

# Module Modeling and Analysis: Integration and Reasoning

by *Gerrit Muller* Embedded Systems Institute

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`www.gaudisite.nl`

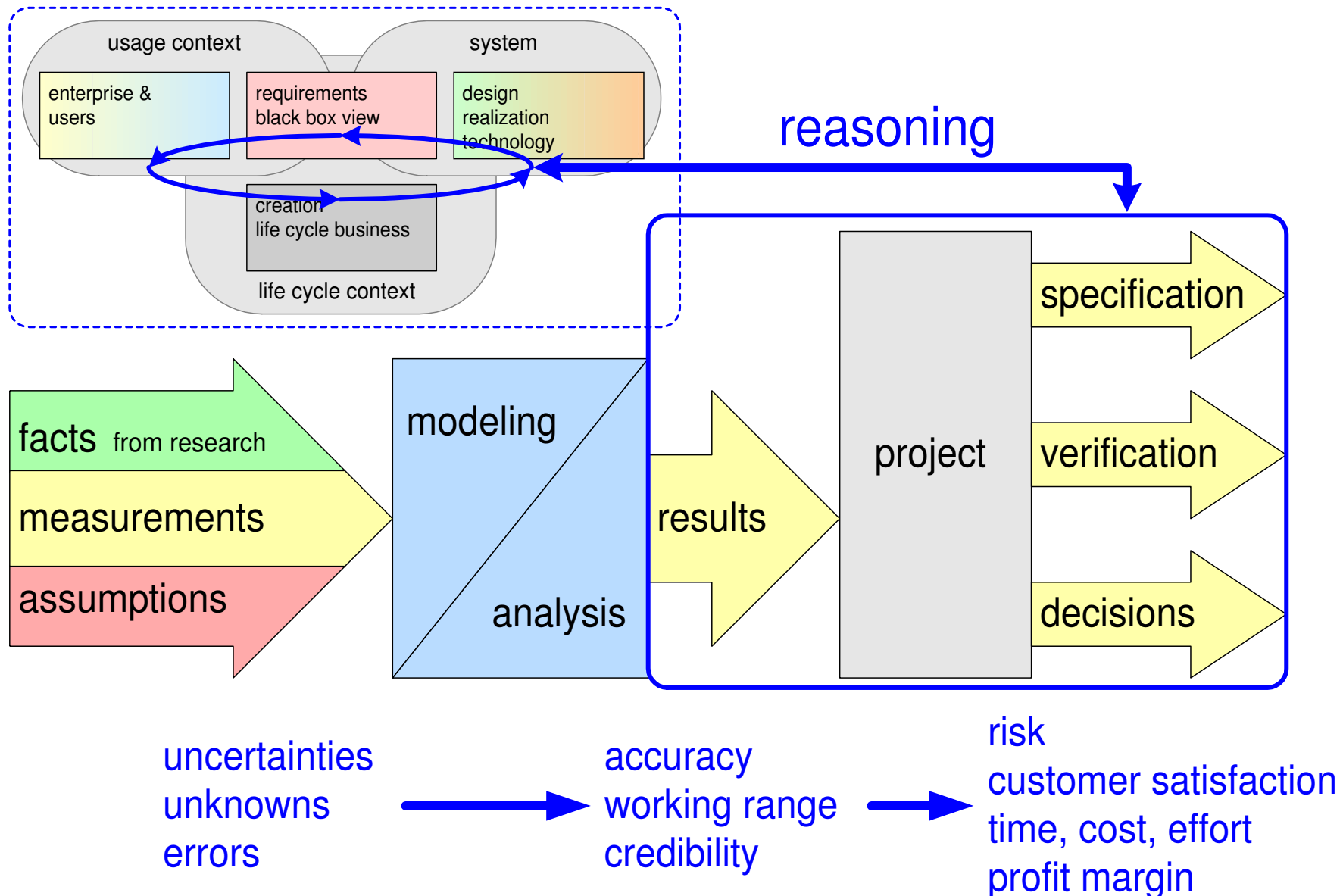
## Abstract

This module addresses the integration of small or partial models into bigger models. We also discuss how multiple models are used and how to reason using multiple models.

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# Where are we in the Course?



# Modeling and Analysis: Reasoning

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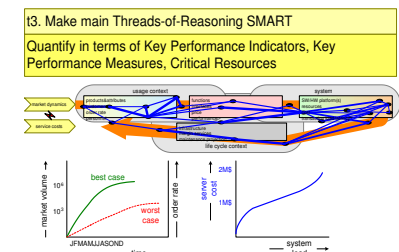
## Abstract

Models are made to facilitate decision making. These decisions range from business decisions, such as Service Level Agreements, to requirements, and to detailed design decisions. The space of decisions is huge and heterogeneous. The proposed modeling approach is to use multiple small and simple models. In this paper we discuss how to reason by means of multiple models.

## Distribution

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status: preliminary  
draft  
version: 0.6



## *content*

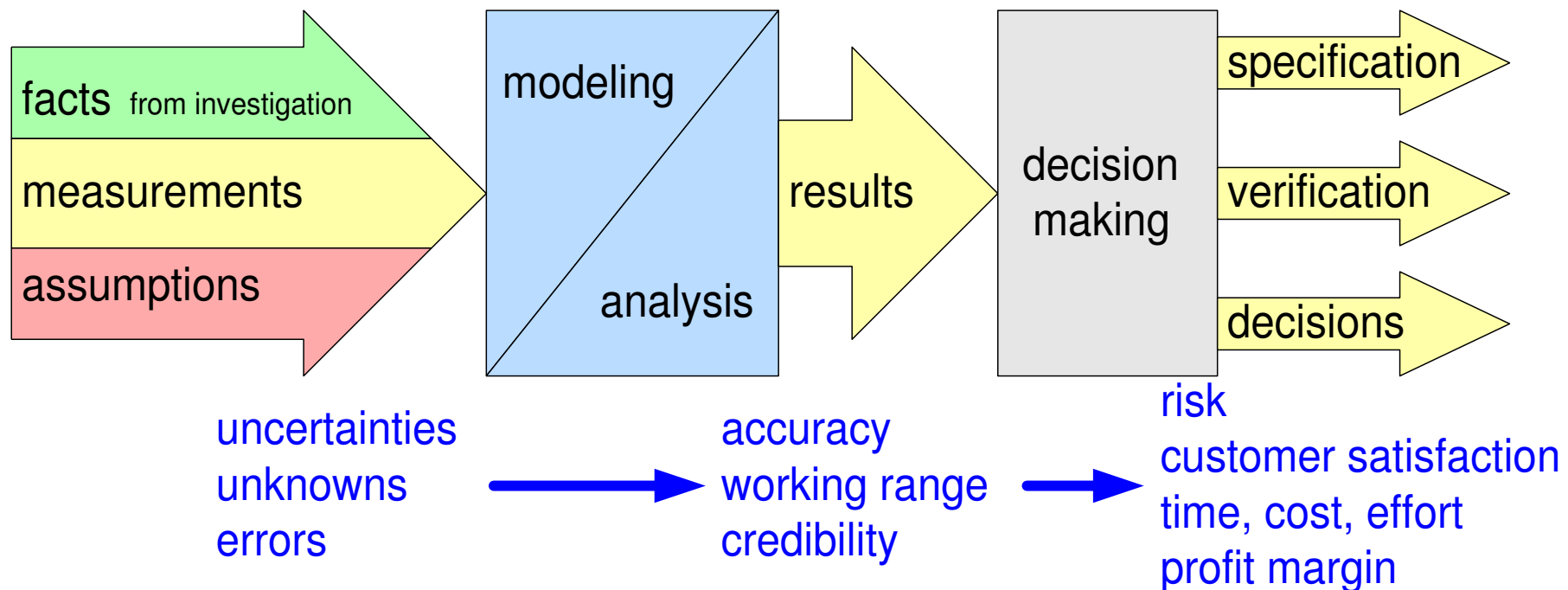
From chaos to order: inputs, assumptions, models and decisions

Reasoning approach: stepwise top-down and bottom-up

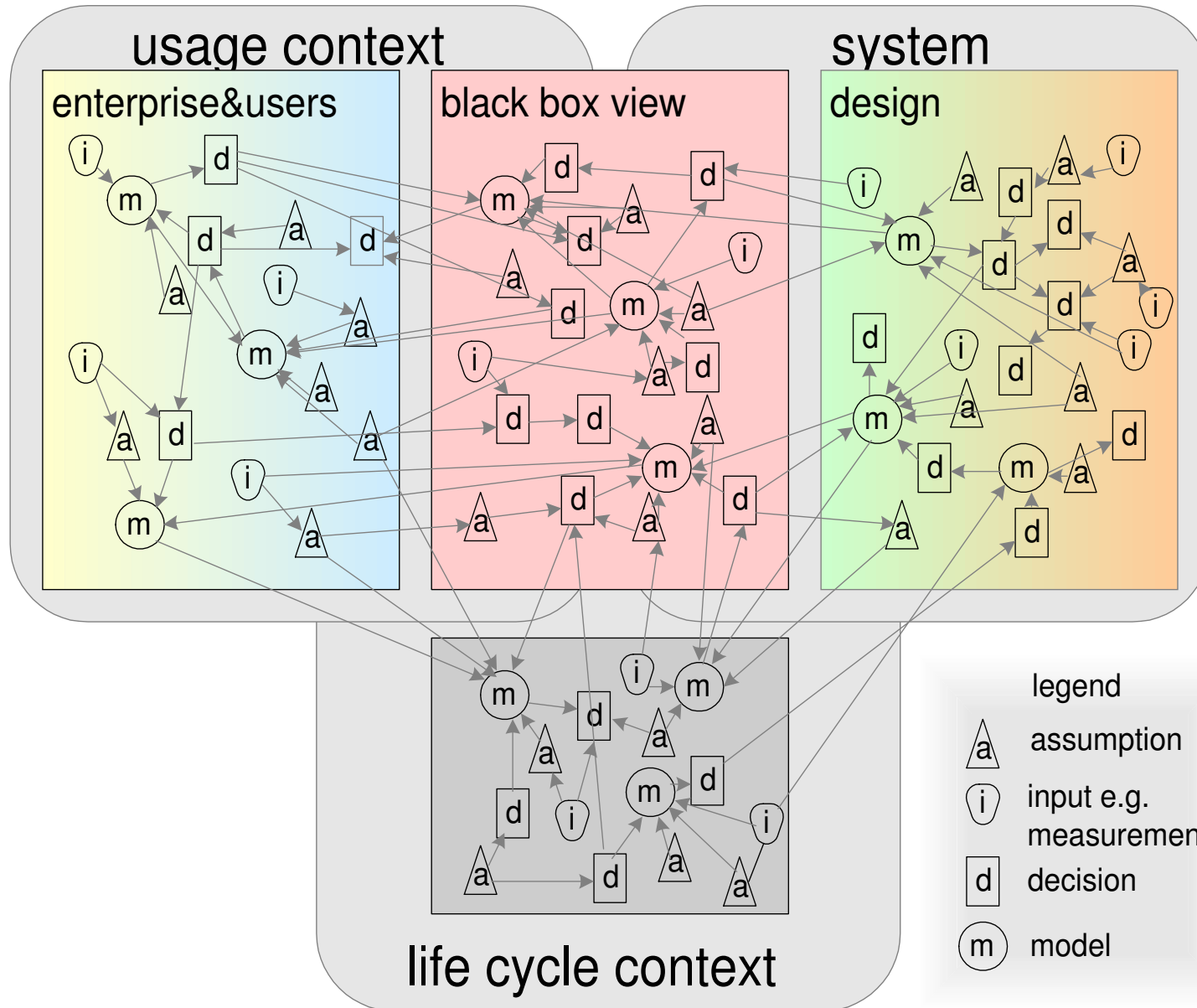
Life cycles of models in relation to project life cycle

