Module Modeling and Analysis: Integration and Reasoning

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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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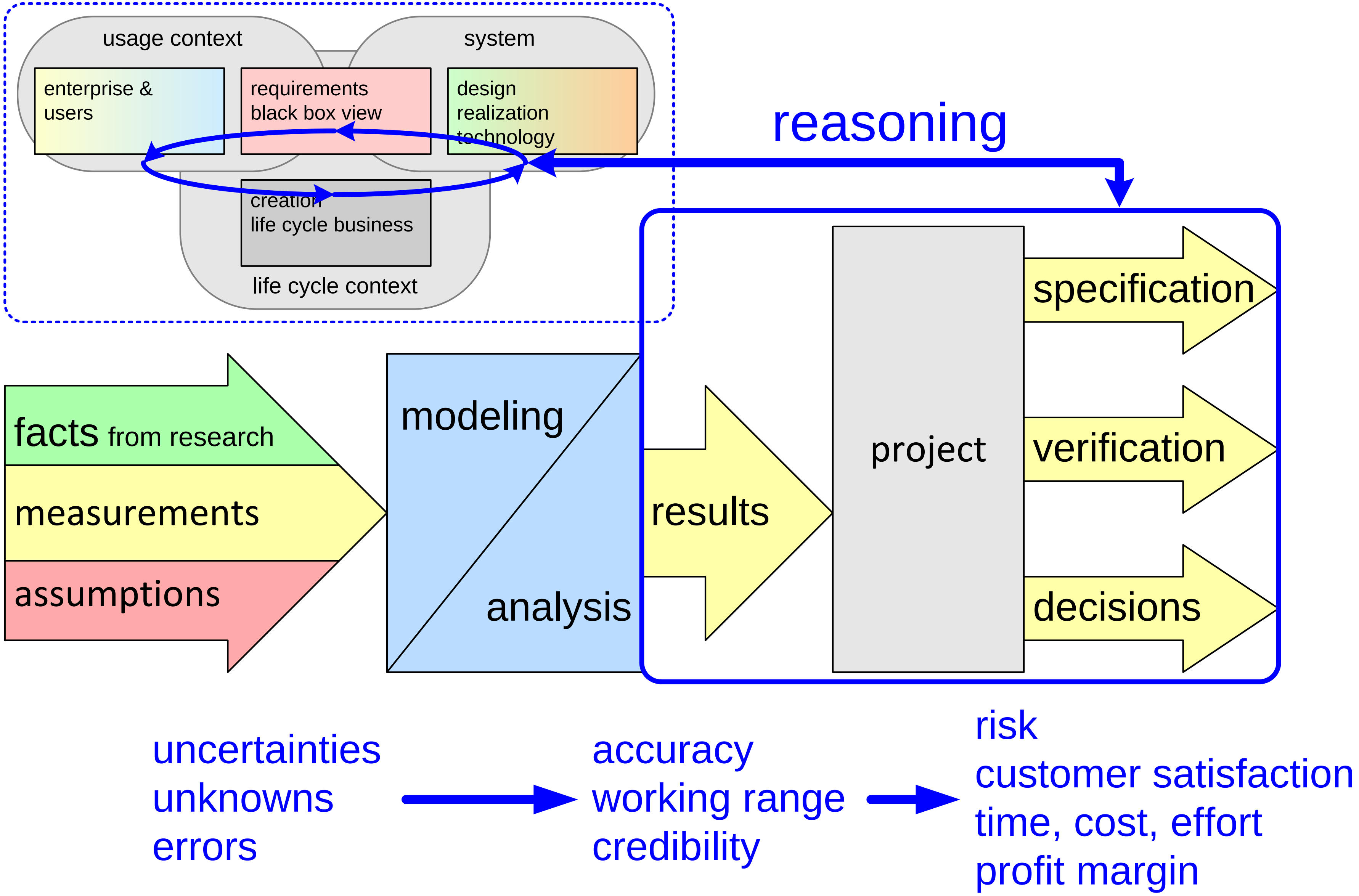
version: 0.3

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.

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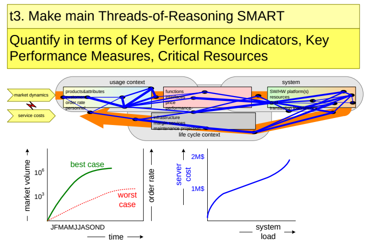


