Module 33, Architectural Reasoning Design Fundamentals

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Abstract

This module discusses fundamental design methods and techniques, especially partitioning, interface, behavior, and quantified performance design.

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System Partitioning Fundamentals

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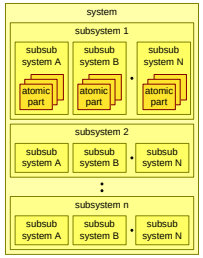
Abstract

The fundamental concepts and approach system partitioning are explained. We look at physical decomposition and functional decomposition in relation to supply chain, lifecycle support, project manageemnt, and system specification and design.



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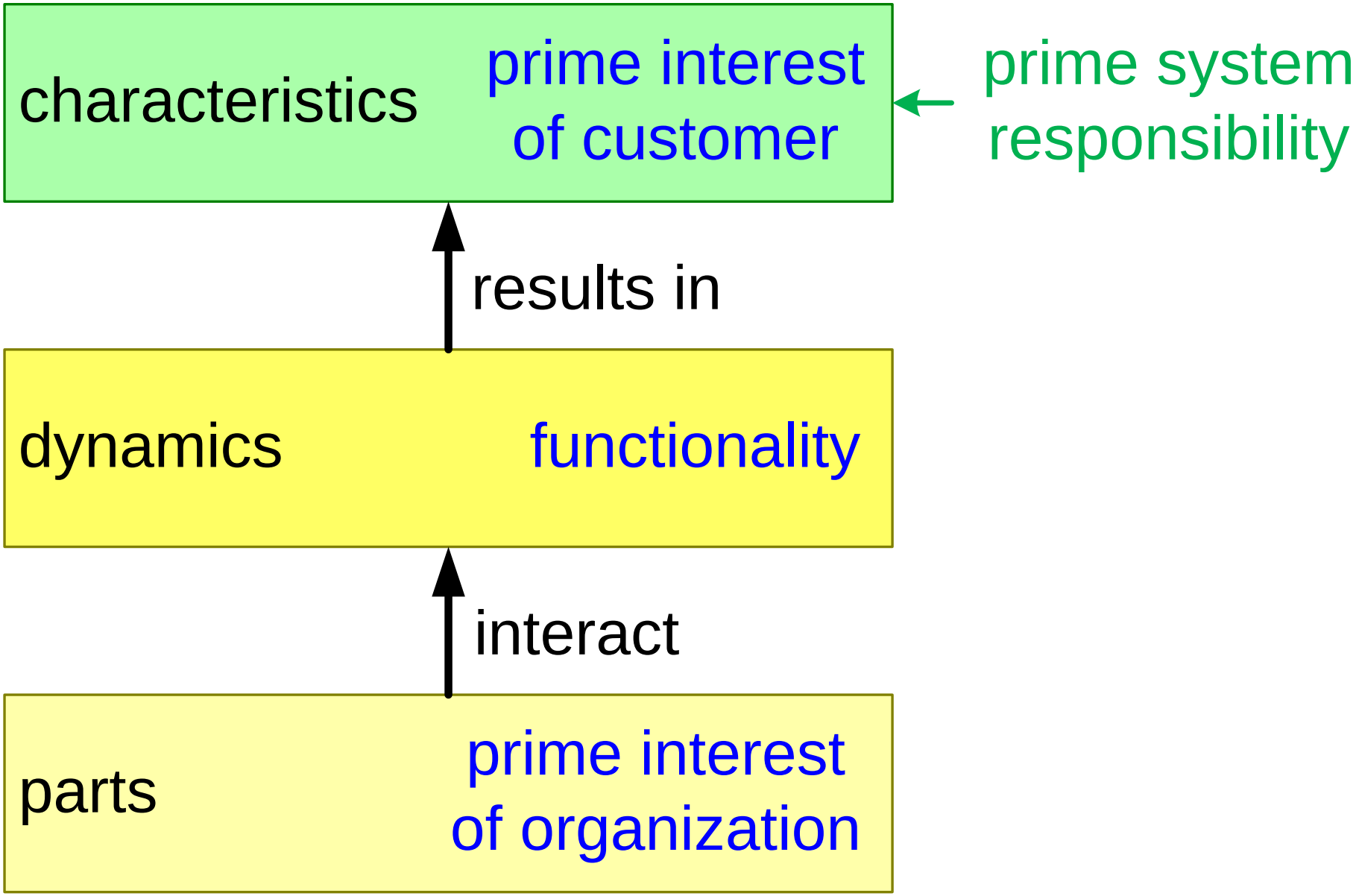
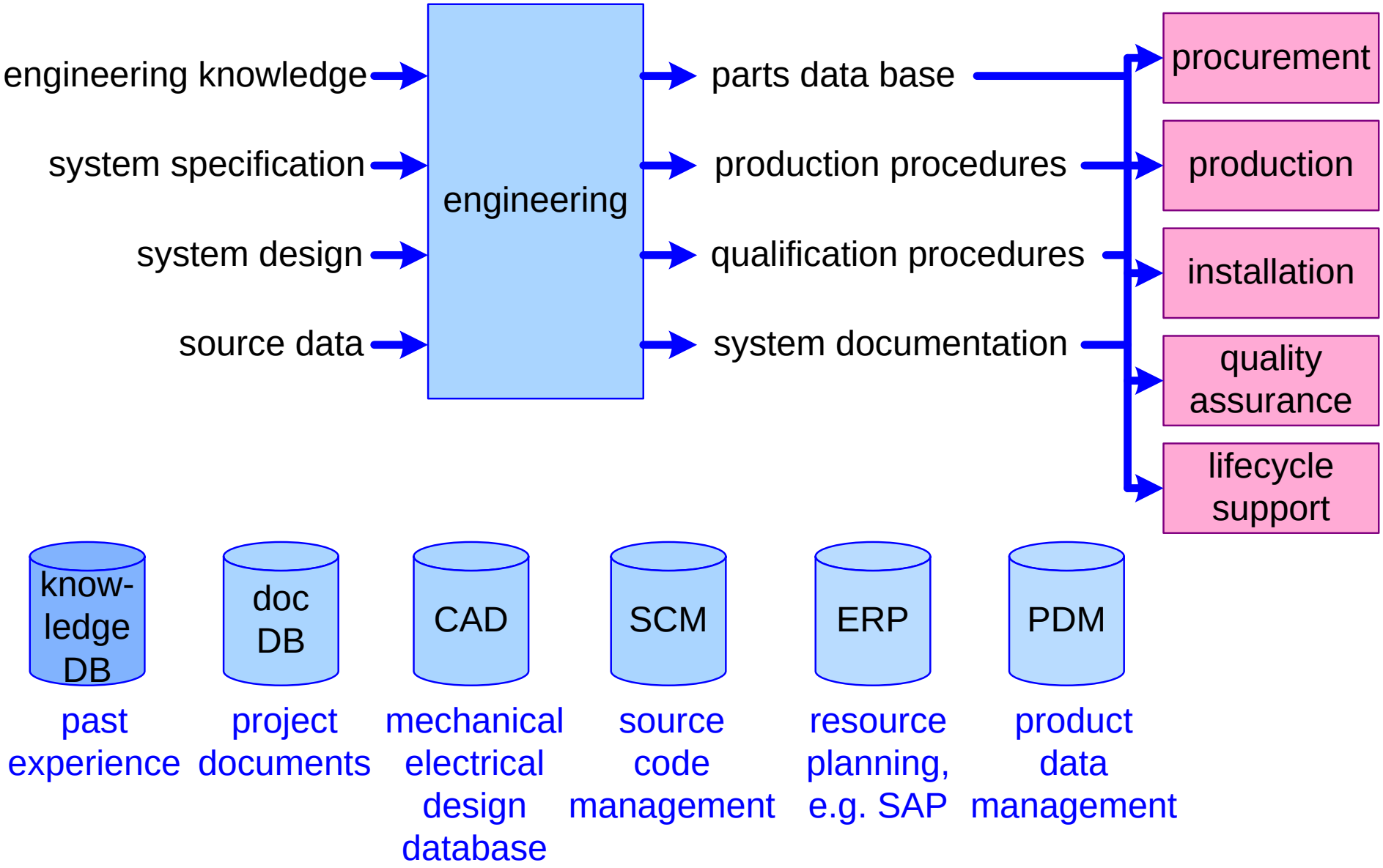
version: 0.2