# Purpose of Modeling

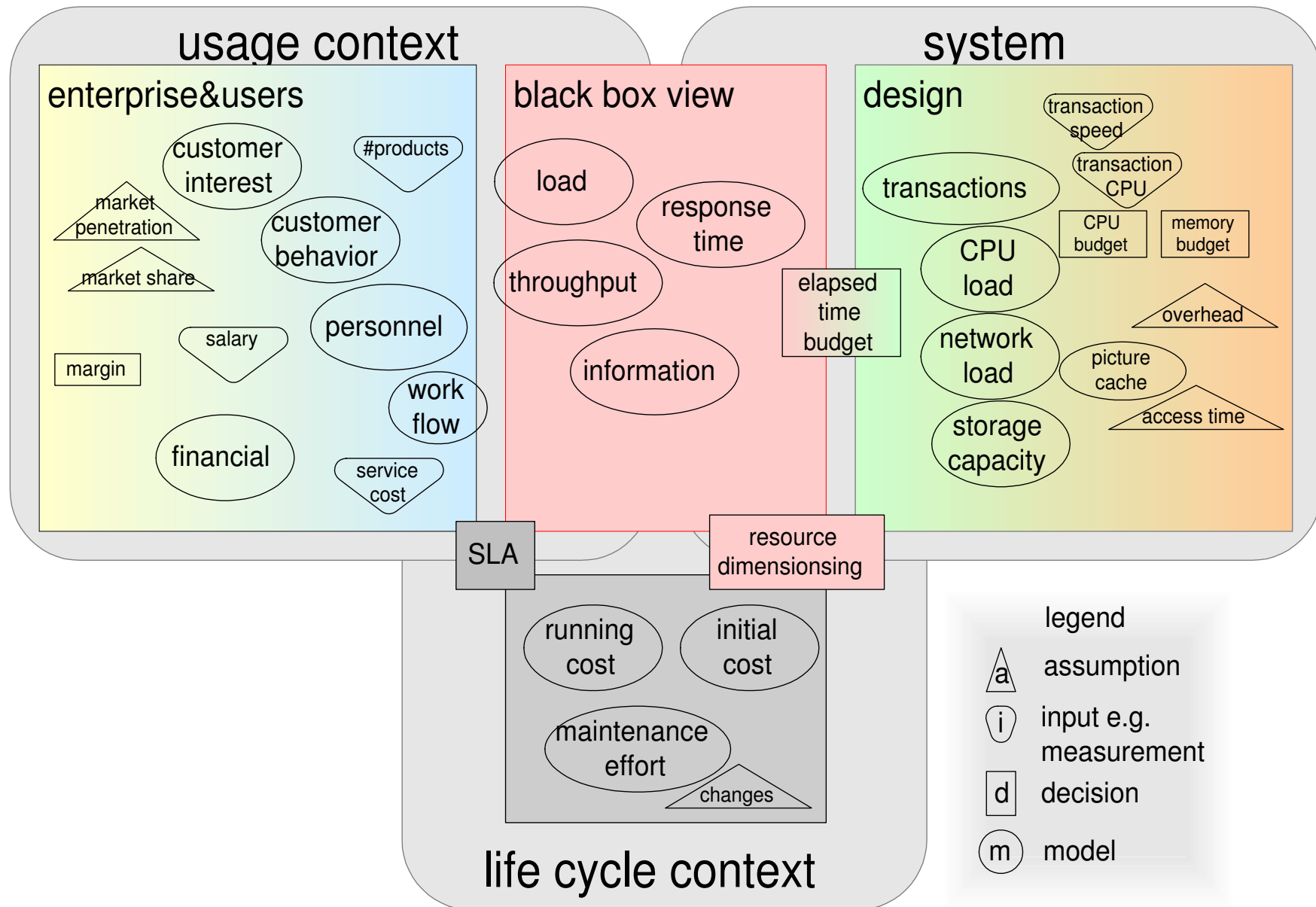
*How to use multiple models to facilitate decisions?  
How to get from many fragments to integral insight?  
How many models do we need?  
At what quality and complexity levels ?*



