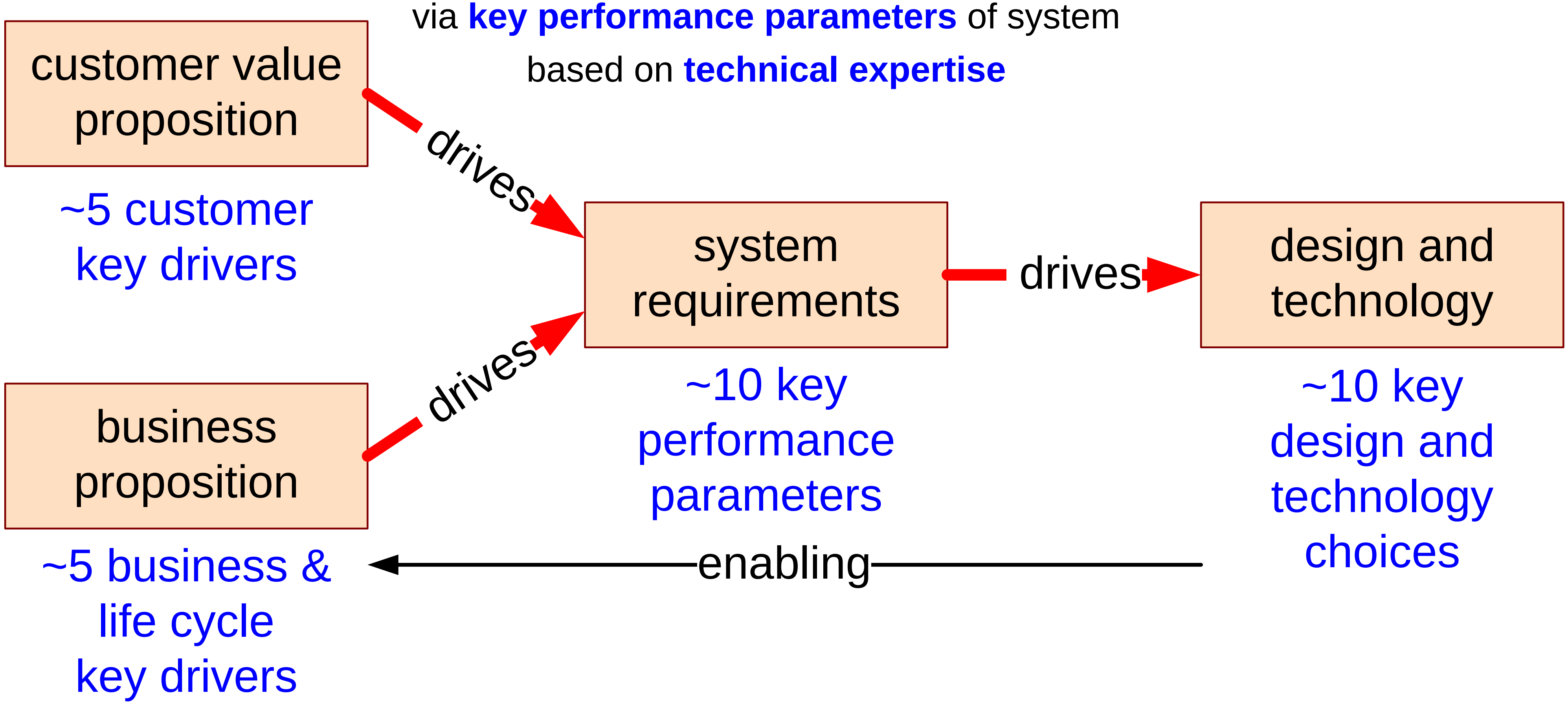
Systems Architecting: delivering solutions that are fit for purpose

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

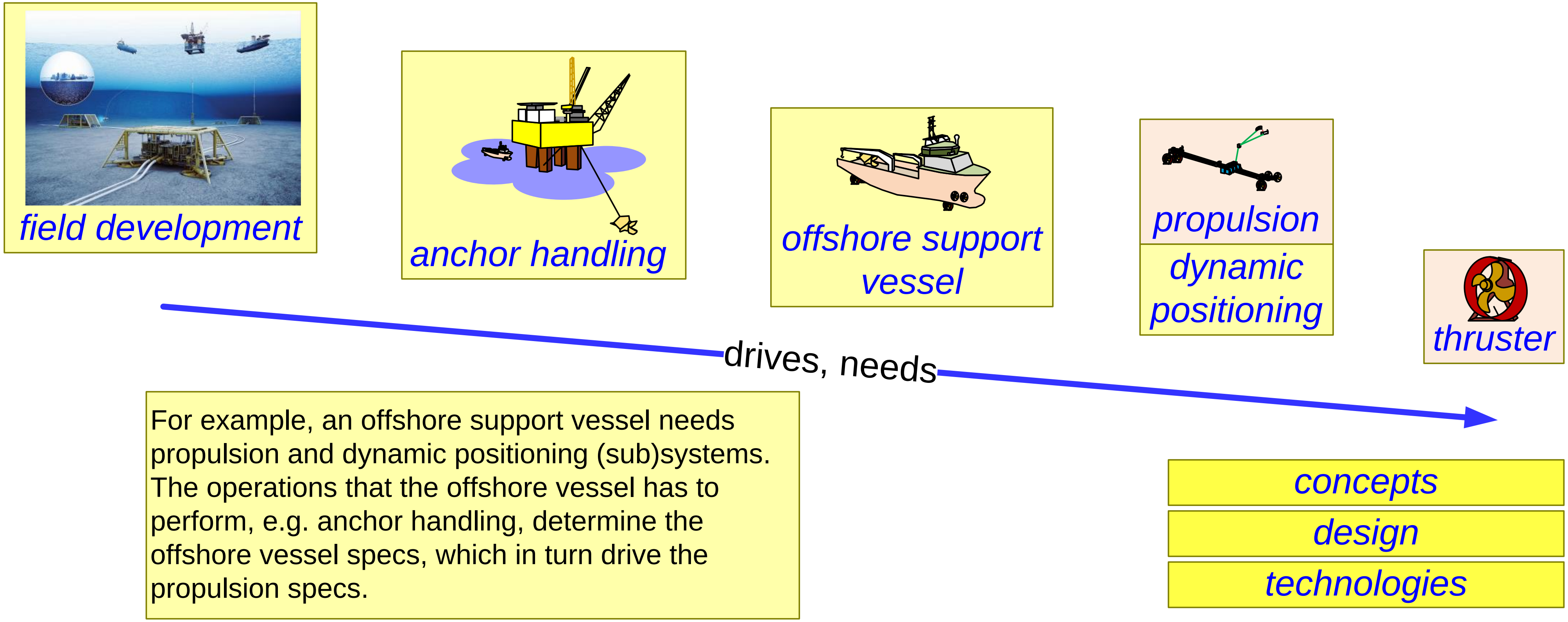
Achieving **customer** and **business key drivers**