content

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

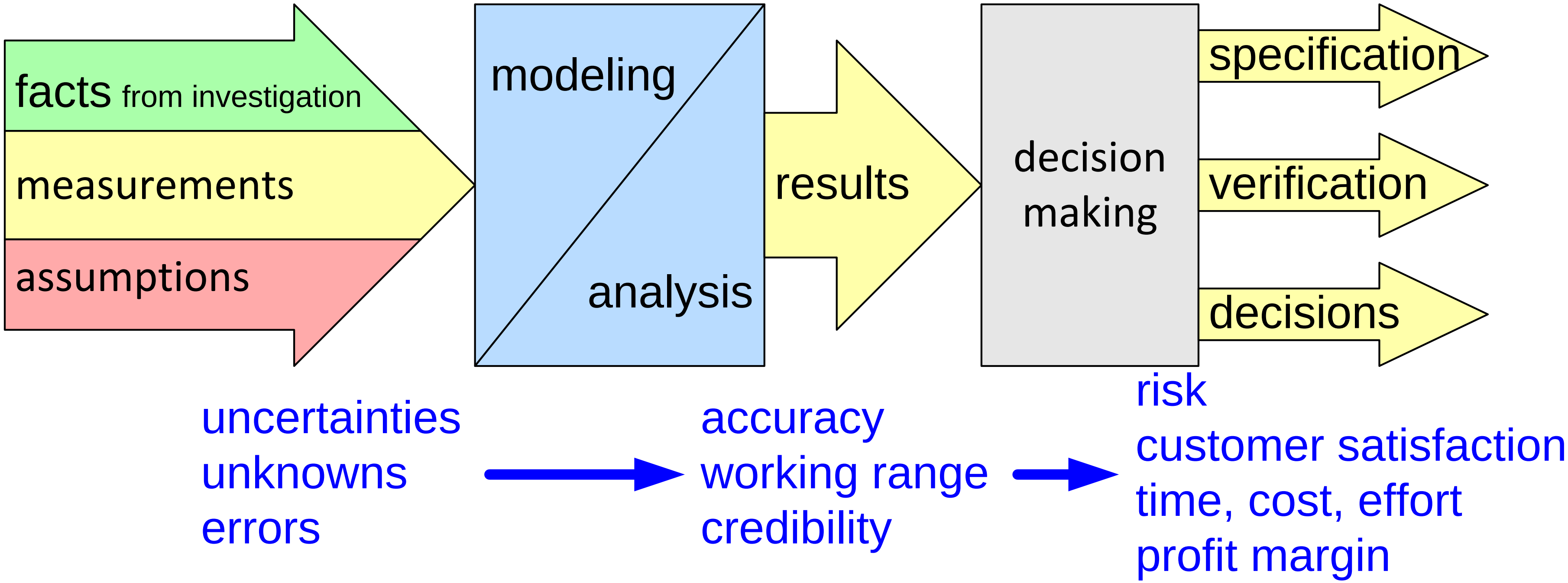
Purpose of Modeling

How to use multiple models to facilitate decisions?

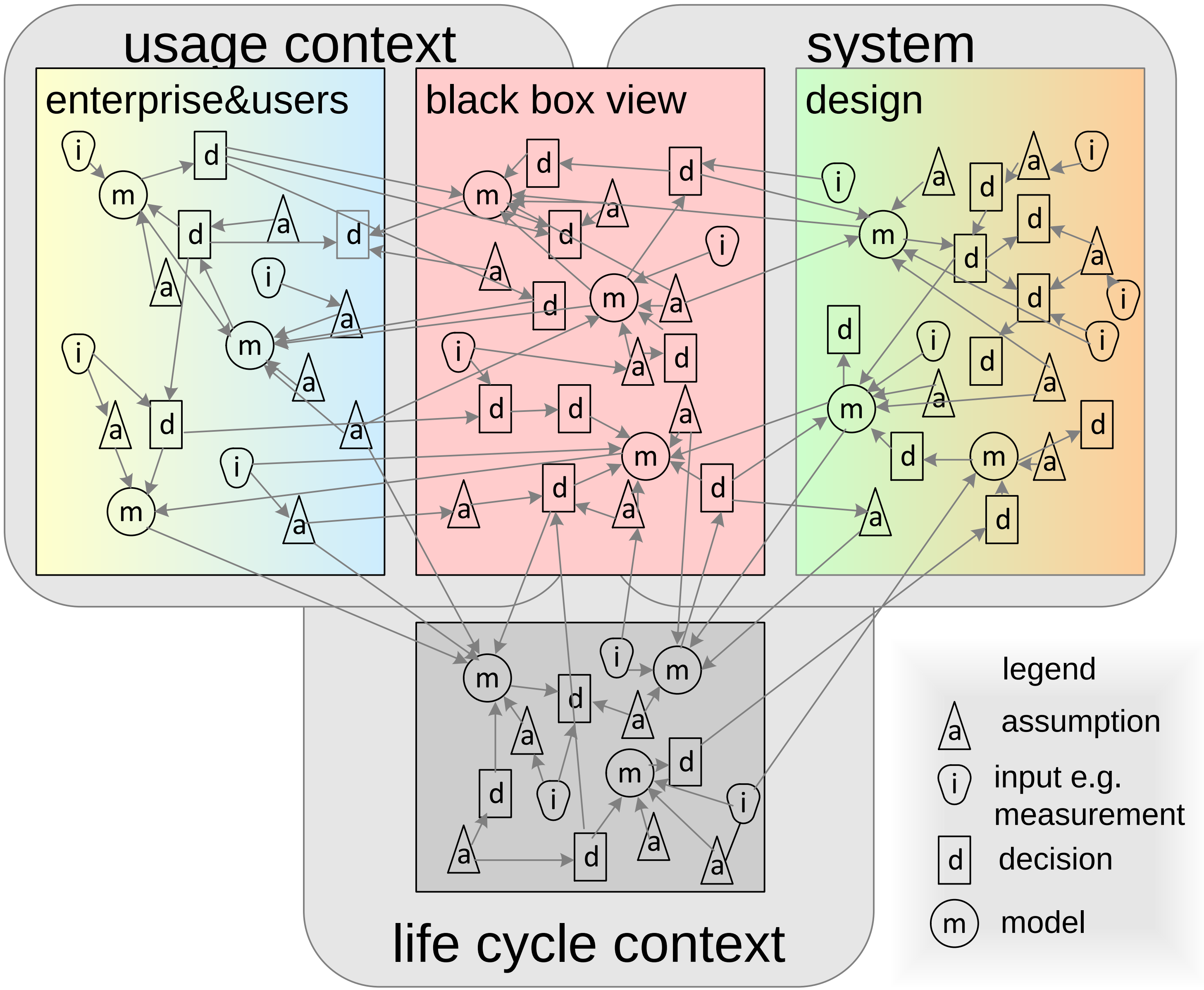
How to get from many fragments to integral insight?