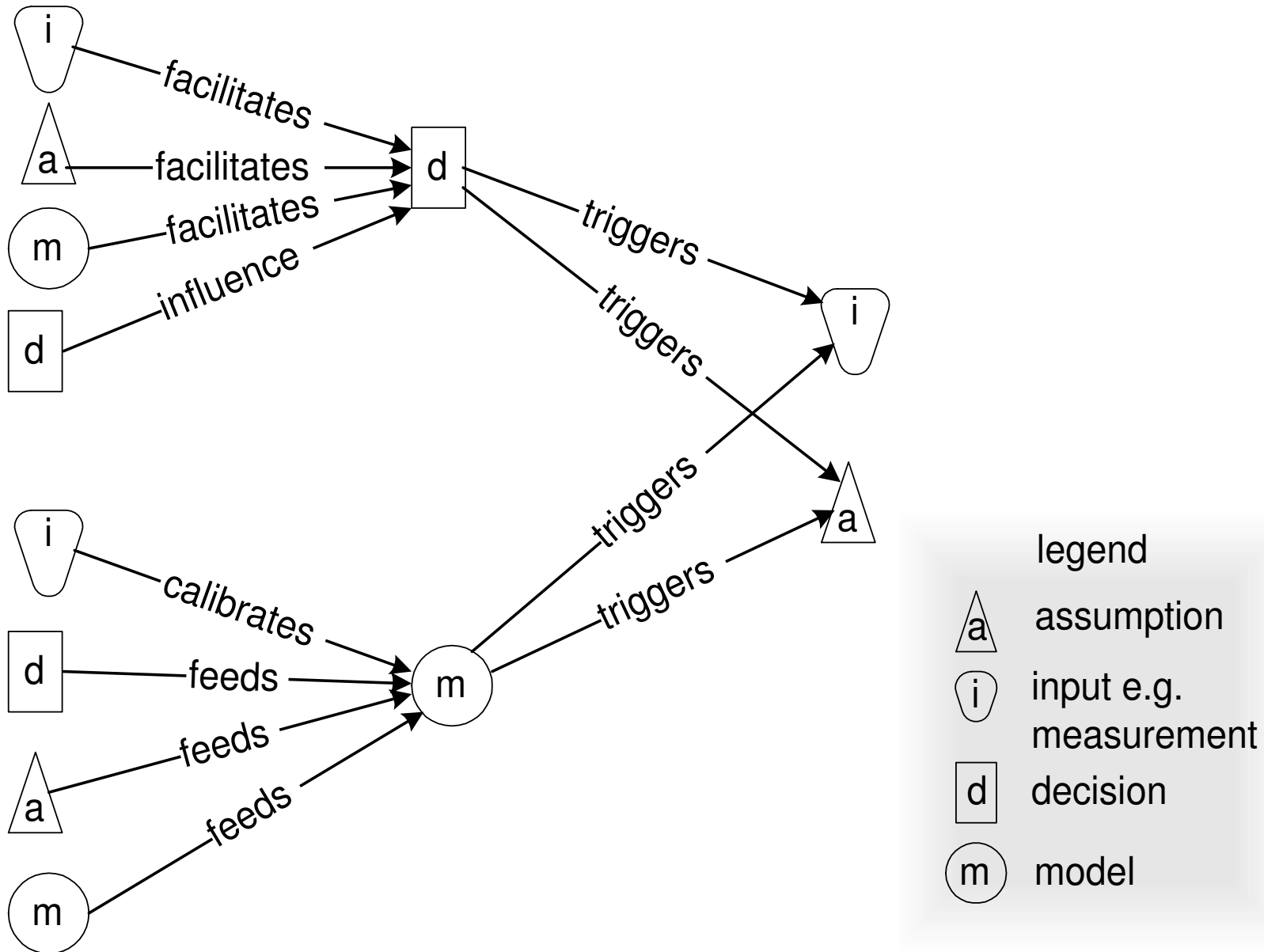
# Graph of Decisions and Models



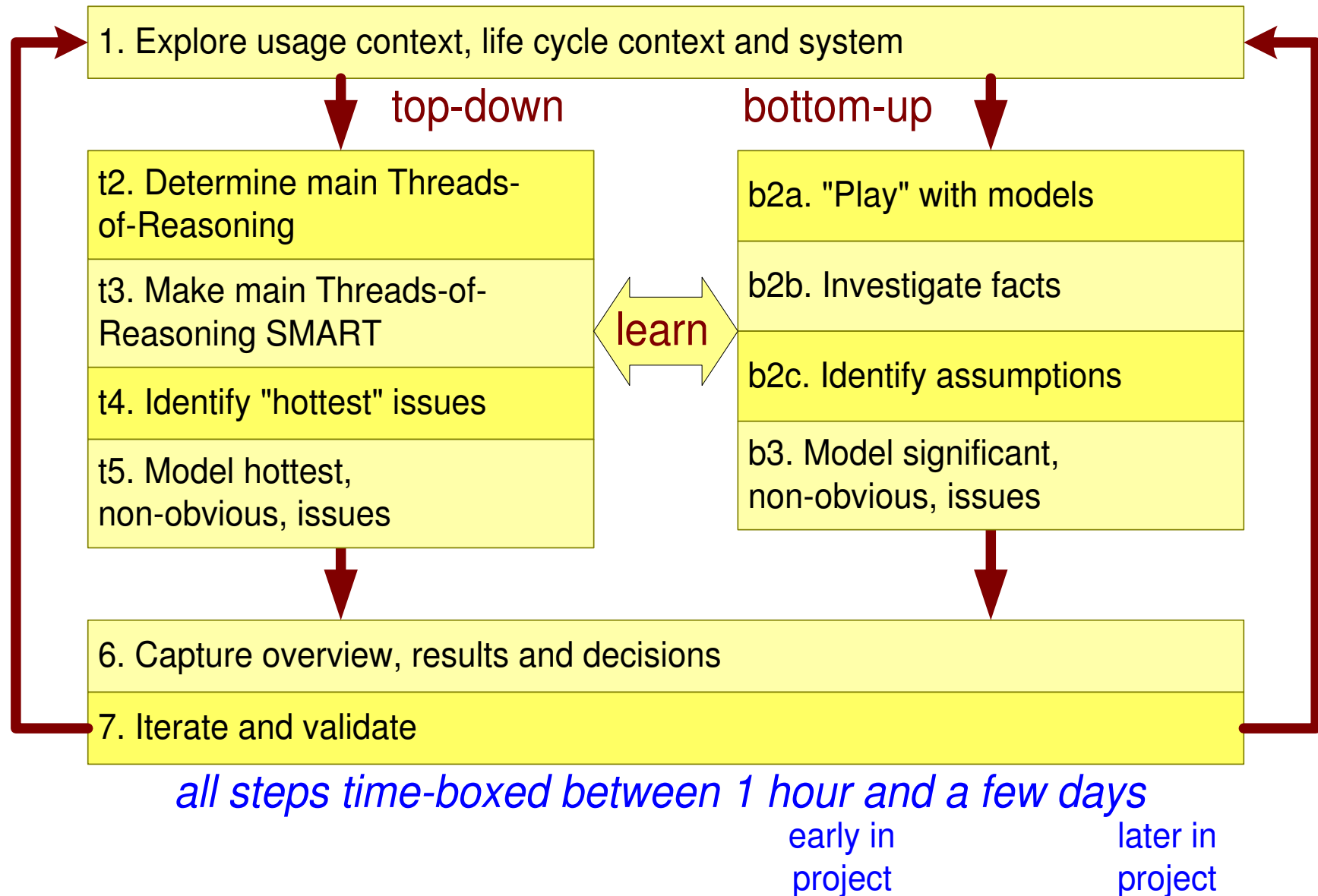
# Example Graph for Web Shop



# Relations: Decisions, Models, Inputs and Assumptions



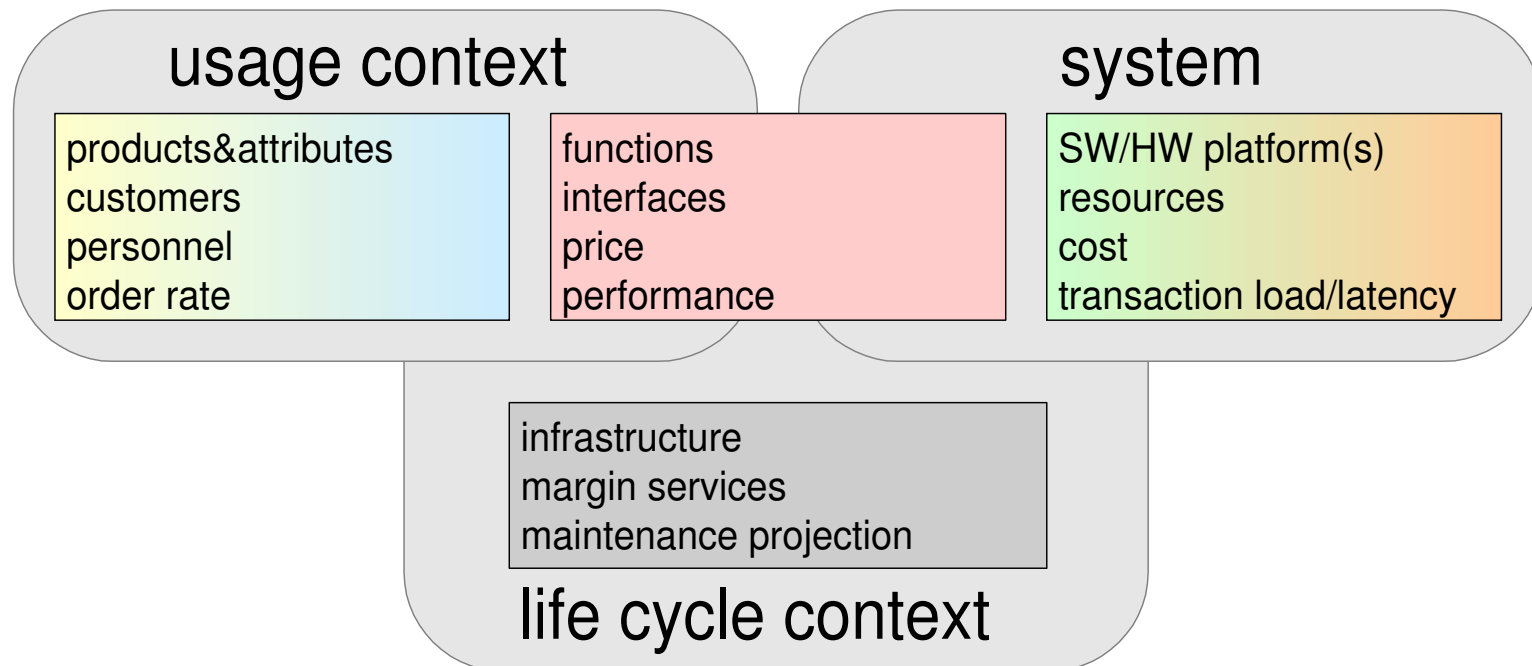
# Reasoning Approach



# 1. Explore

1. Explore usage context, life cycle context and system

Populate with "known" facts, numbers, issues from preceeding projects, available work products and stakeholders

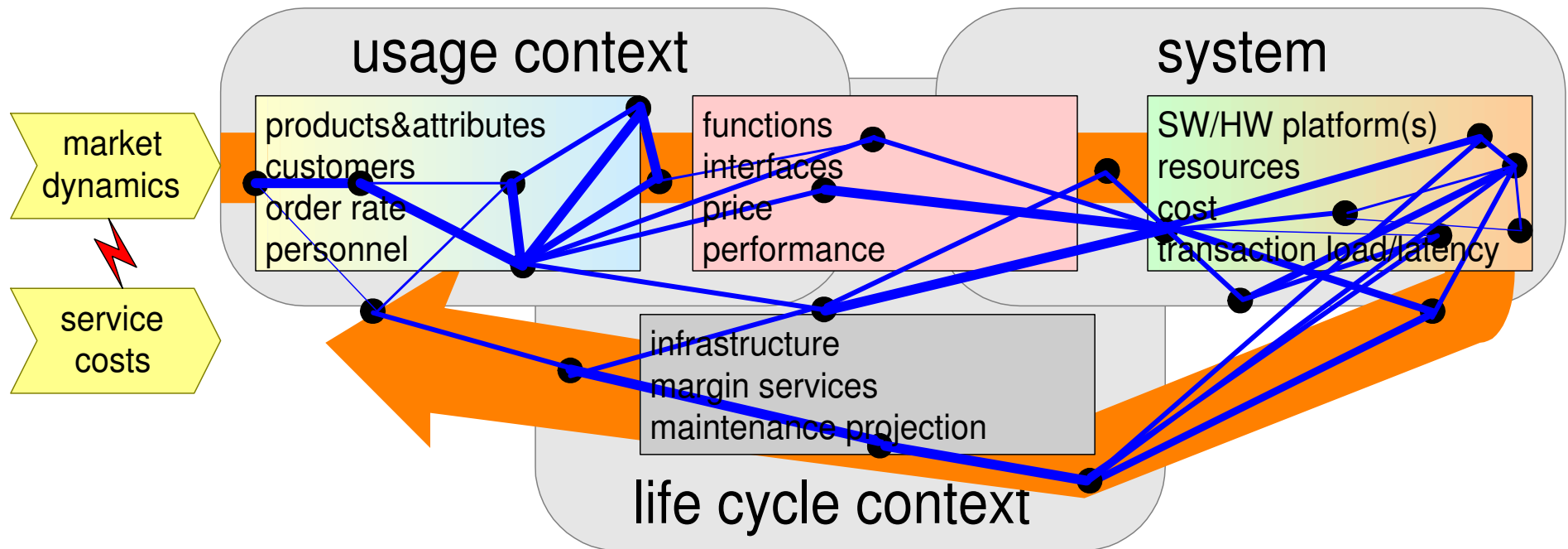


# t2. Thread-of-Reasoning

## t2. Determine main Threads-of-Reasoning

### Architecting and System Design

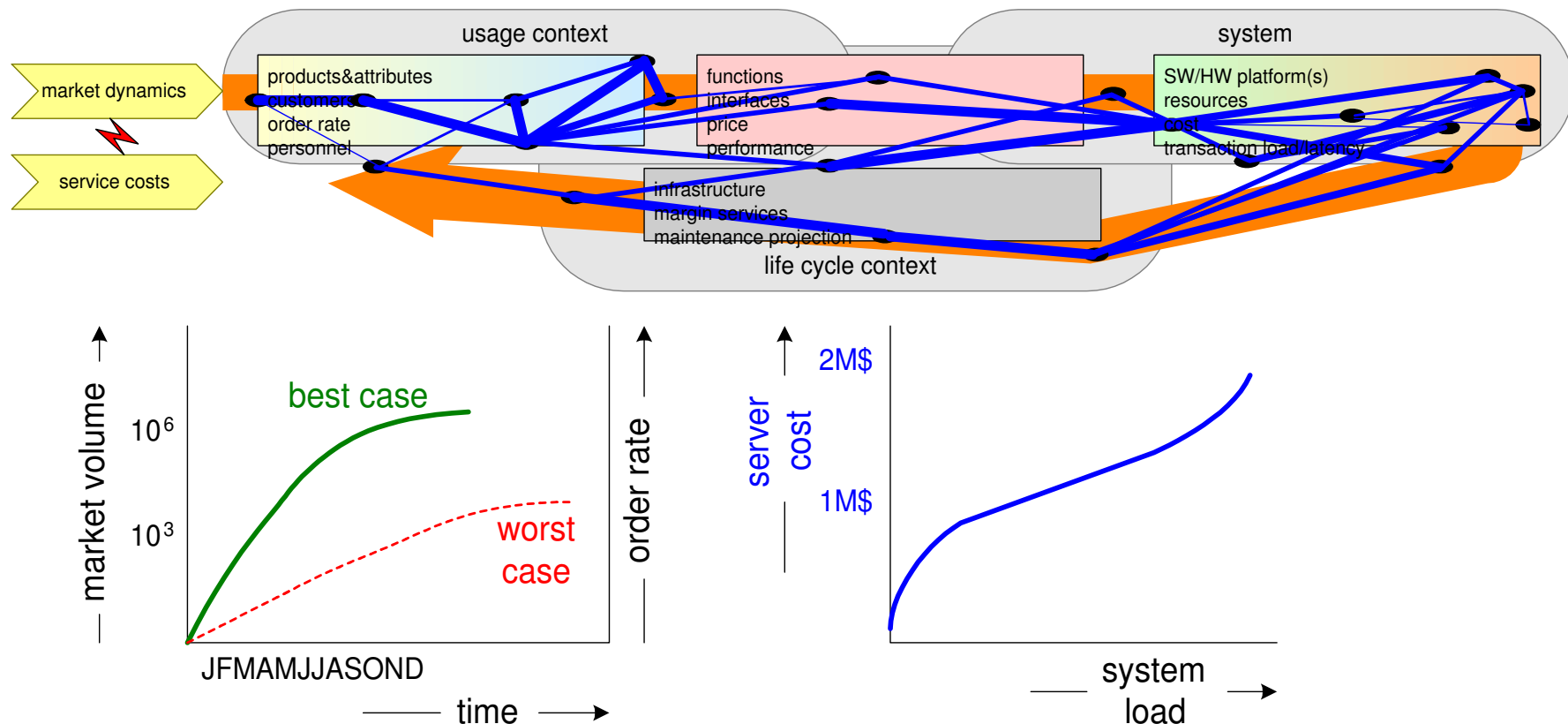
e.g. <http://www.gaudisite.nl/ModuleTORSides.pdf>