via **key performance parameters** of system

based on **technical expertise**

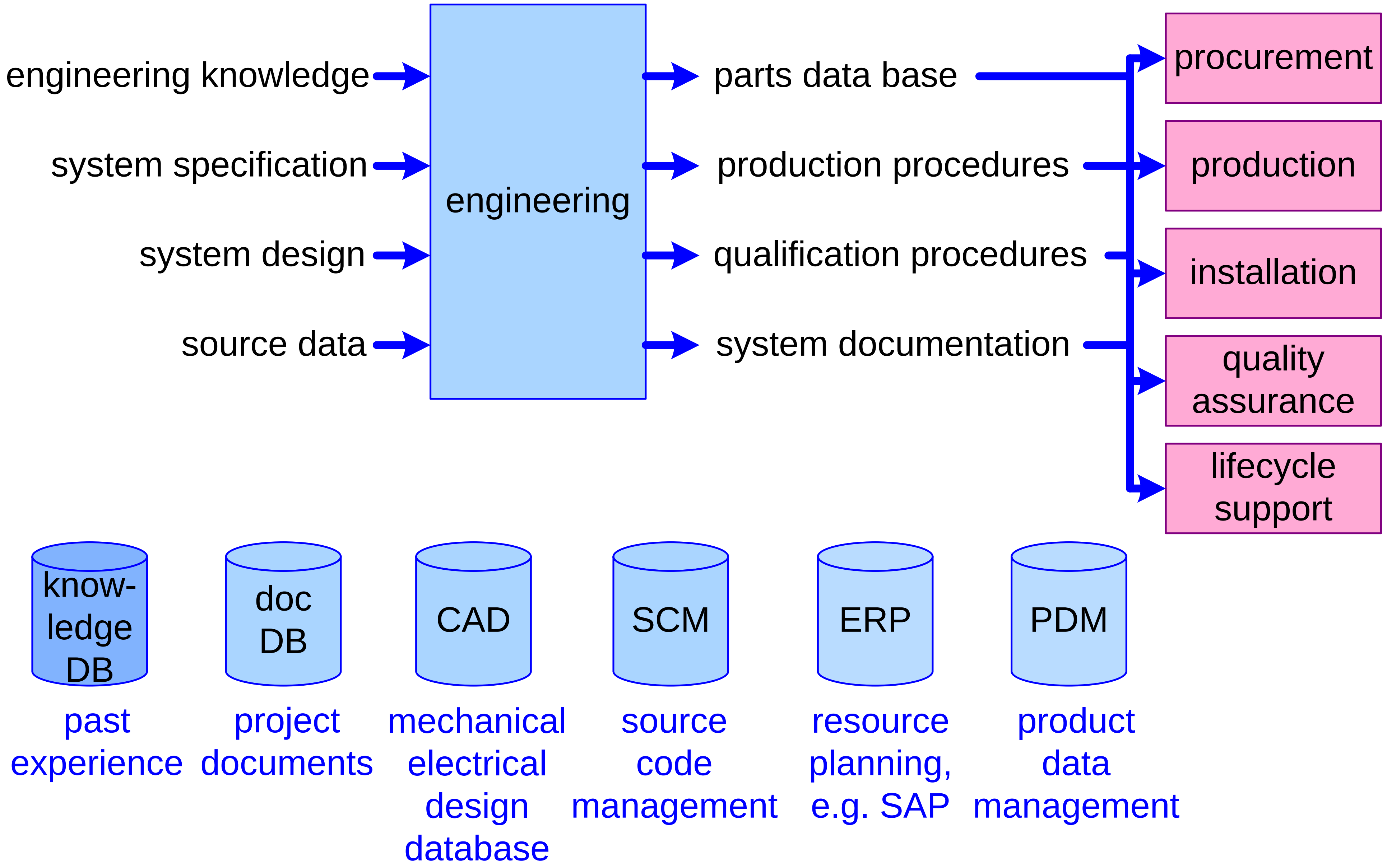


System needs drive subsystem specification and design



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.