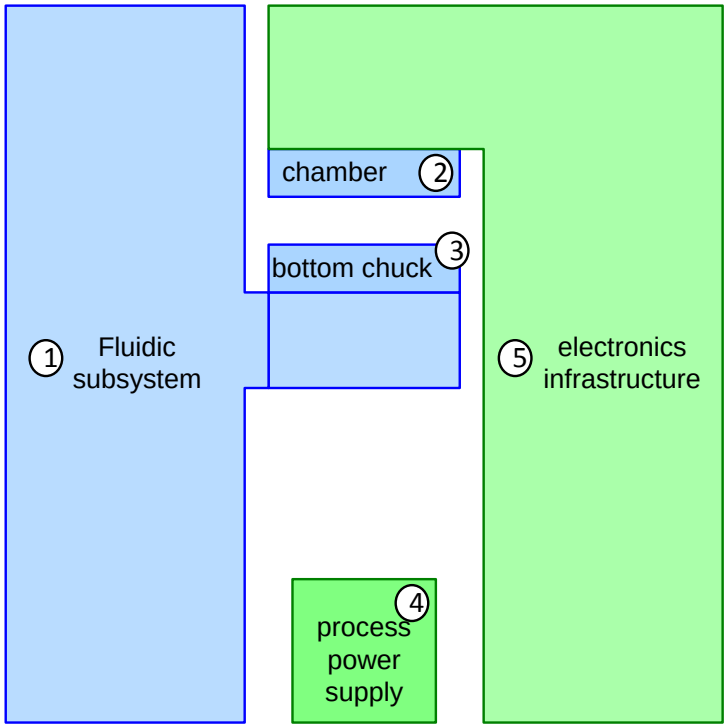
Parts, Dynamics, Characteristics



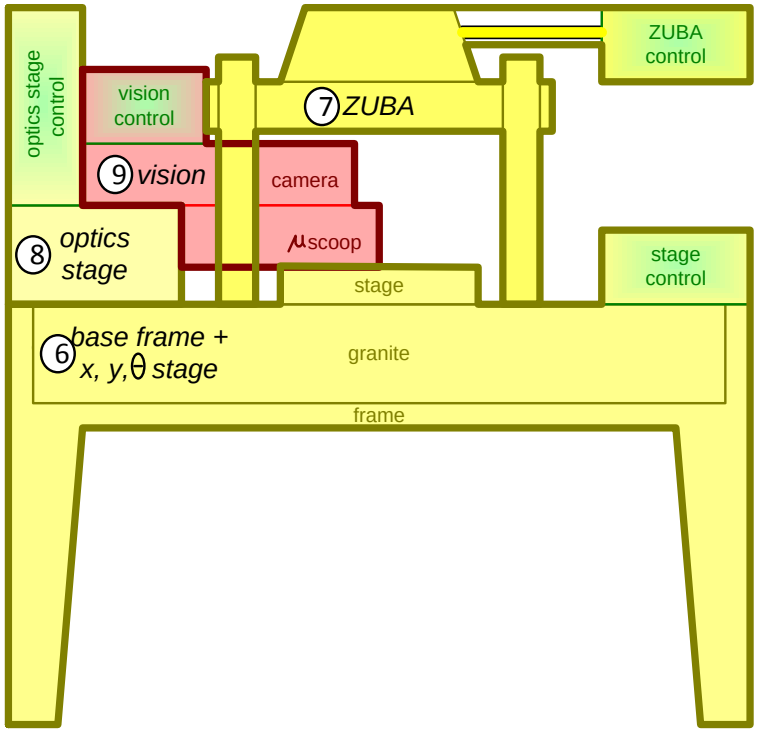
Engineering



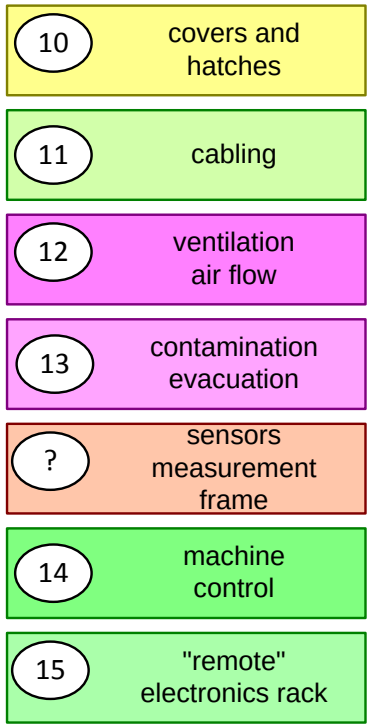
Example Physical Decomposition



back side view

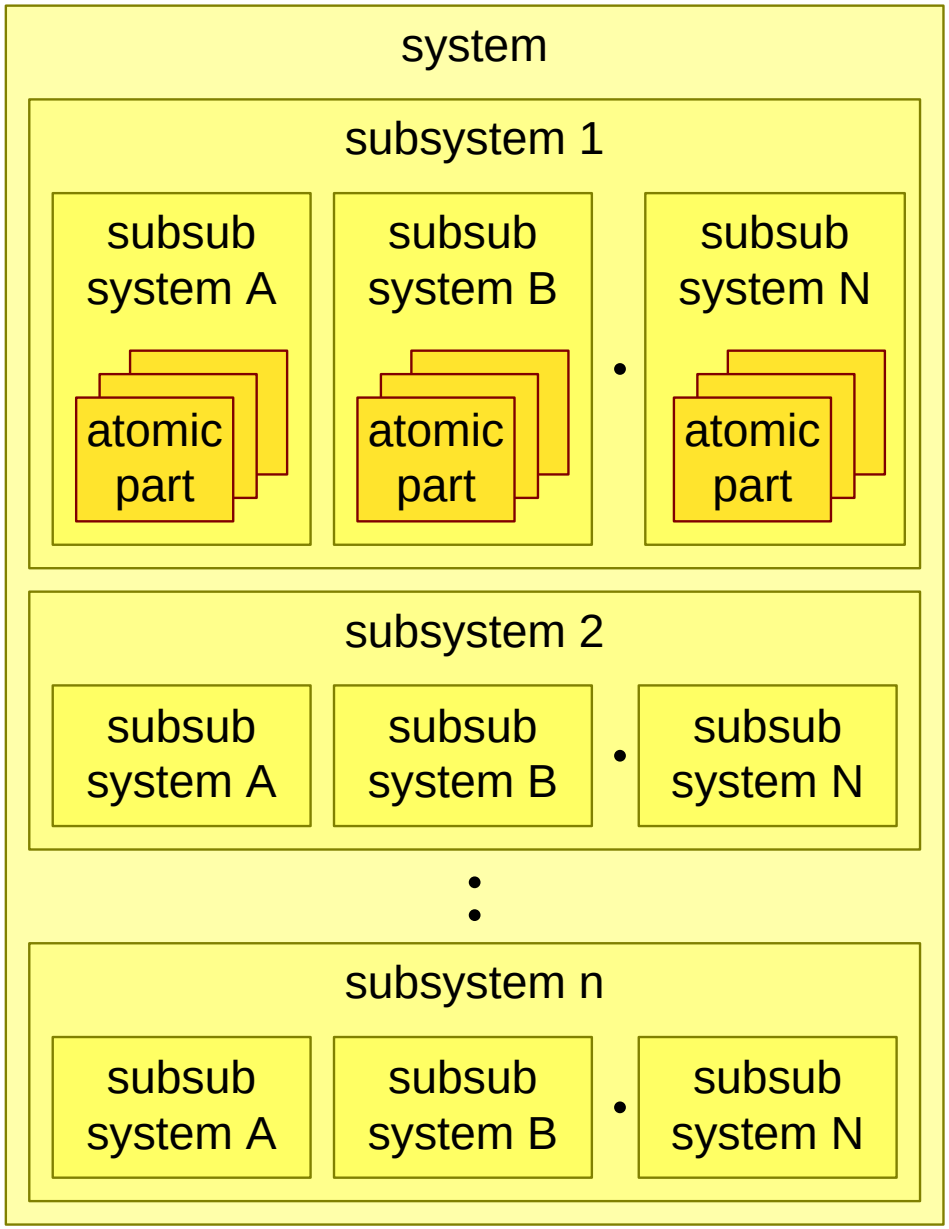


front side view

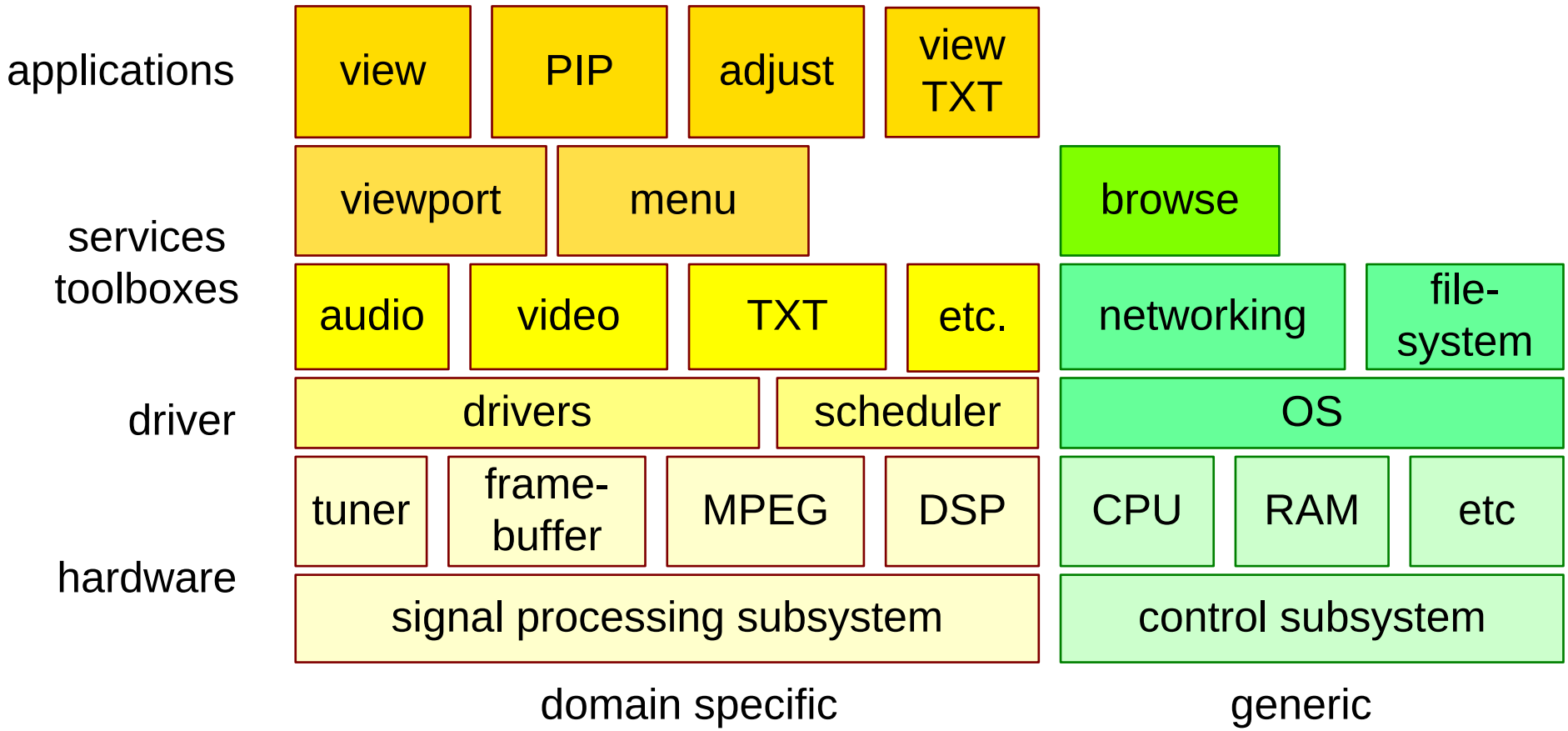


integrating

Partitioning is Applied Recursively