# t3. SMART'en Thread-of-Reasoning

t3. Make main Threads-of-Reasoning SMART

Quantify in terms of Key Performance Indicators, Key Performance Measures, Critical Resources



# Intermezzo: the acronym SMART

---

- Specific

quantified

- Measurable

verifiable

*acronym consensus*

- Assignable (Achievable, Attainable,  
Action oriented, Acceptable, Agreed-upon, Accountable)

- Realistic (Relevant, Result-Oriented)

- Time-related (Timely, Time-bound, Tangible, Traceable)

*variation of meaning*

# t4: Identify Hottest

## t4. Identify "hottest" issues

assess explored landscape:

highest (perceived) risk  
most important/valuable  
most discussed  
historic evidence  
urgency

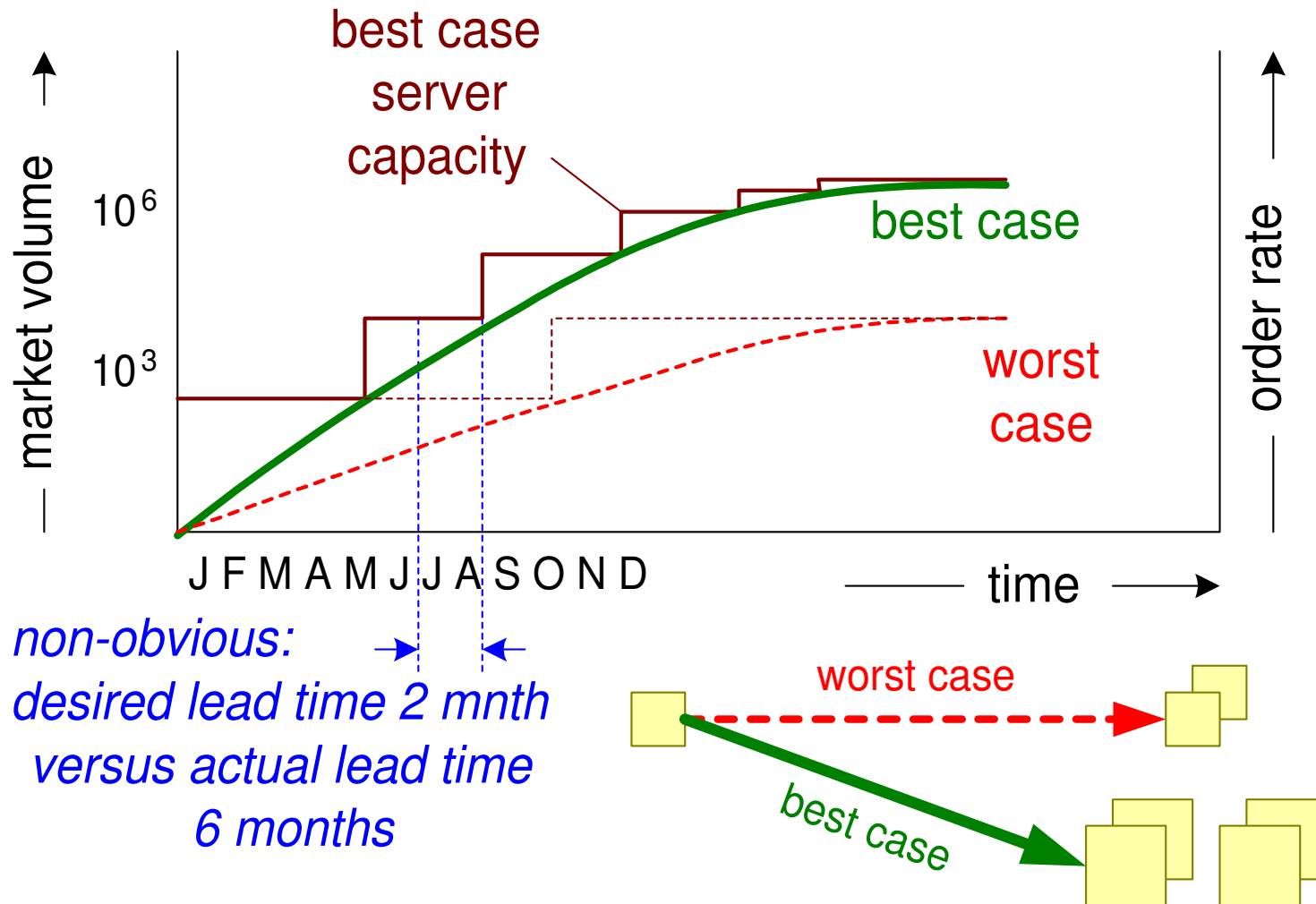
1..5 scale,  
1 = low risk  
5 = high risk  
et cetera

rank issues according to aggregated assessment

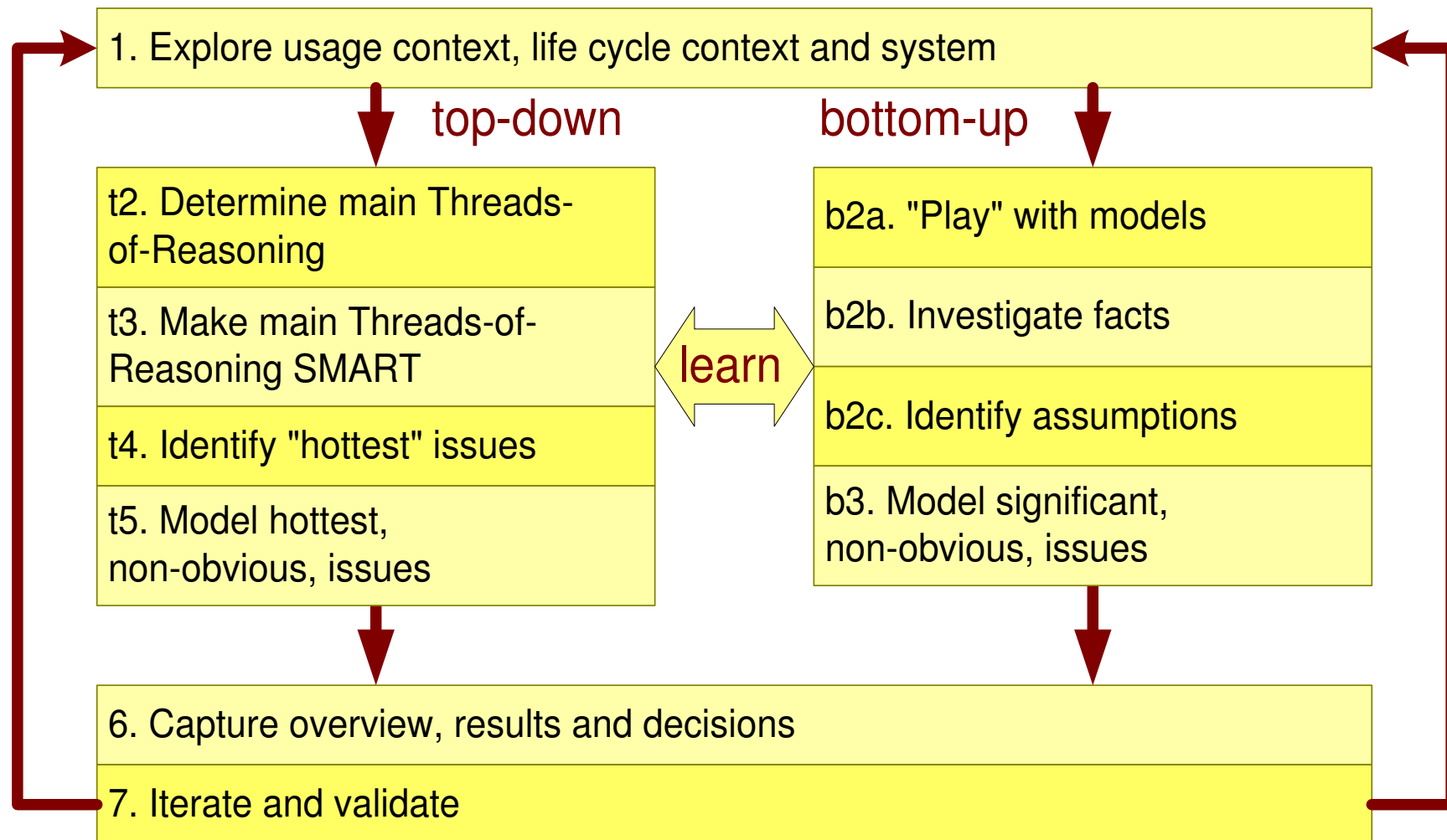
	risk	value	discussion history	urgency	ranking
server cost	2	3	2	1	3
order rate	4	5	5	3	5
transactions	3	3	3	4	2
response time	3	5	1	4	2
availability	2	5	1	3	3
network bandwidth	1	1	3	1	3
storage capacity	1	1	1	2	3

# t5: Model Hottest Issues

## t5. Model hottest, non-obvious, issues



# From *top-down* to *bottom-up*



*all steps time-boxed between 1 hour and a few days*

early in  
project

later in  
project

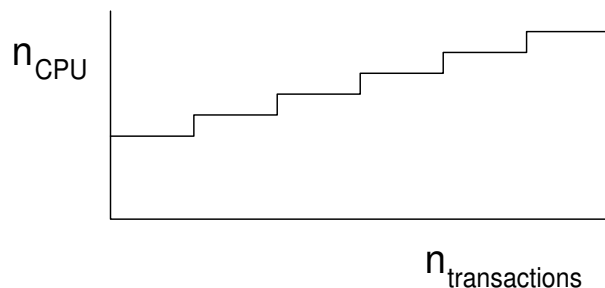
# b2abc: Bottom-up

b2a. "Play" with models	b2b. Investigate facts	b2c. Identify assumptions
vary inputs vary model structure  to understand <i>model applicability</i> , <i>design quality</i> and <i>specification feasibility</i>	market research measurements preceeding systems micro benchmarks literature, supplier info	What is the basis for model structure, design decision, specification, quantification et cetera? <i>Most assumptions are implicit and hidden!</i>

$$n_{\text{CPU}} = t_{\text{required total}} / t_{1 \text{ CPU}}$$

$$t_{\text{required total}} = n_{\text{transactions}} * t_{1 \text{ transaction}} + t_{\text{other}}$$

$$t_{1 \text{ transaction}} = 1 \text{ ms (on 1 CPU)}$$



[http://www.tpc.org/tpcc/results/tpcc\\_perf\\_results.asp](http://www.tpc.org/tpcc/results/tpcc_perf_results.asp)

**IBM System p5 595**  
 TPC-C Throughput 4,033,378  
 Total # of Processors: 32  
 Total # of Cores: 64  
 $1/t_{1 \text{ transaction}} = 4 * 10^6 / 60 / 64$   
min to sec / # cores  
 $t_{1 \text{ transaction}} \approx 1 \text{ ms}$

server load dominated by transactions  
 transaction load scales linear  
 TPC-C is representative  
 what is the effect of other TPC-C workload?