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

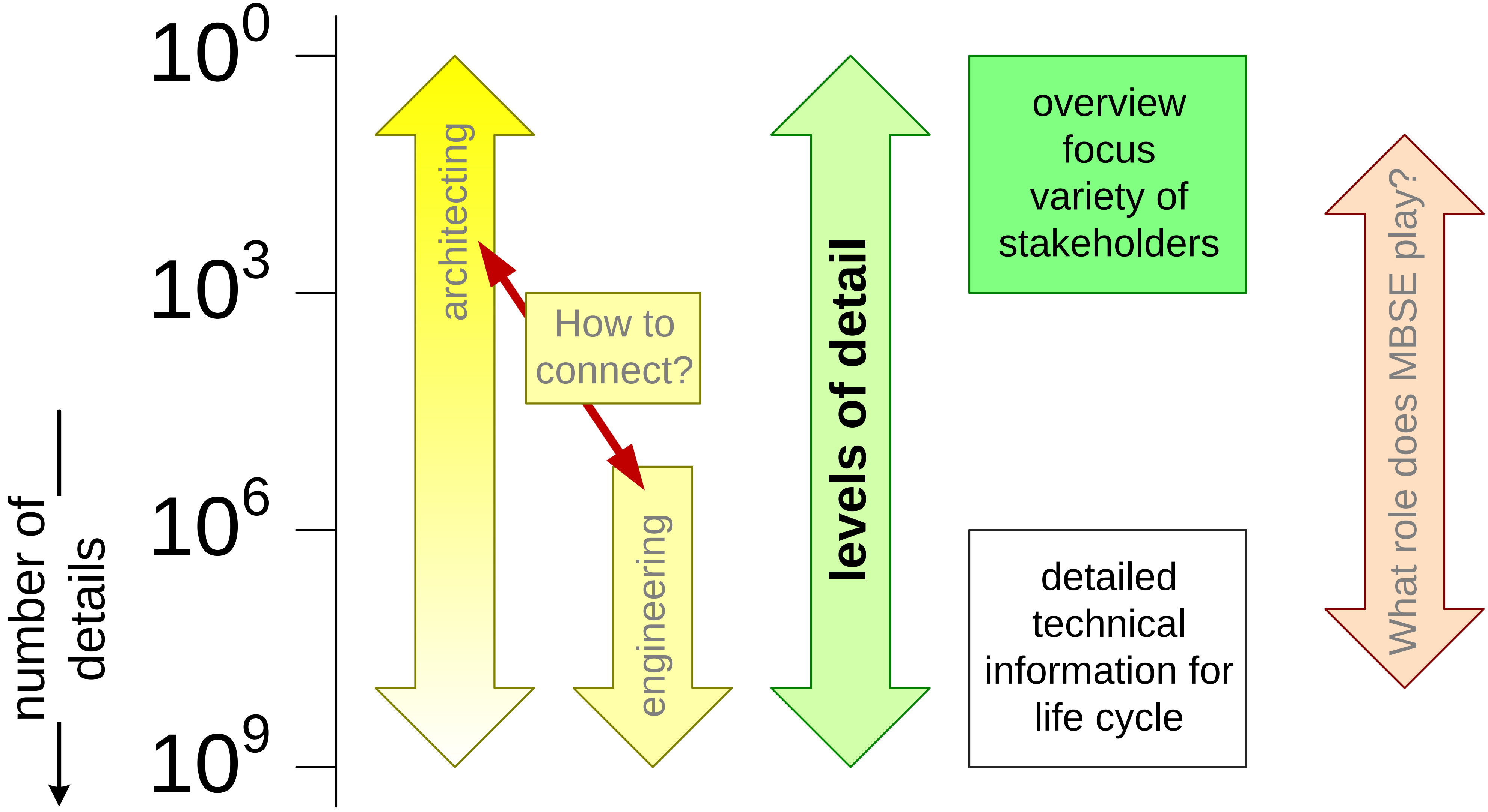
proposed architecting solutions

- **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

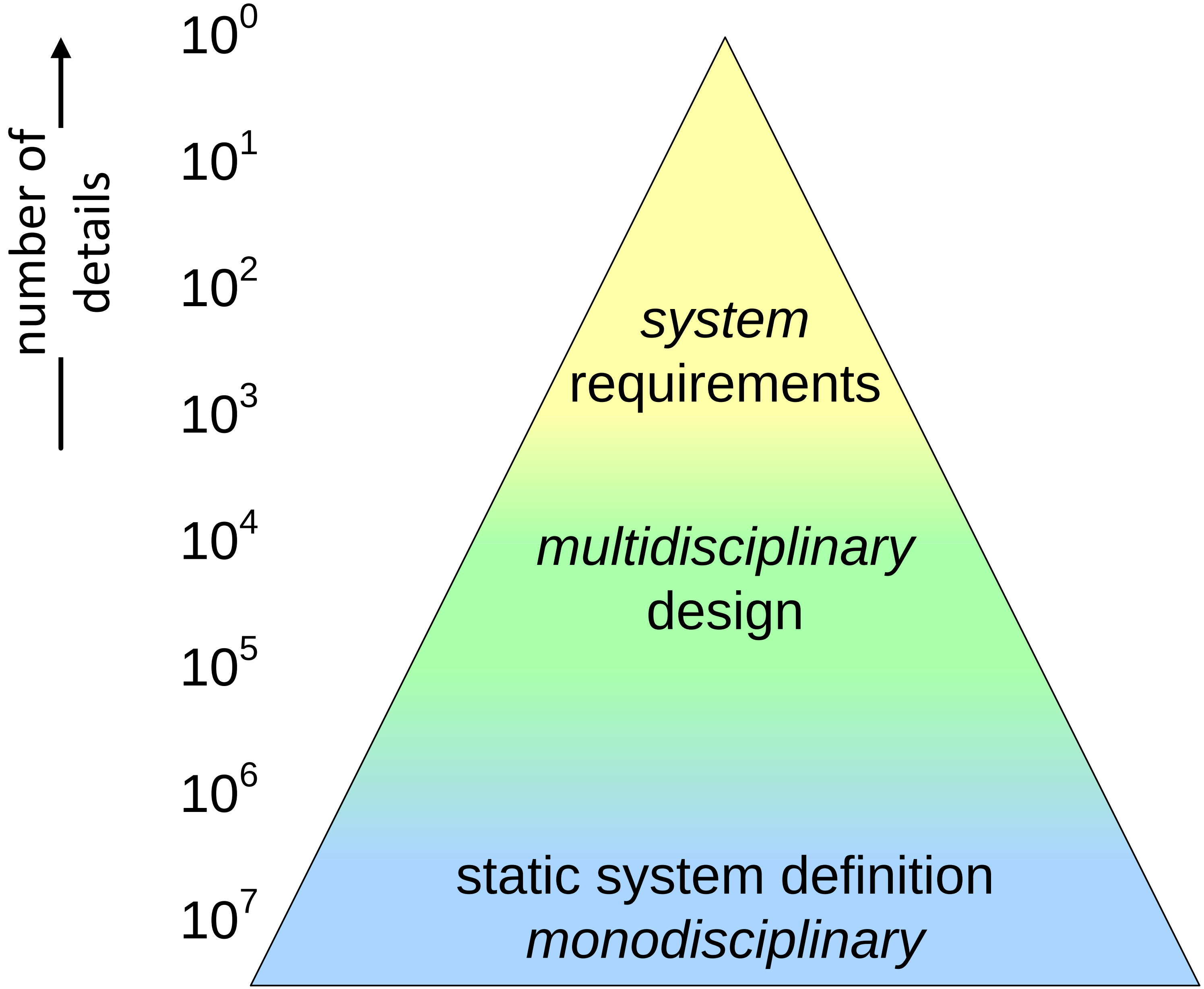
proposed engineering solutions