Software plus Hardware Decomposition



Guidelines for Partitioning

the part is cohesive

functionality and technology belongs together

the coupling with other parts is minimal

minimize interfaces

the part is selfsustained for production and qualification

can be in conflict with cost or space requirements

clear ownership of part

e.g. one department or supplier

How much self-sustained?

control SW	application SW	HMI SW	control electronics	control interface
cooling	EMC shielding	main function	qualification support	adjustment support
power stabilization	power conversion	power distribution	production support	mechanical package

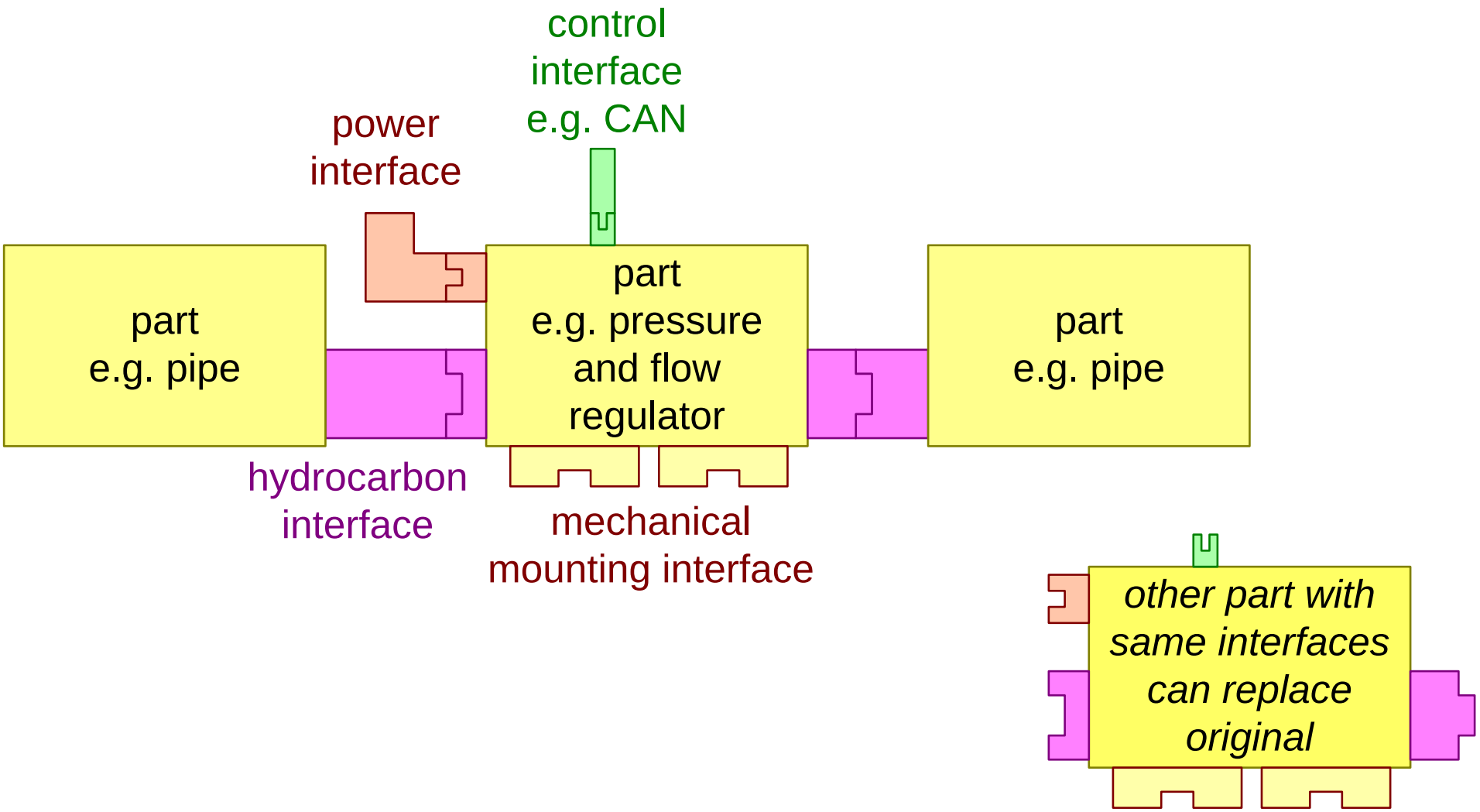
How self sustained should a part be?