# Bottom-up, more detailed steps

---

Make a list of technologies, components and resources to be used

transactions, data base engine, memory, disk

Make a list of important qualities

performance, reliability, security, maintainability

Make a characterization matrix of technologies, components and resources versus qualities

1..5 scale,  
1 = low risk  
5 = high risk  
et cetera

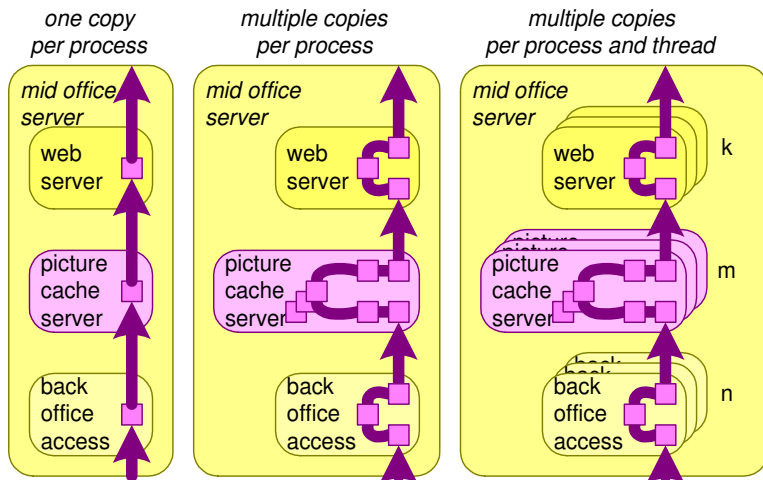
Perform step 2abc on most critical

class 4 and 5 risks

# b3: Model Significant Issues

## b3. Model significant, non-obvious, issues

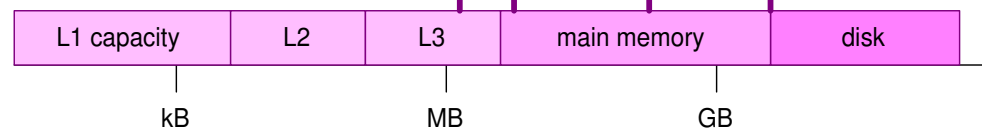
for example, memory use in server(s) for picture transfers and buffering



n	m	k	s	c	MB
1	1	1	1.E+05	10	1.5
2	4	10	1.E+05	20	5.3
2	4	1000	1.E+05	100	296.2
2	4	1000	1.E+06	100	2962.1

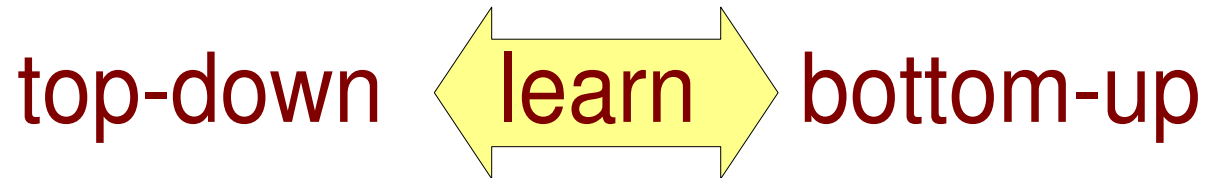
memory use  
product browsing only  
pictures only  
single server

picture memory =  
 $3 * n * s +$   
 $5 * m * s + c * s +$   
 $3 * k * s$   
 where  
 n = # back office access threads  
 m = # picture cache threads  
 k = # web server threads  
 s = picture size in bytes  
 c = in memory cache capacity  
 in # pictures



What is the performance impact of memory use on other processing?

# Learning Concurrent Bottom-up and Top-down

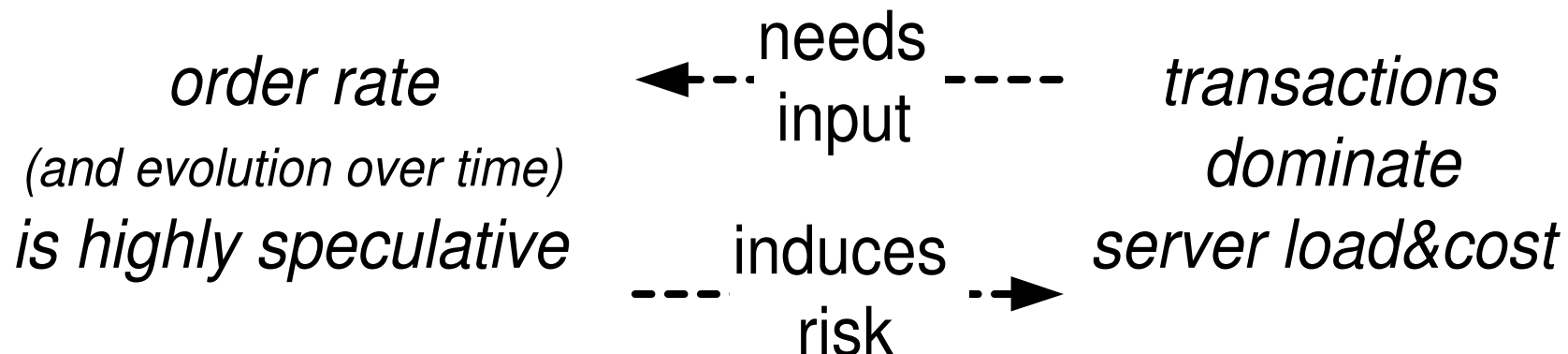


top-down: what is *hidden* in details?

top-down: do we address the *relevant* decomposition?

bottom-up: do we address relevant details?

bottom-up: what details have *significant* impact?



# Example top-down and bottom-up

top-down:

what is impact of catalogue size and changes?

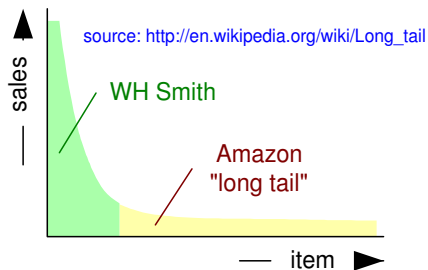
bottom-up:

what is relevant concurrency (k), cache size (c), or picture size (s)?

new books per year

UK (1)	206k (2005)	107k (1996)
USA(2)	172k (2005)	68k (1996)
China(3)		101k (1994)
India(21)		12k (1996)

source: [http://en.wikipedia.org/wiki/Books\\_published\\_per\\_country\\_per\\_year](http://en.wikipedia.org/wiki/Books_published_per_country_per_year)



	n	m	k	s	c	MB	storage type
	1	1	1	100,000	10	1.5	L3
	2	4	10	100,000	20	5.3	main
highly concurrent	2	4	1000	100,000	100	296	main
large pictures	2	4	1000	1,000,000	100	2,962	main+disk
many pictures	2	4	10	100,000	100,000	9,540	main+disk
all at once	2	4	1000	1,000,000	100,000	98,234	disk