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

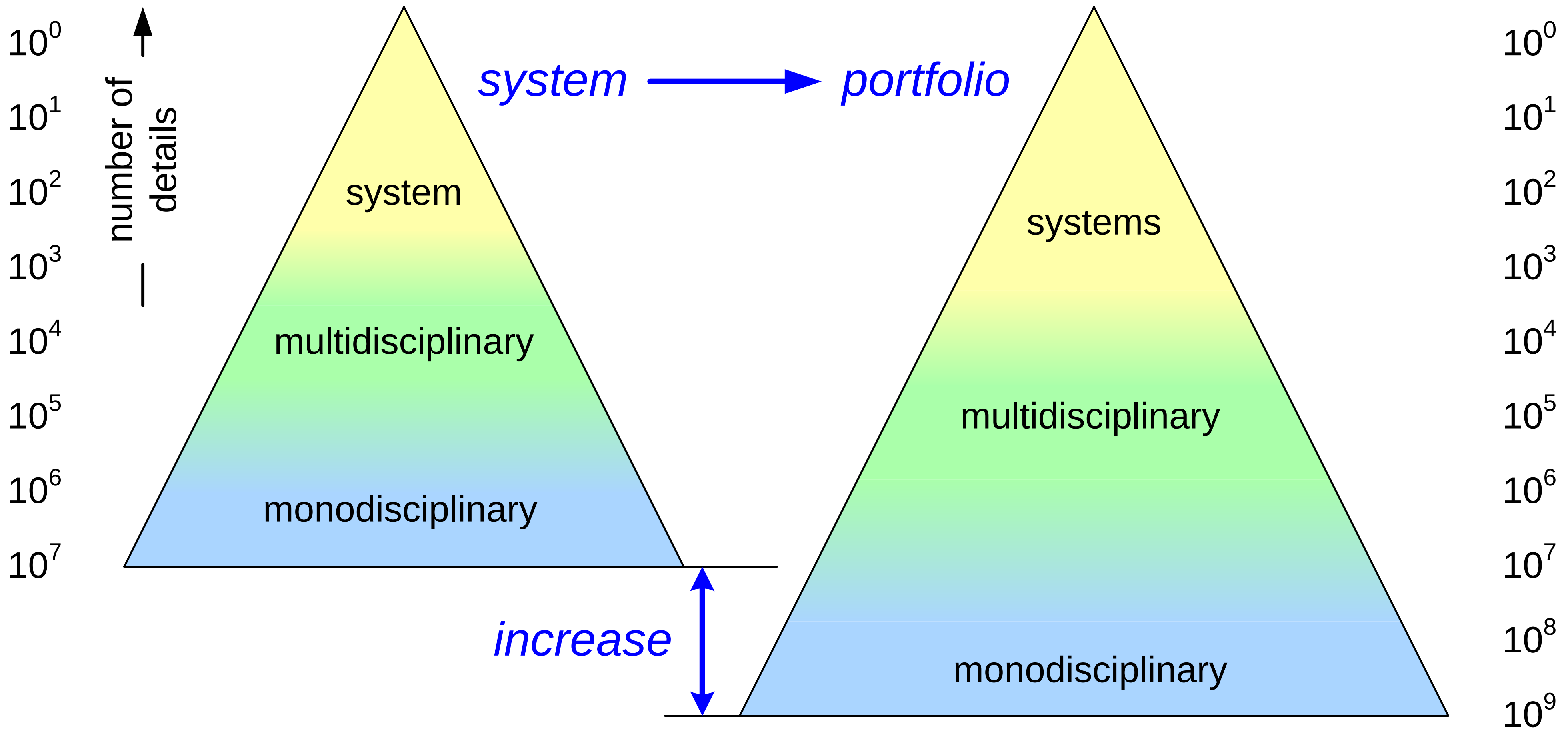
Levels of Detail



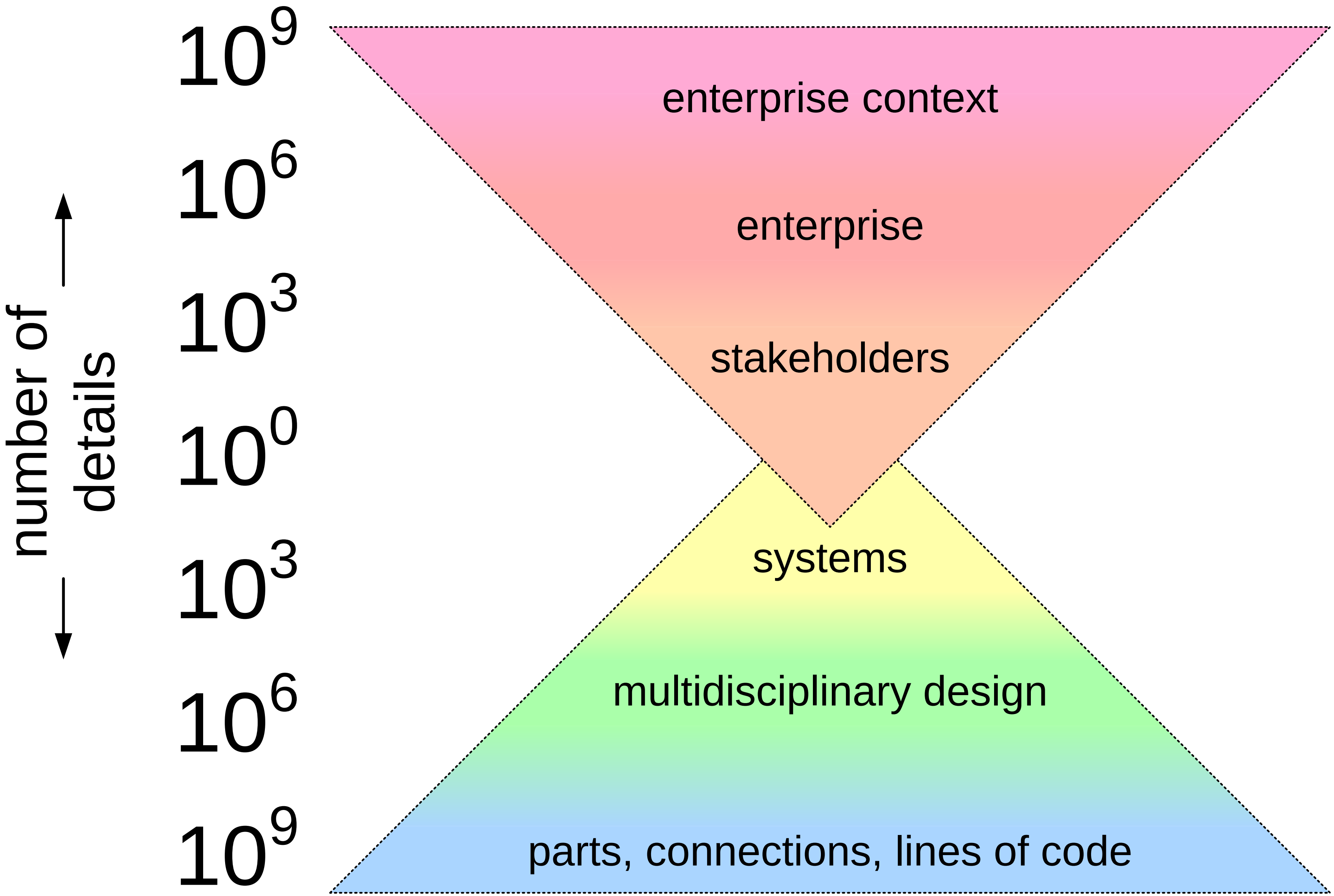
Level of Abstraction Single System



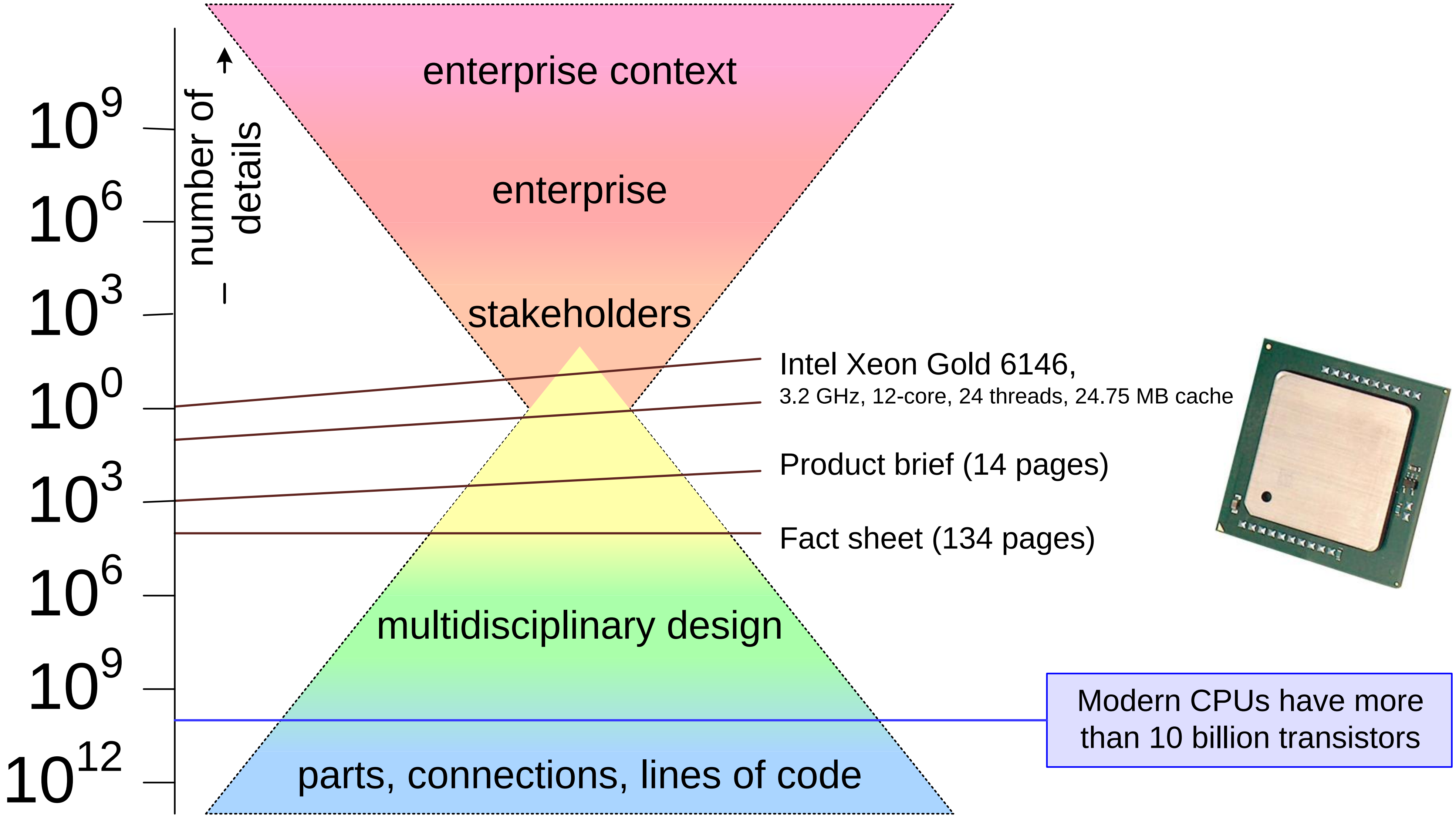
From system to Product Family or Portfolio