How many models do we need?

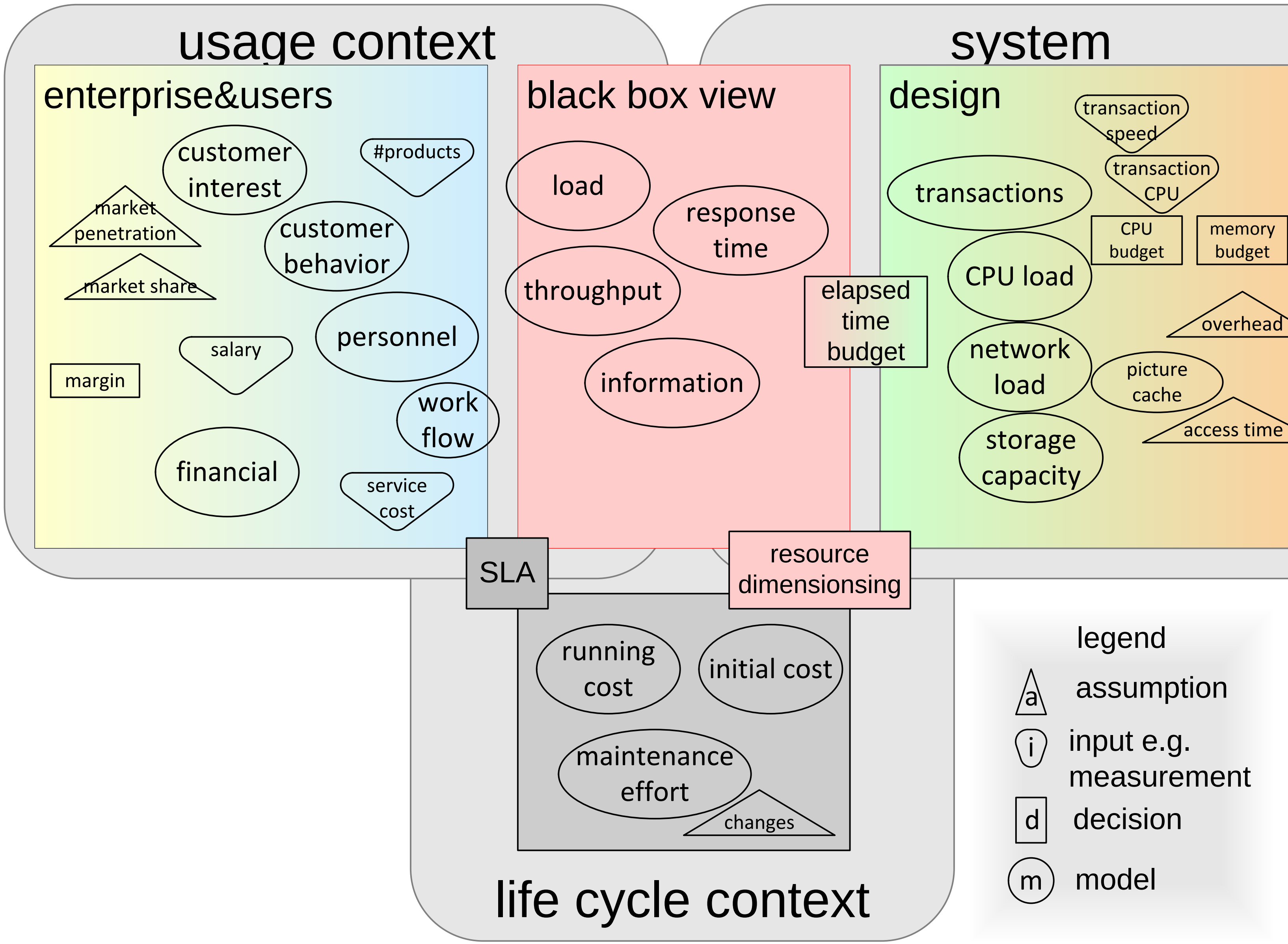
At what quality and complexity levels ?