trade-off:

cost/speed/space optimization

logistics/lifecycle/production flexibility clarity

Decoupling via Interfaces



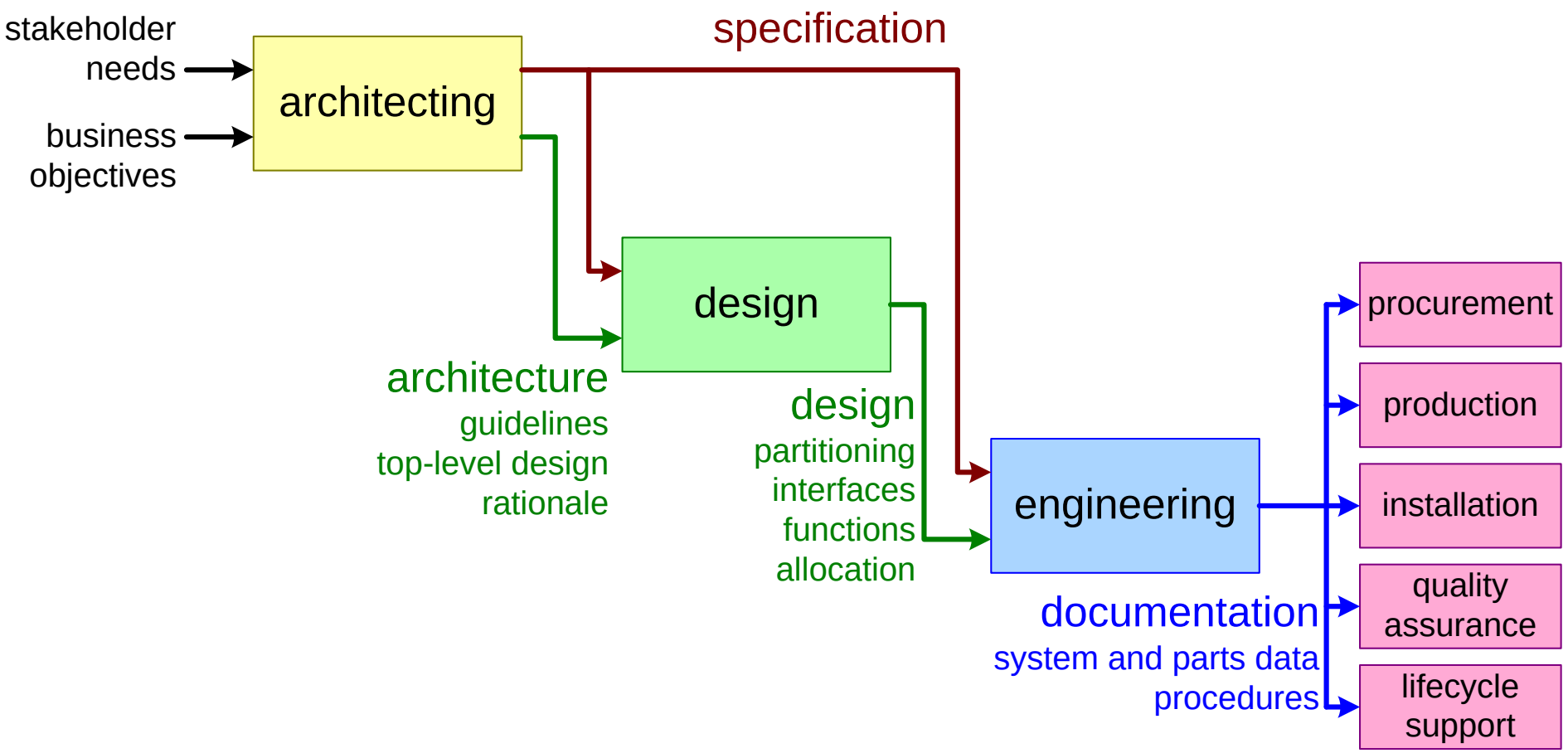
The Ideal Modularity

System is composed

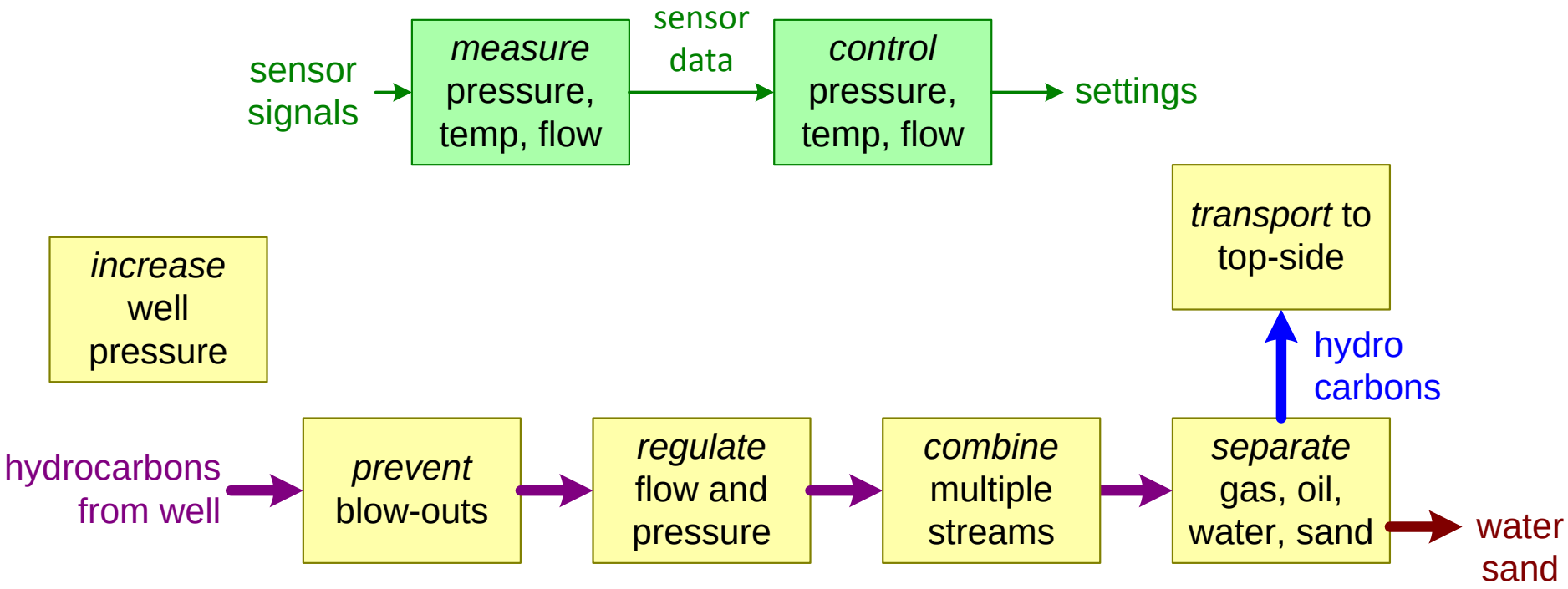
by using standard interfaces

limited catalogue of variants (e.g. cost performance points)

System Creation



Simplistic Functional SubSea Example



Functional Decomposition

How does the system work and operate?

Functions describe *what* rather than *how.*

Functions are *verbs*.