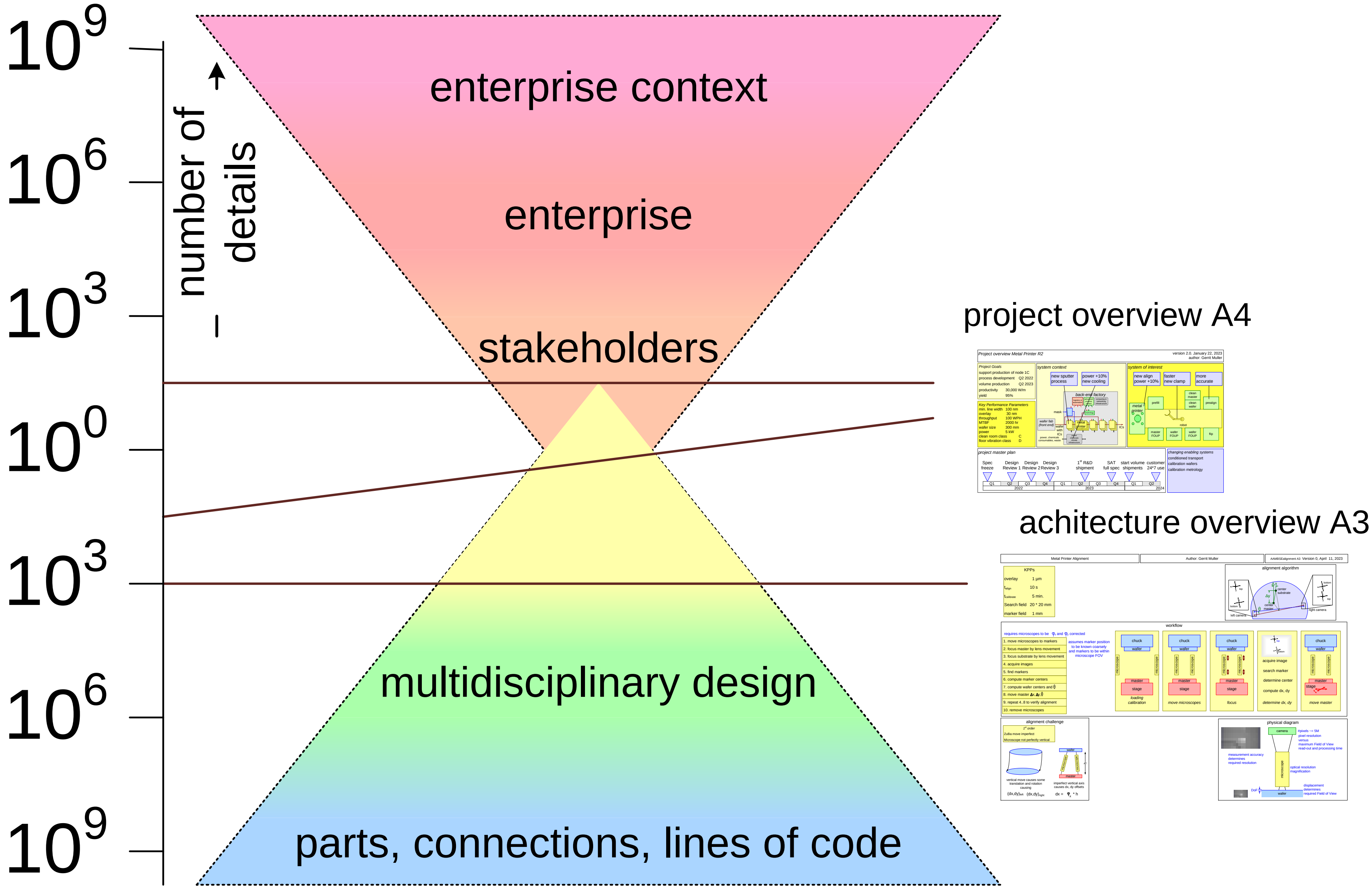
Product Family in Context



Example for a CPU chip



Example for a Metal Printer



A4 Project Overview brings overview and focus

Project overview Metal Printer R2

version 2.0. January 22, 2023
author: Gerrit Muller

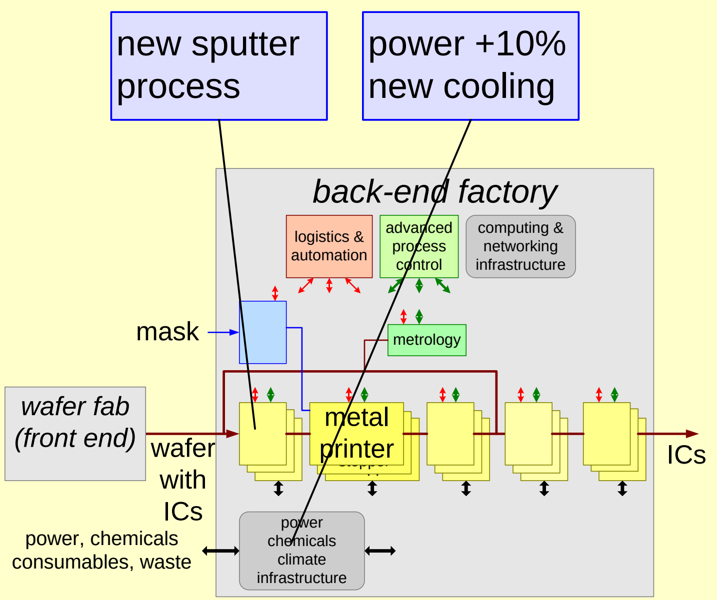
Project Goals

support production of node 1C	
process development	Q2 2022
volume production	Q2 2023
productivity	30,000 W/m
yield	95%