memory use  
product browsing only  
pictures only  
single server

$$\text{picture memory} = 3 * n * s + 5 * m * s + c * s + 3 * k * s$$

where

n = # back office access threads

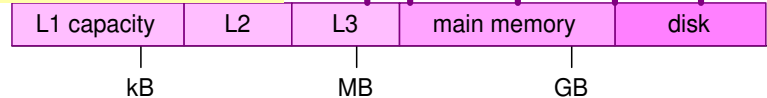
m = # picture cache threads

k = # web server threads

s = picture size in bytes

c = in memory cache

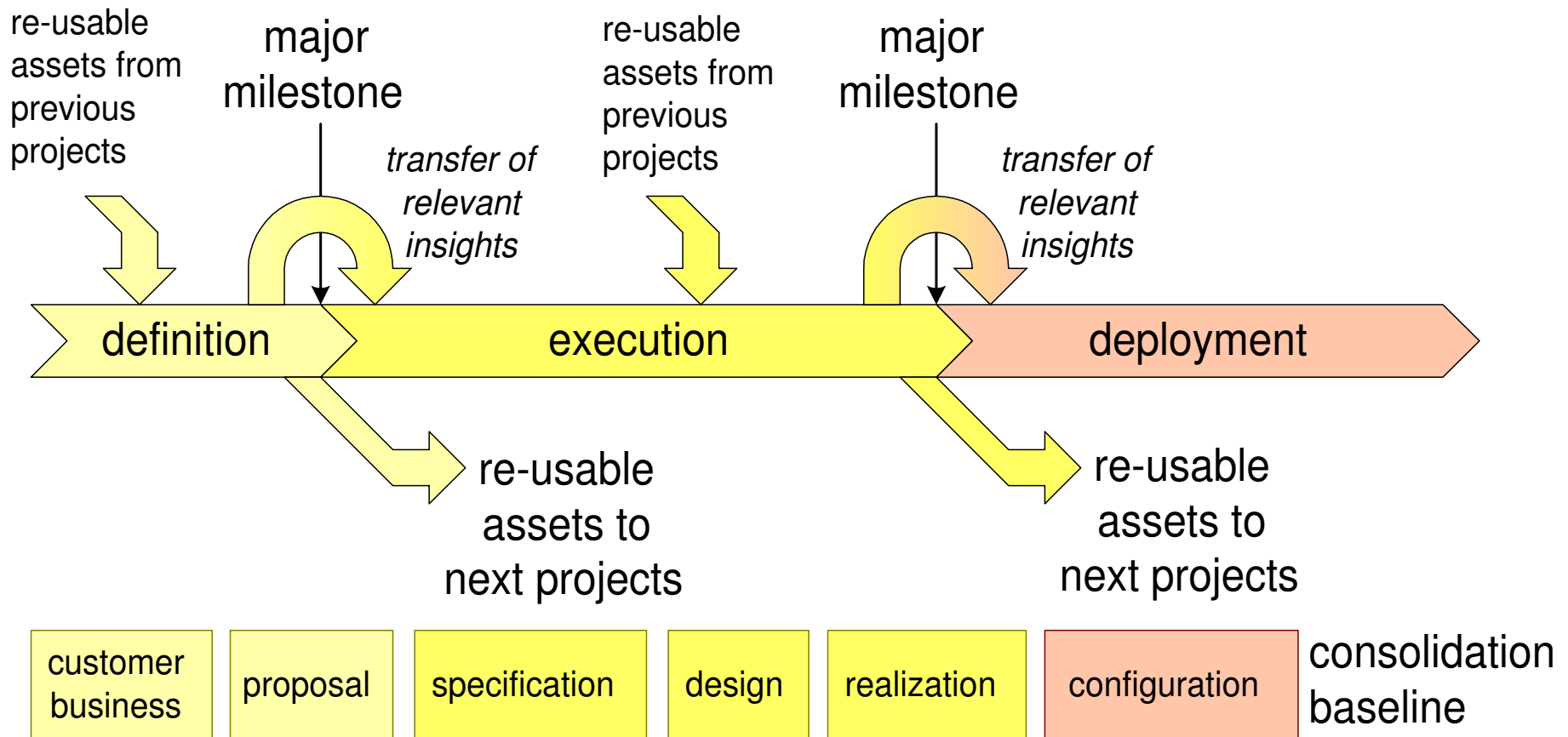
capacity in # pictures



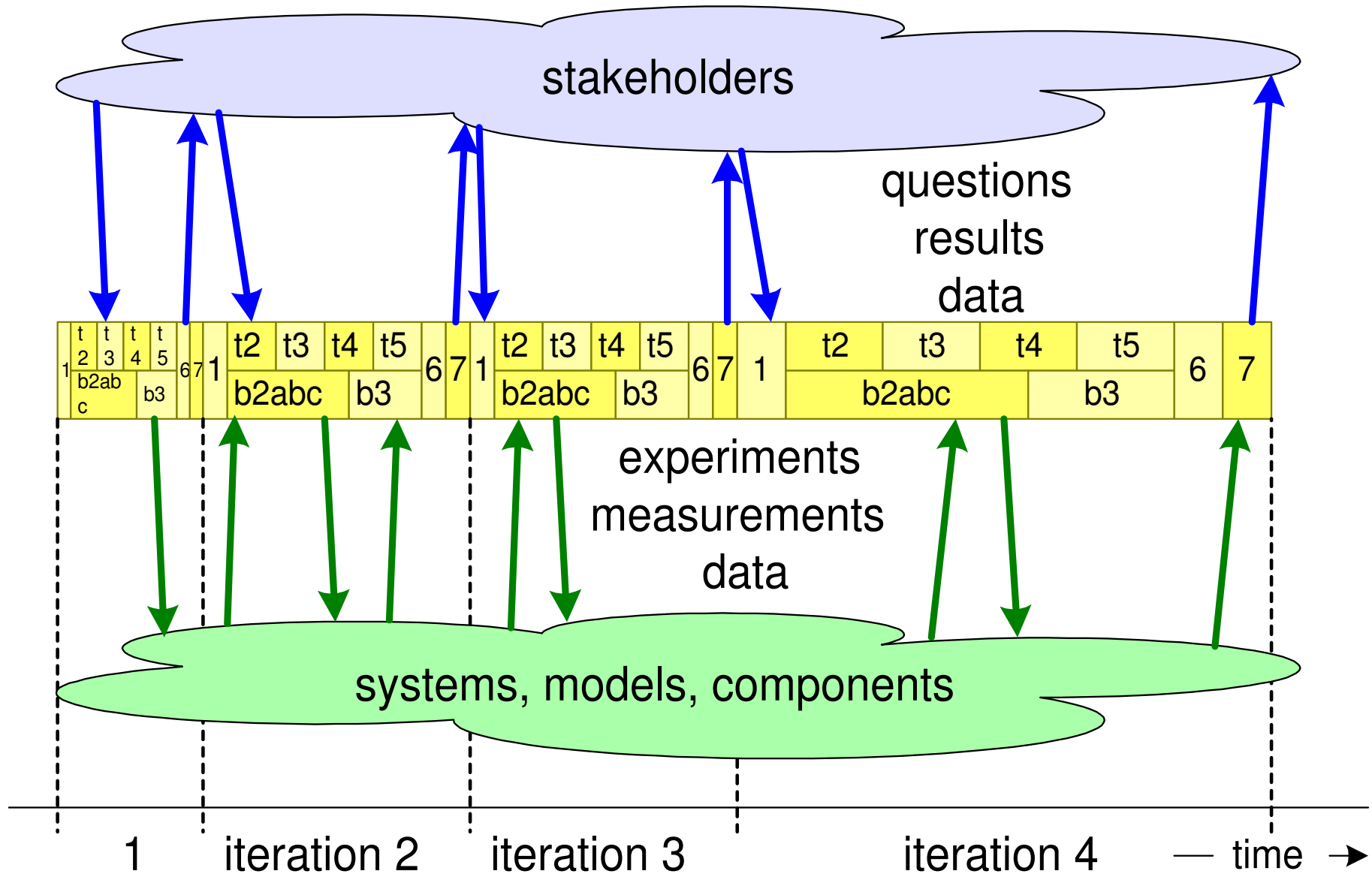
What is the performance impact of memory use on other processing?

# 6. Capture overview, results and decisions

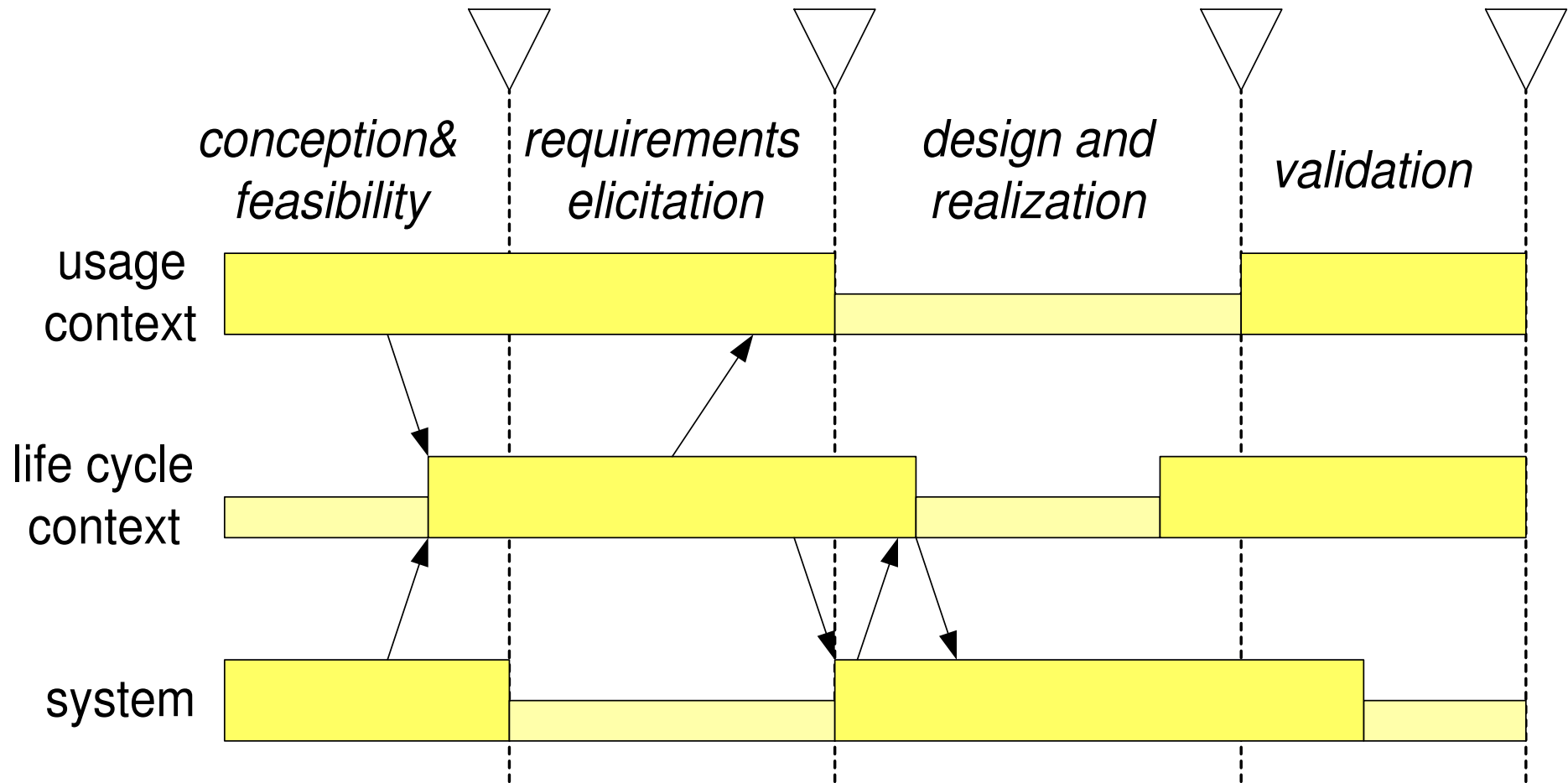
## 6. Capture overview, results and decisions