Input-Process-Output paradigm.

Multiple kinds of flows:

- physical (e.g. hydrocarbons)
- information (e.g. measurements)
- control

At lower level one part ~= one function

- pump pumps, compressor compresses, controller controls

At higher level functions are complex interplay of physical parts

- e.g. regulating constant flow, pressure and temperature

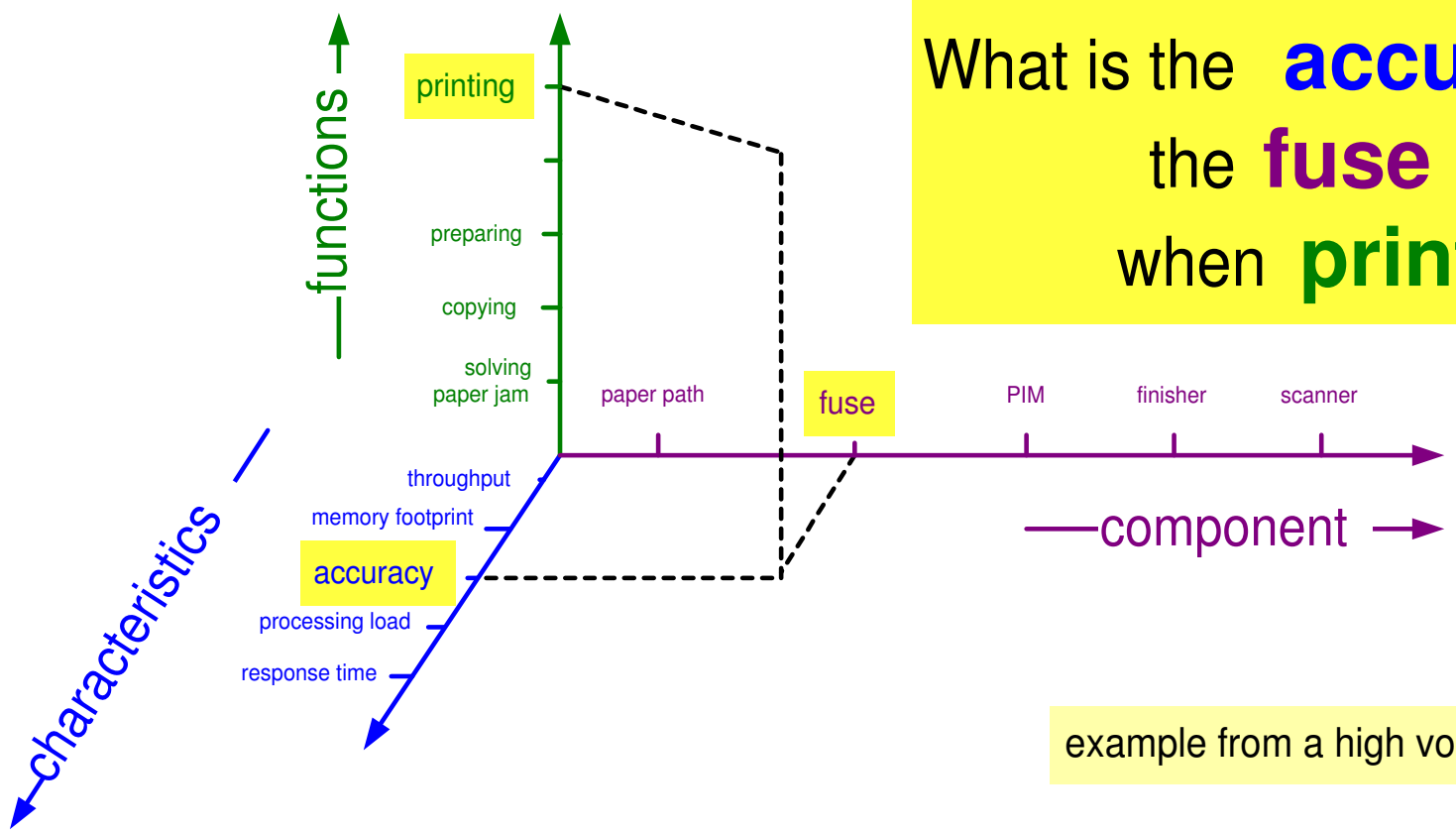
Quantification

Size	2.4m * 0.7m * 1.3m
Weight	1450 Kg
Cost	30000 NoK
Reliability	MTBF 4000 hr
Throughput	3000 l/hr
Response time	0.1 s
Accuracy	+/- 0.1%