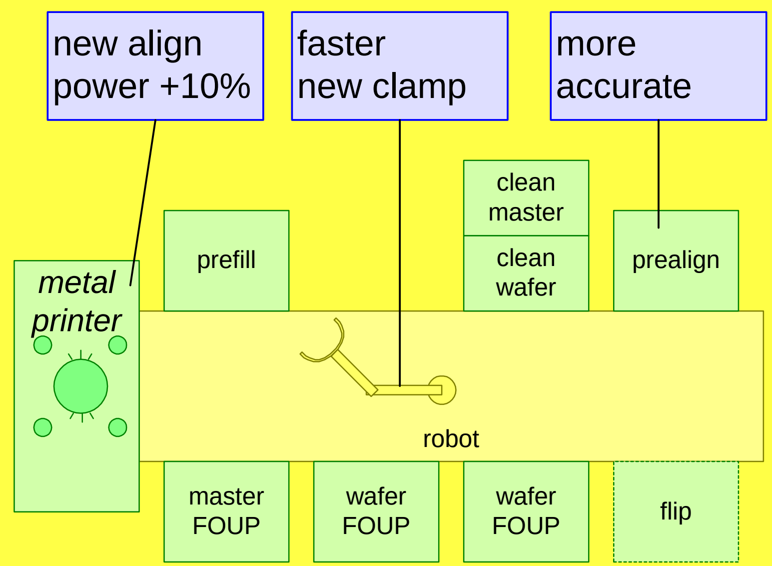
Key Performance Parameters

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

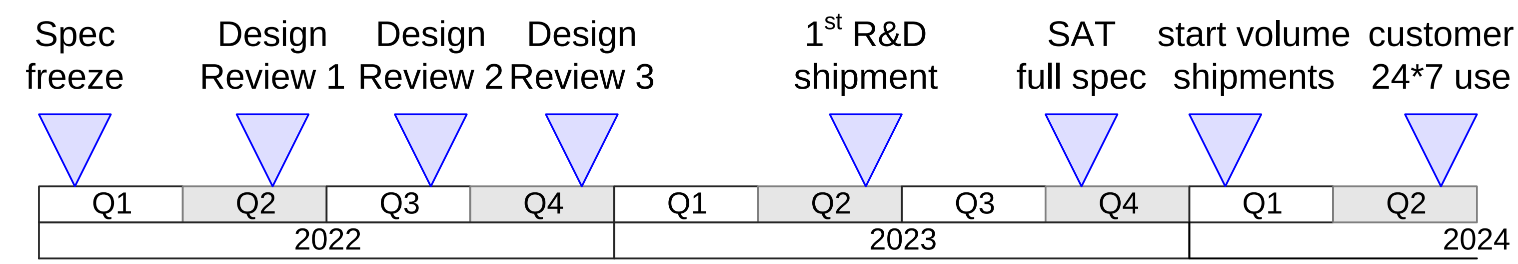
system context



system of interest



project master plan



changing enabling systems

conditioned transport
calibration wafers
calibration metrology

Metal Printer Alignment

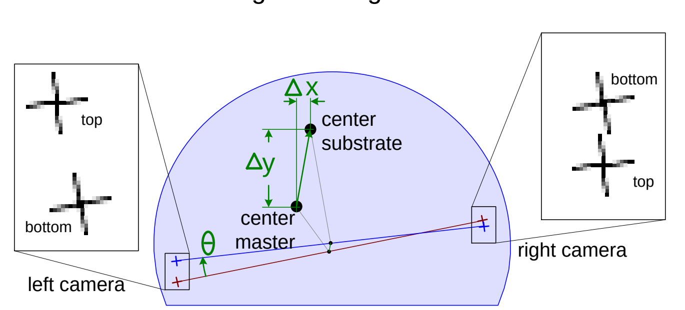
Author: Gerrit Muller

AAMBSEalignment A3 Version 0, April 11, 2023

KPPs

overlay	1 µm
t_{align}	10 s
$t_{calibrate}$	5 min.
Search field	20 * 20 mm
marker field	1 mm

alignment algorithm

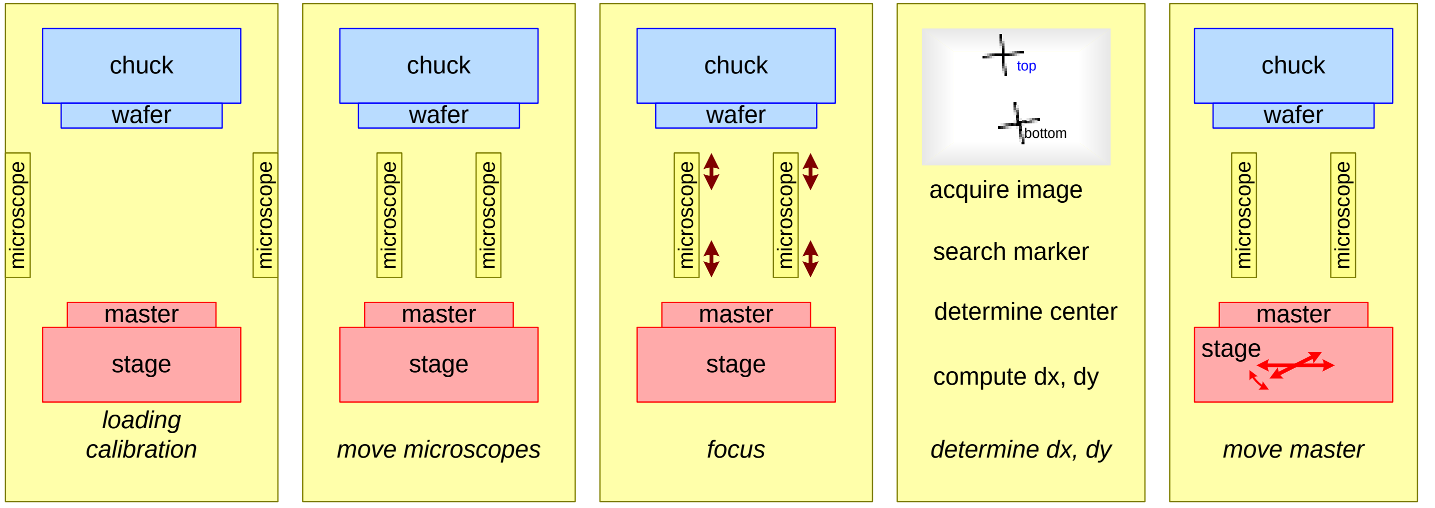


workflow

requires microscopes to be φ_x and φ_y corrected

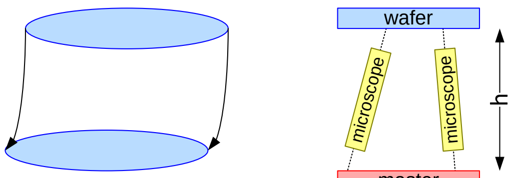
1. move microscopes to markers
2. focus master by lens movement
3. focus substrate by lens movement
4. acquire images
5. find markers
6. compute marker centers
7. compute wafer centers and θ
8. move master **Δ**x, **Δ**y, θ
9. repeat 4..8 to verify alignment
10. remove microscopes

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



alignment challenge

1st order
ZuBa move imperfect
Microscope not perfectly vertical



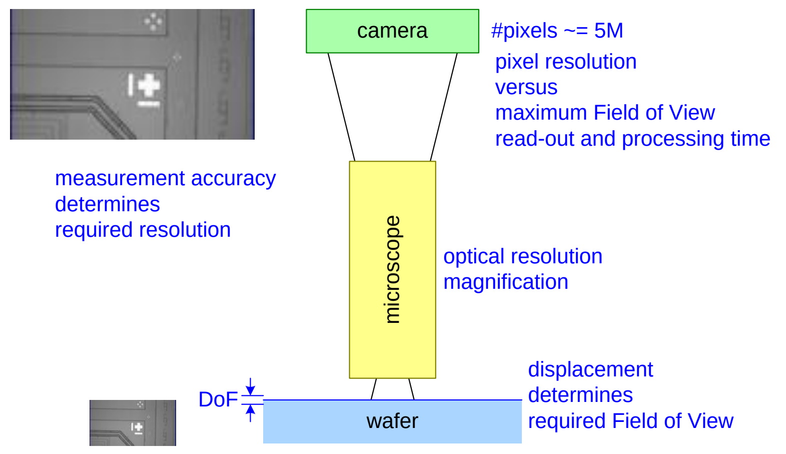
vertical move causes some translation and rotation causing