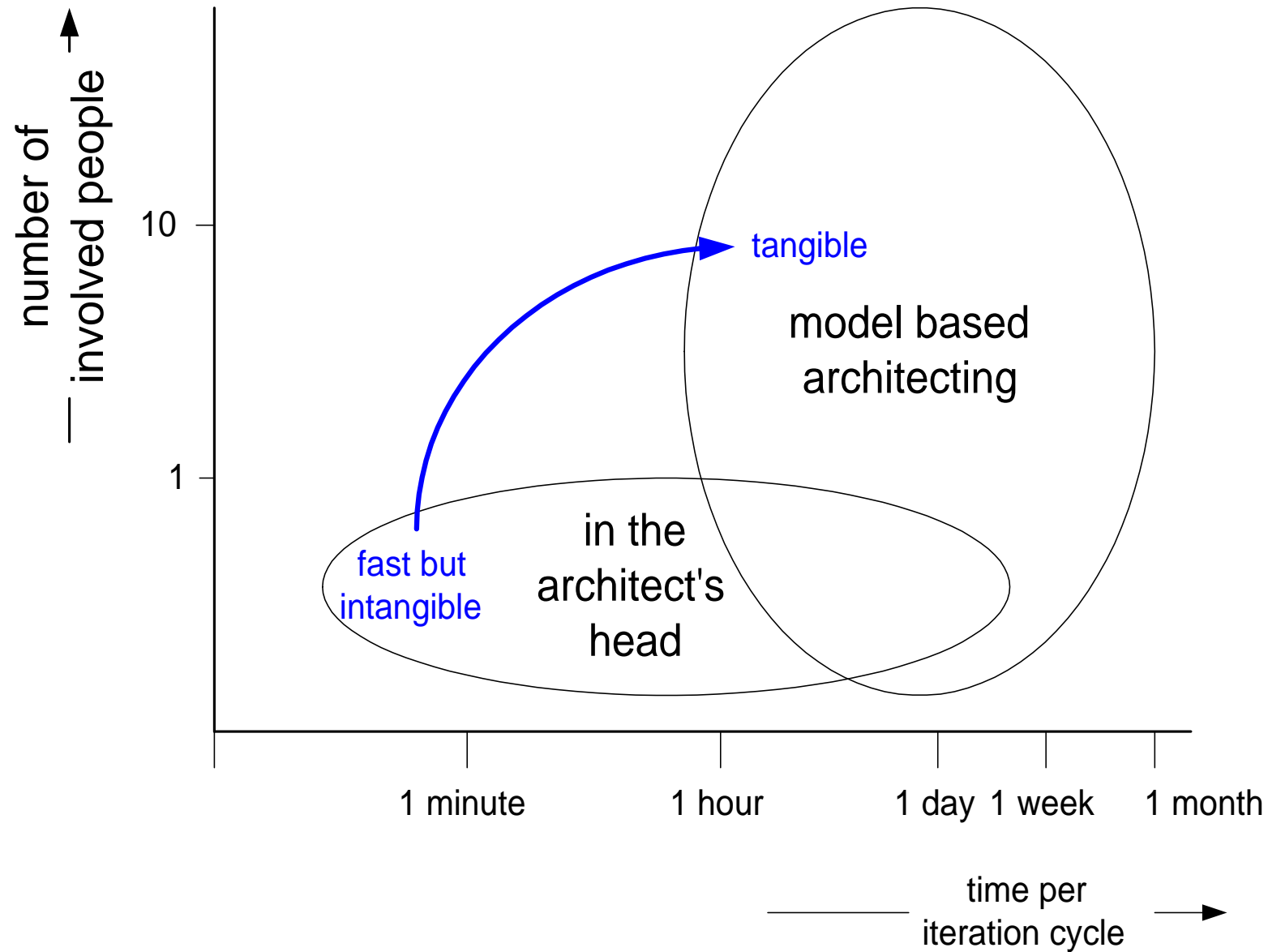
# 7. Iterate and Validate



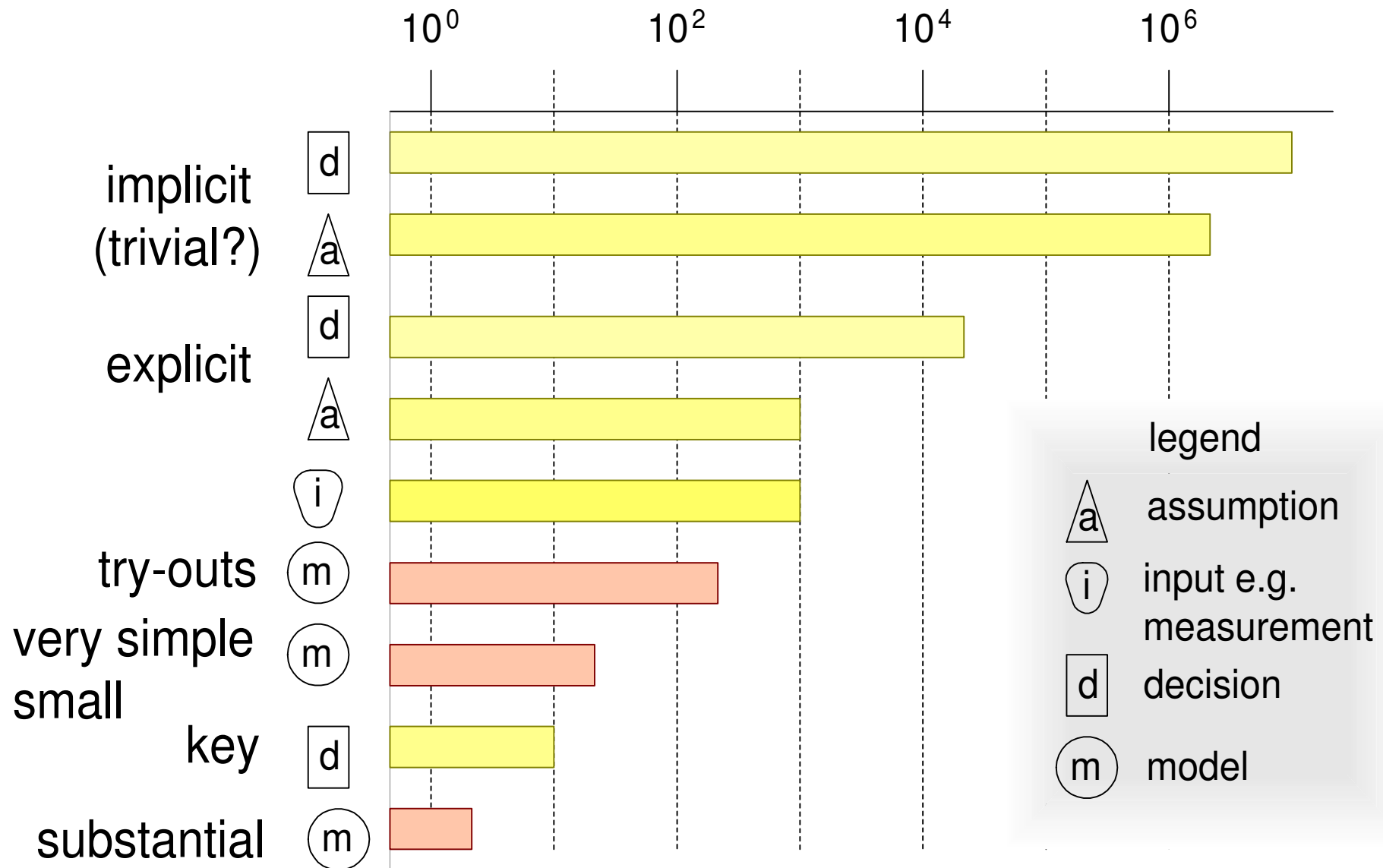
# Focus is Shifting during Project



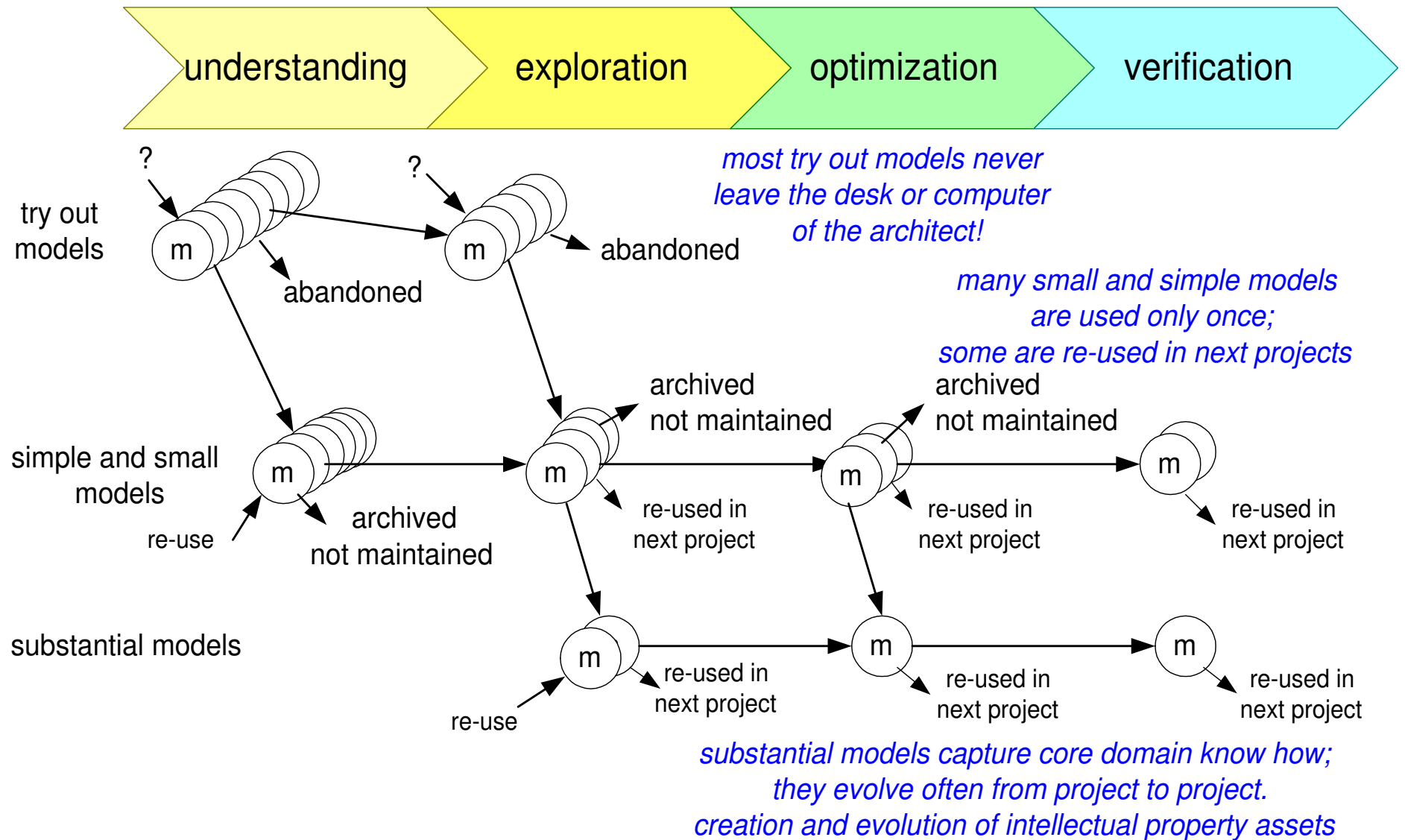
# Models Support Communication



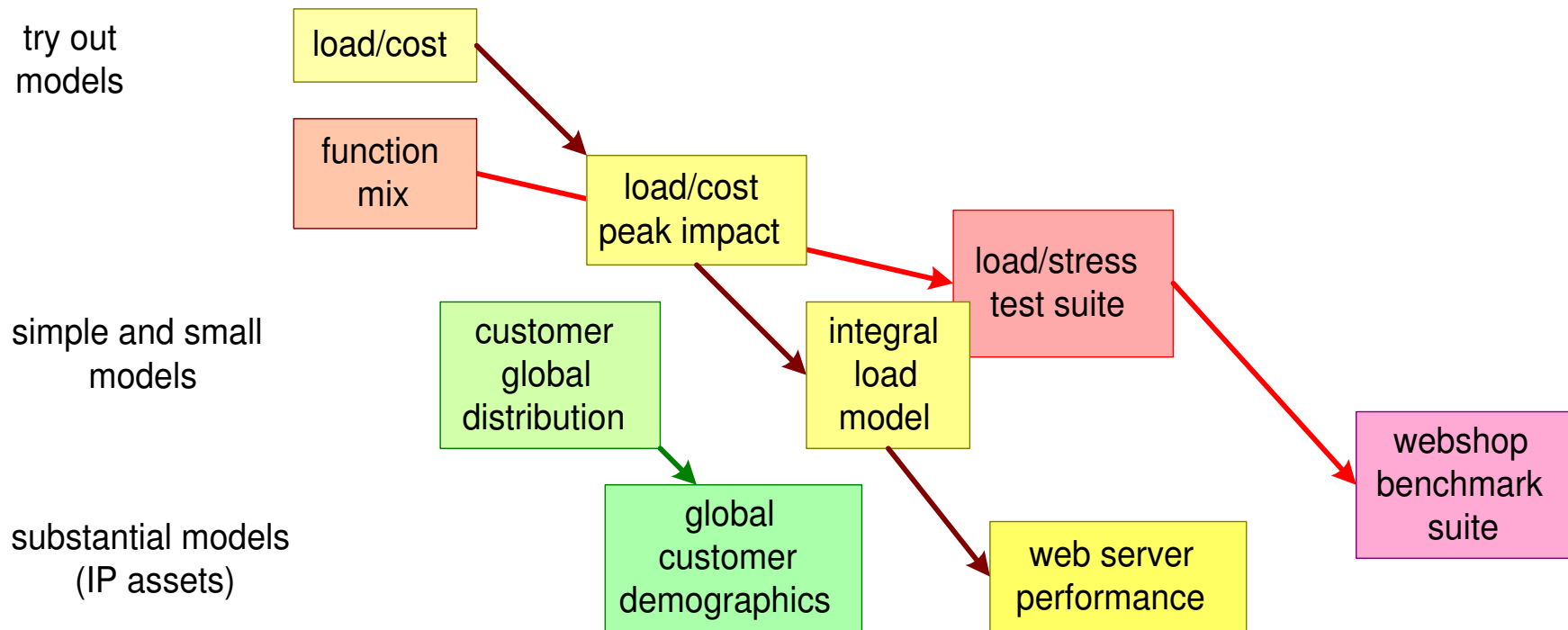
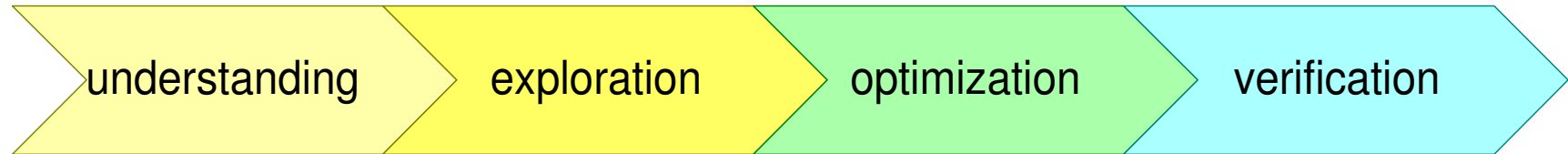
# Frequency of Assumptions, Decisions and Modeling