many characteristics of a system, function or part can be quantified

*Note that quantities have **unit***

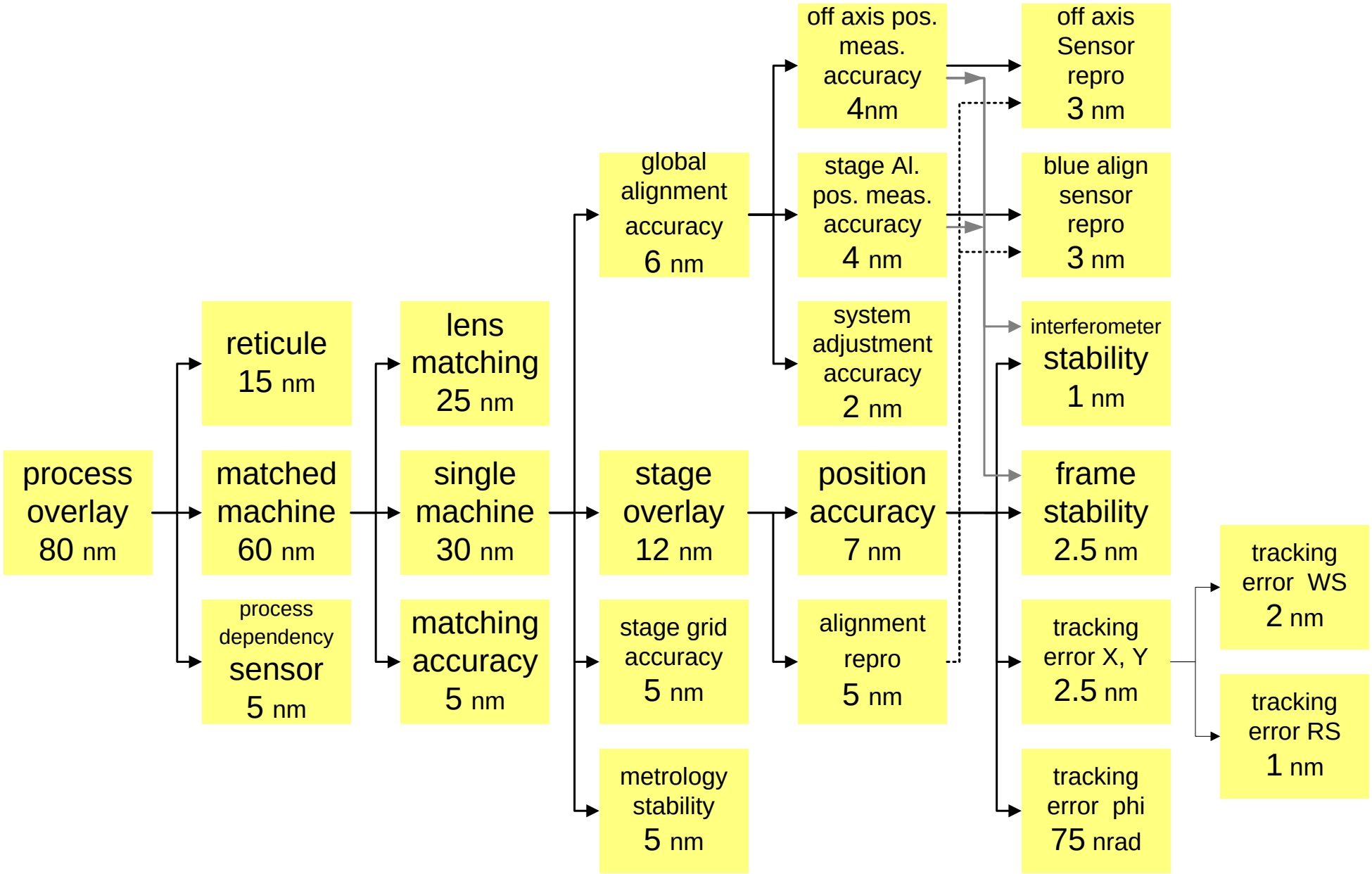
How about the **<characteristic>**
of the **<component>**
when performing **<function>**?



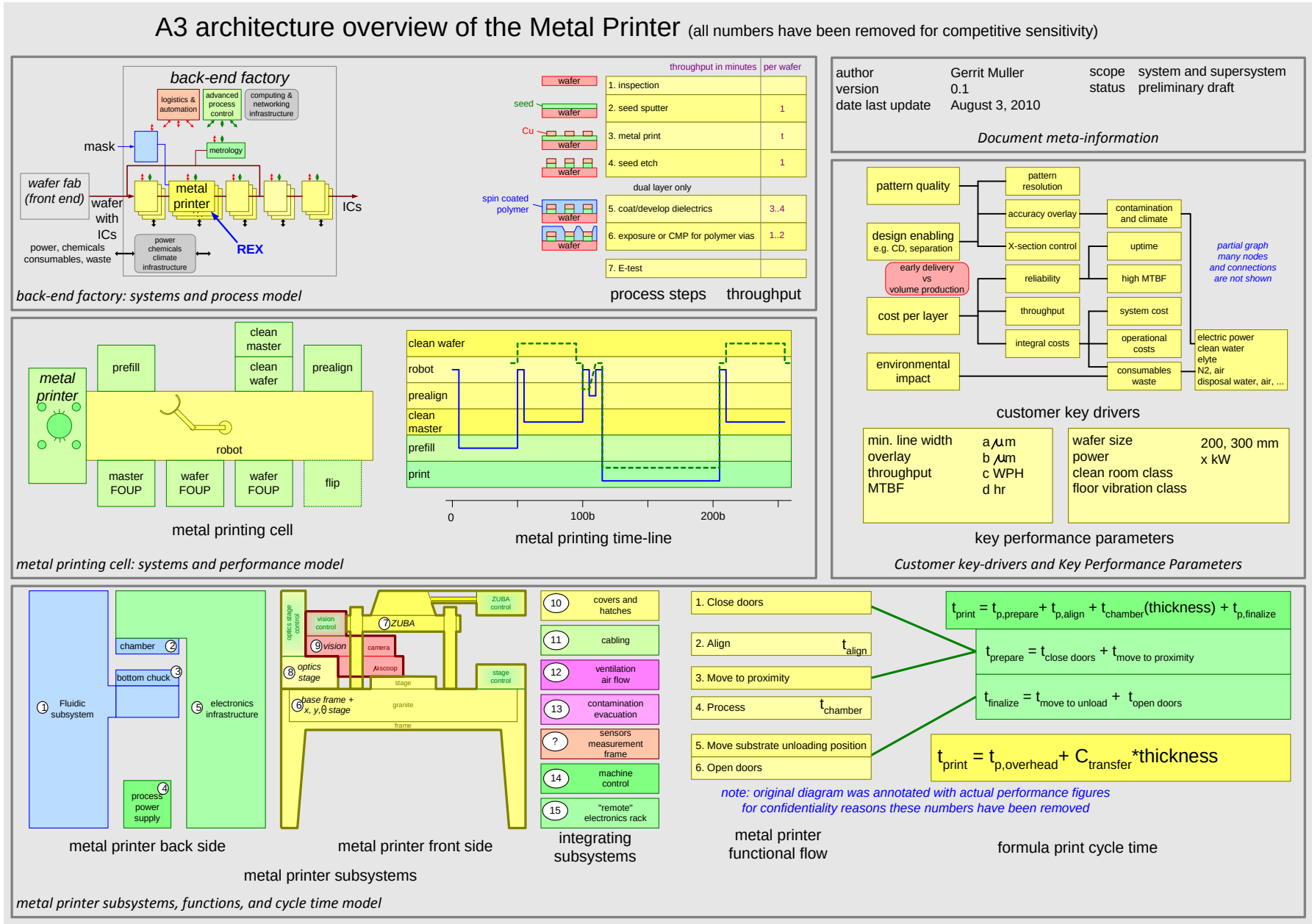
What is the **accuracy** of
the **fuse**
when **printing**