$(dx,dy)_{left}$ $(dx,dy)_{right}$

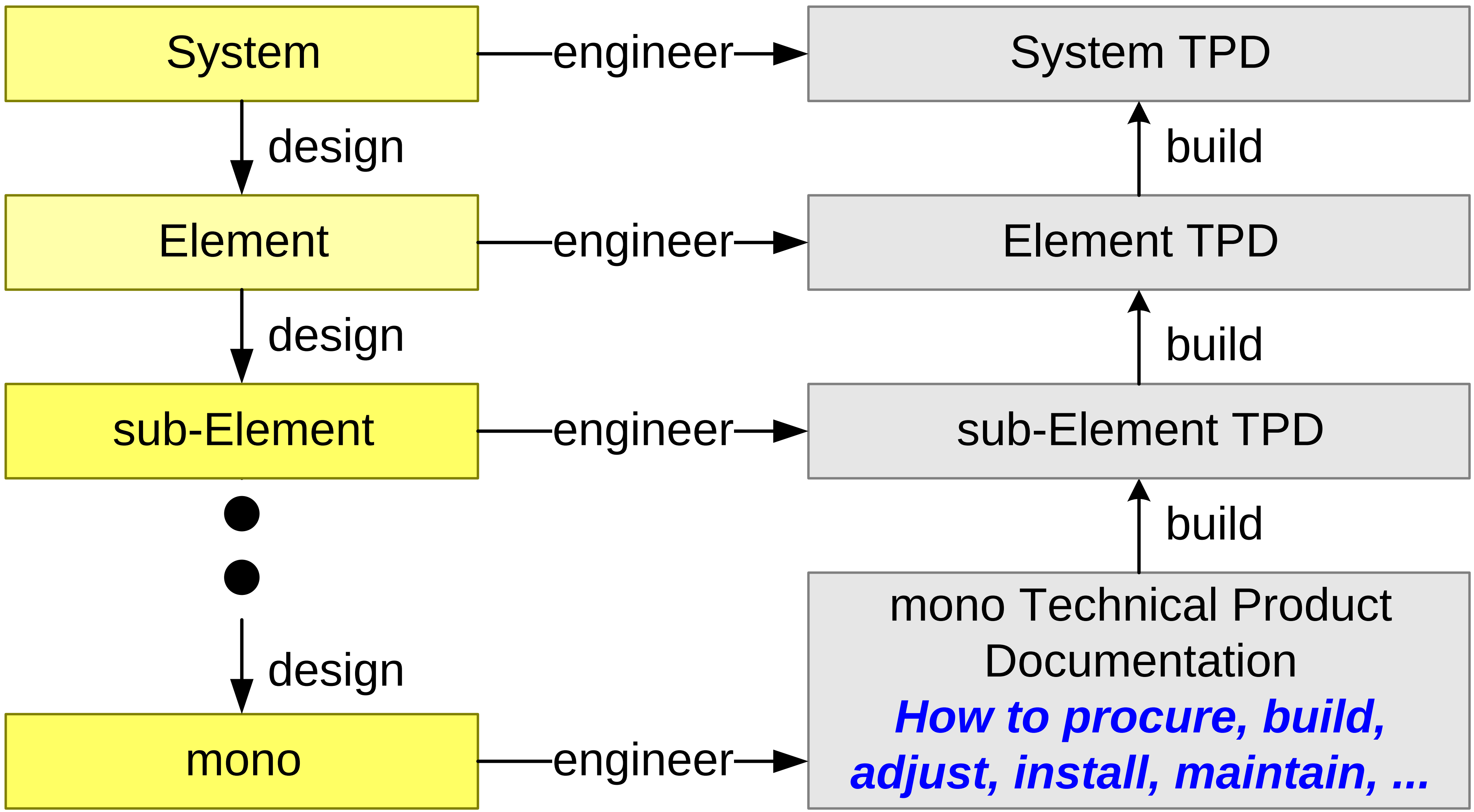
imperfect vertical axis causes dx, dy offsets