# Life Cycle of Models



# Examples of Life Cycle of Models



## *Conclusions*

Top-down and bottom-up provide complementary insights

Key words for selection: hottest, non-obvious, significant, relevant

Multiple small models are used in combination

Some models evolve from very simple to more substantial

## *Techniques, Models, Heuristics of this module*

Threads-of-reasoning

SMART

Key Performance Indicators, Key Performance Measures, Critical Resources

Ranking matrices

# Modeling and Analysis: Modularity and Integration

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## **Abstract**

More substantial models are created step by step. We will discuss the order of creation and modularity considerations. The modules have to be integrated into the desired substantial model.

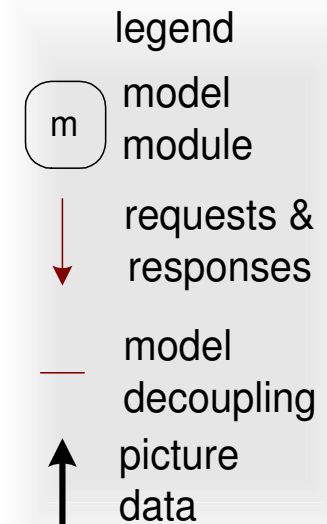
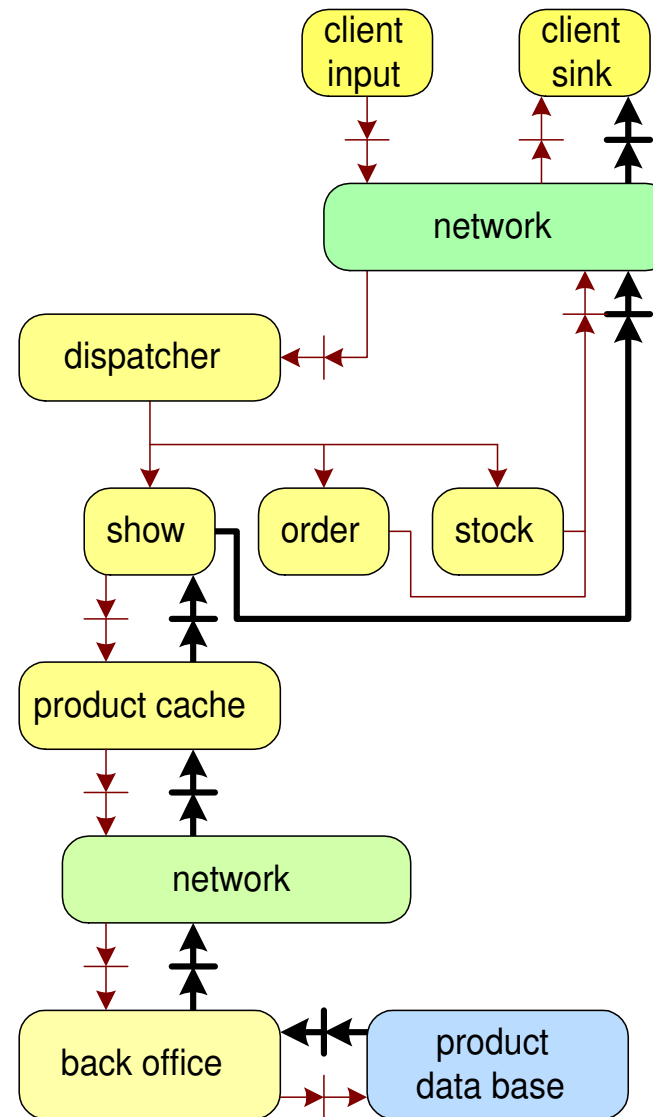
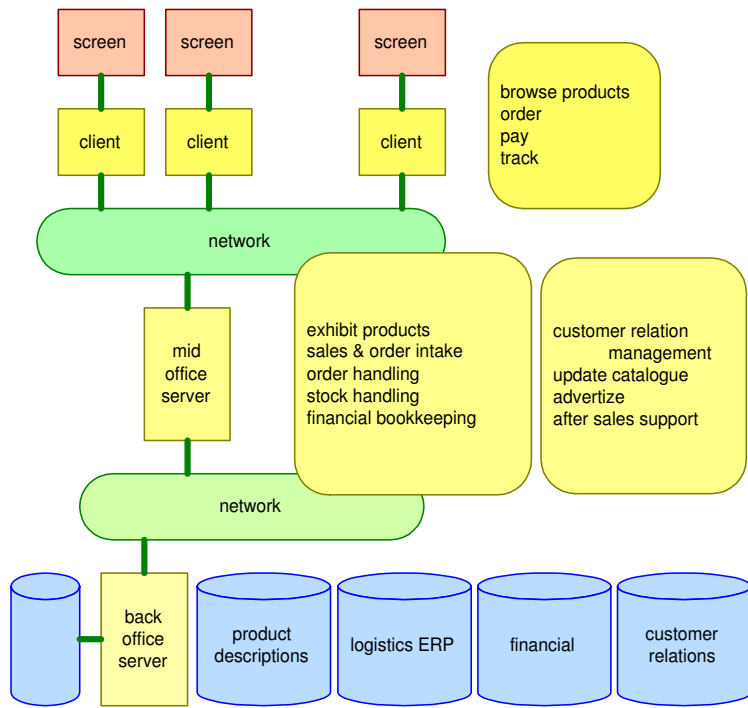
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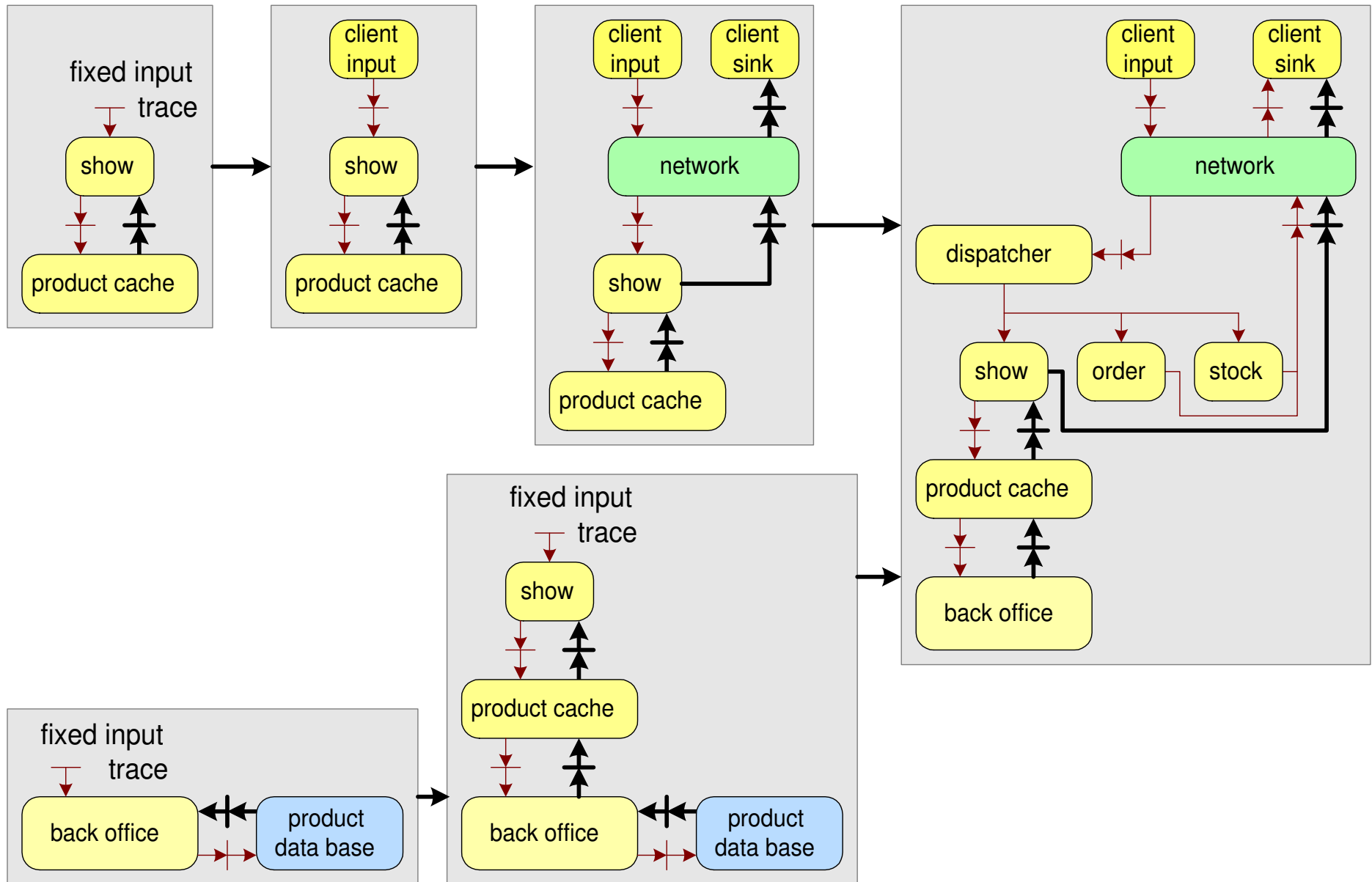
November 29, 2010  
status: planned  
version: 0

logo  
TBD

# Example of (Partial) Flow Simulator



# Example of Incremental Model Creation



# Approach for Incremental Model Creation

Start with the hottest issue

what creates the most discussion or uncertainty?

Ensure immediate feedback

does this model help to answer the questions that we have?

Keep flexible decoupling point

e.g. human readable/editable files

Extend model only for a good purpose

don't integrate models because it *can* be done

Create effective visual outputs

simple animations, graphs, tables, ...

Refactor regularly

based on increasing insight, feedback and purpose

# Attention Points for Every Integration Step

Does the output of the integrated model match your expectation?

Can you explain the model behavior?

Can you explain the variation of the output?