example from a high volume printer

Example Technical Budget



Example of A3 overview



Exercise Dynamic Behavior

Capture the **dynamic behavior** of the **internals** of your system in **multiple** diagrams.

Diagrams that capture dynamic behavior are among others:

- Functional flow (of control or information, material or goods, or energy)
- Activity or sequence diagrams (e.g. with “swimming lanes”)
- State diagrams

Exercise Block Diagram

Make a set of **block diagrams** capturing the **static parts** and **interfaces**.

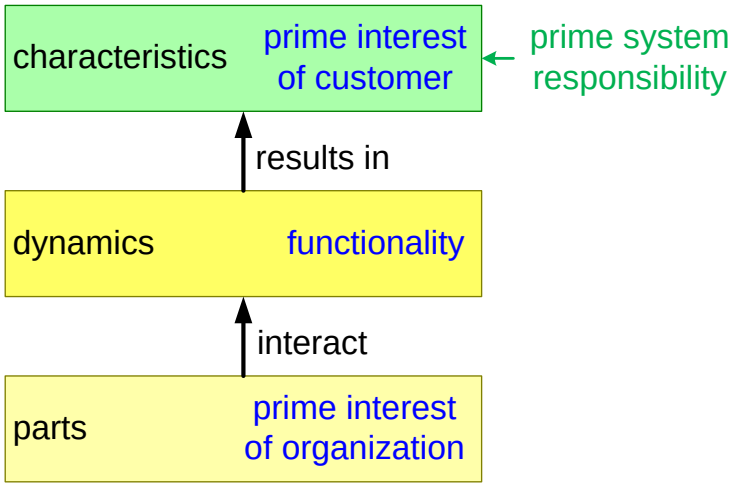
Ensure coverage of the entire system, e.g. including service, training, production, etc.

Show both **hardware** and **software**

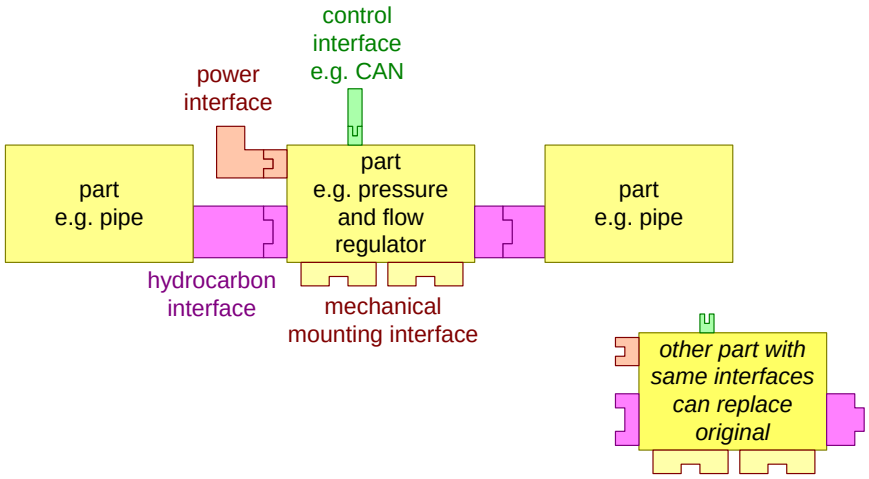
Good block diagrams have in the order of 10 to 20 blocks

Design Fundamentals

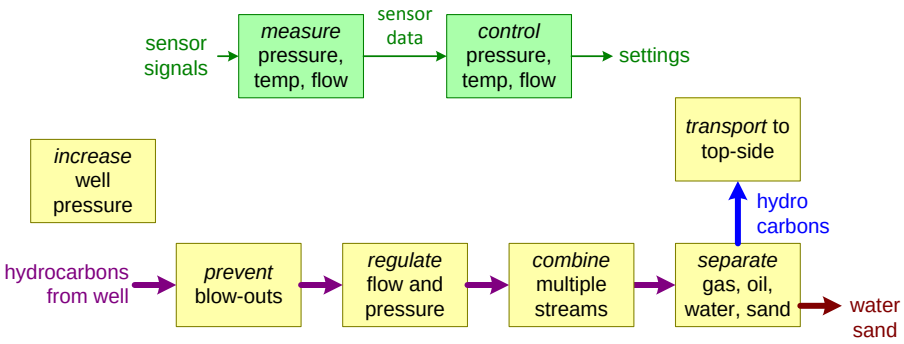
Parts, Dynamics, Characteristics



Decoupling via Interfaces



Dynamic Behavior



Question Generator

How about the **<characteristic>**
of the **<component>**
when performing **<function>**?