$dx = \varphi_x * h$

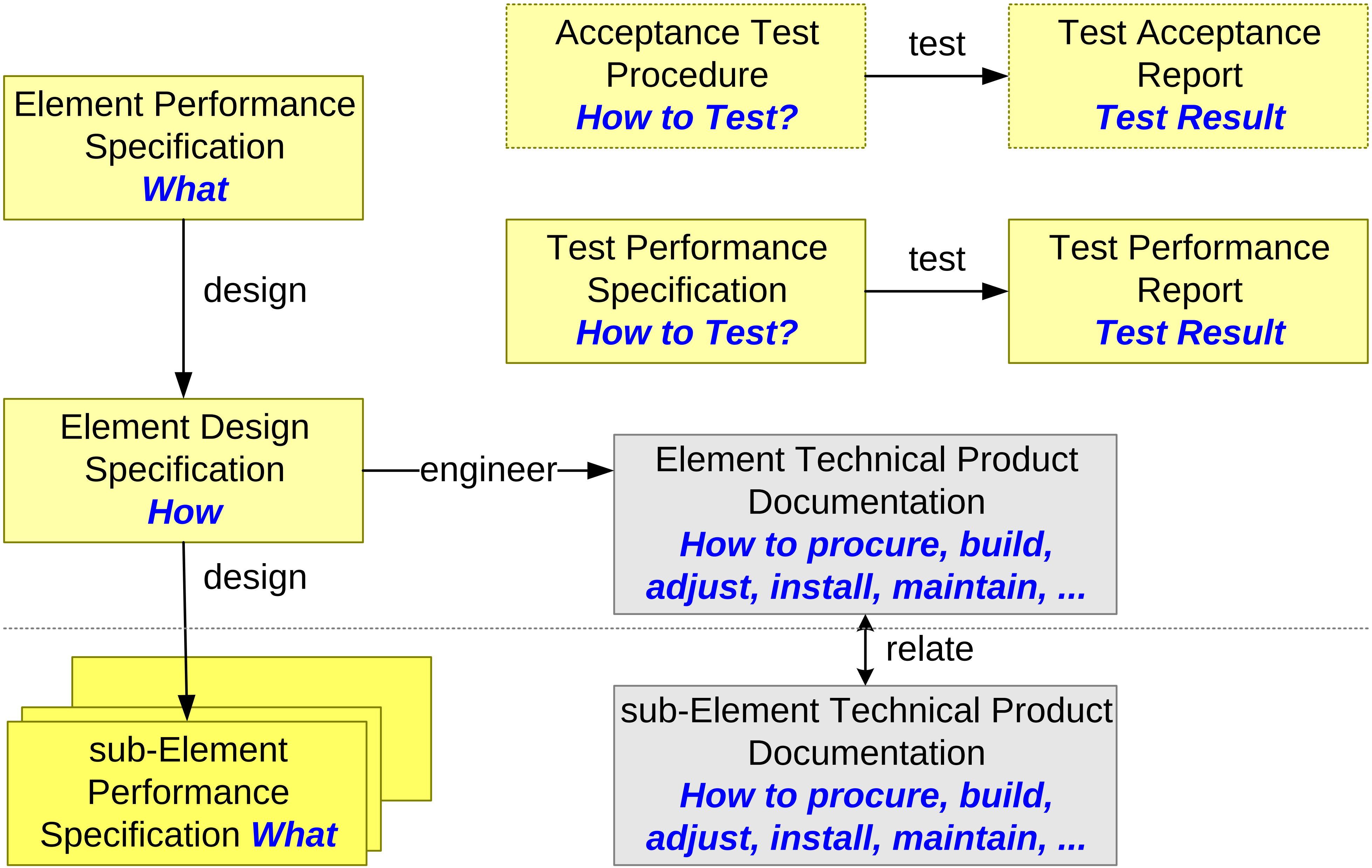
physical diagram



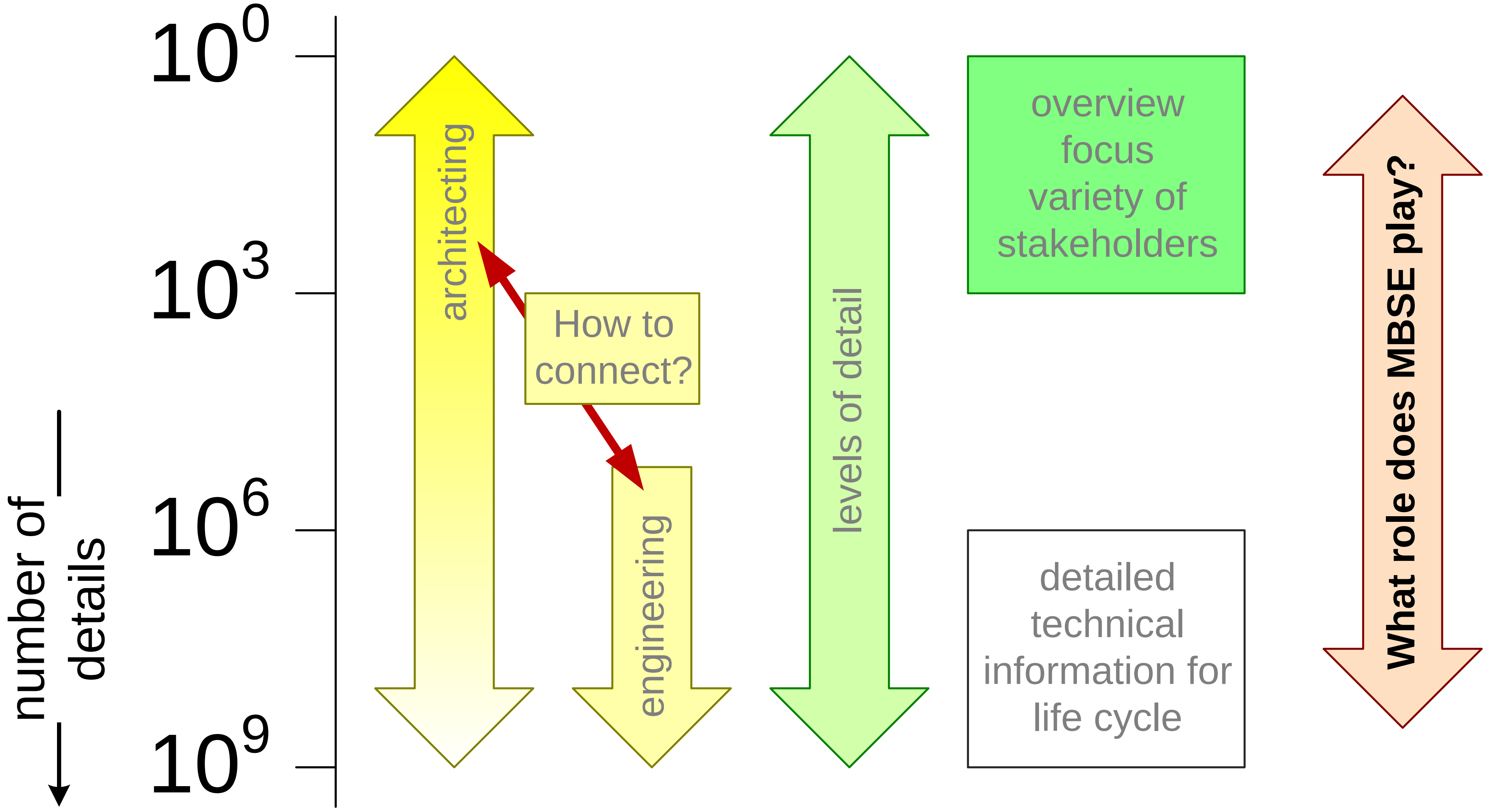
TPD translates design into life cycle instructions



Each Element needs information from specification to qualificatio



What Role does MBSE Play?



The definition of MBSE is broad and ambitious

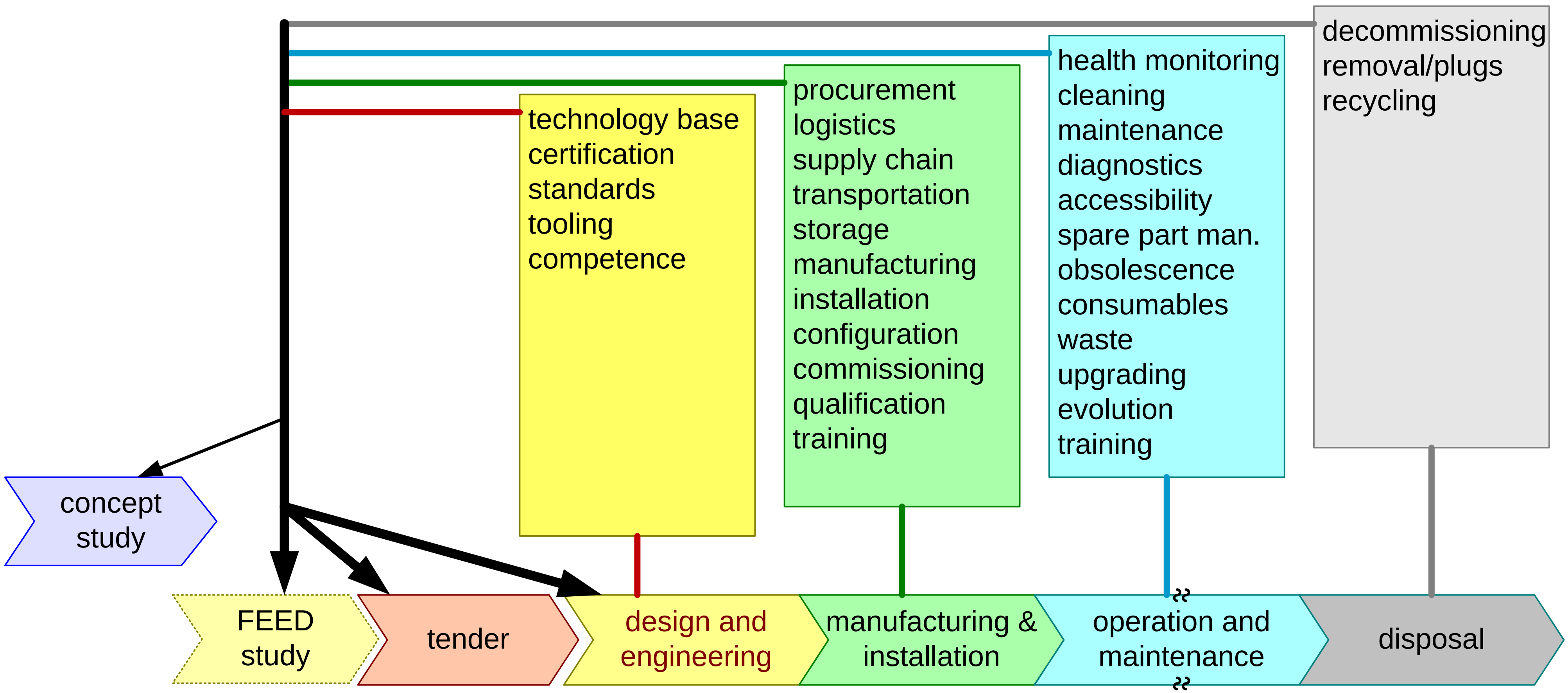
Model-based Systems Engineering [MBSE] is a paradigm that uses **formalized representations** of systems, known as models, **to support and facilitate** the performance of **Systems Engineering [SE] tasks throughout a system's life cycle**.

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.

The life cycle has many information needs



What is the real MBSE objective?

- 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)