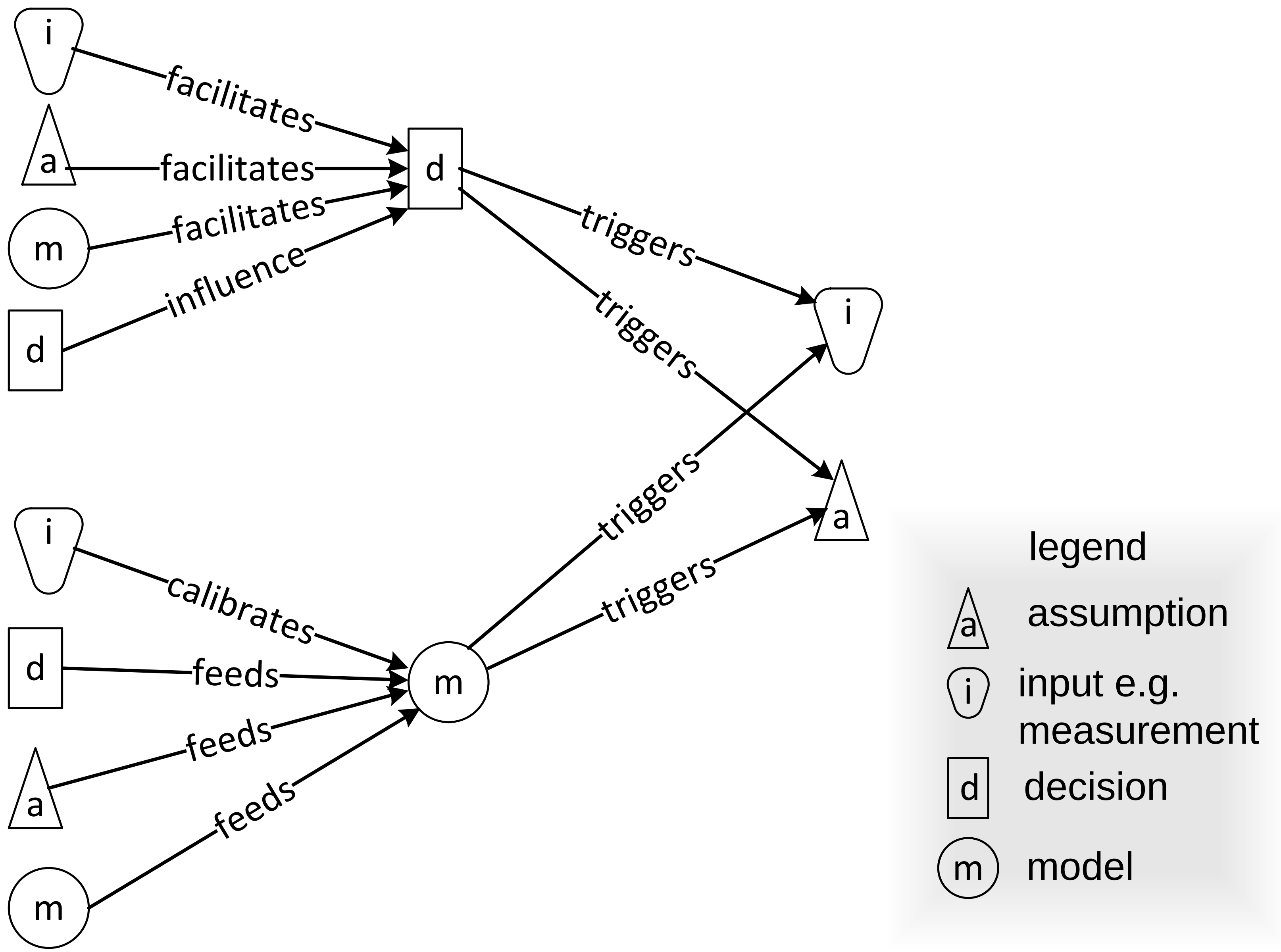
Graph of Decisions and Models



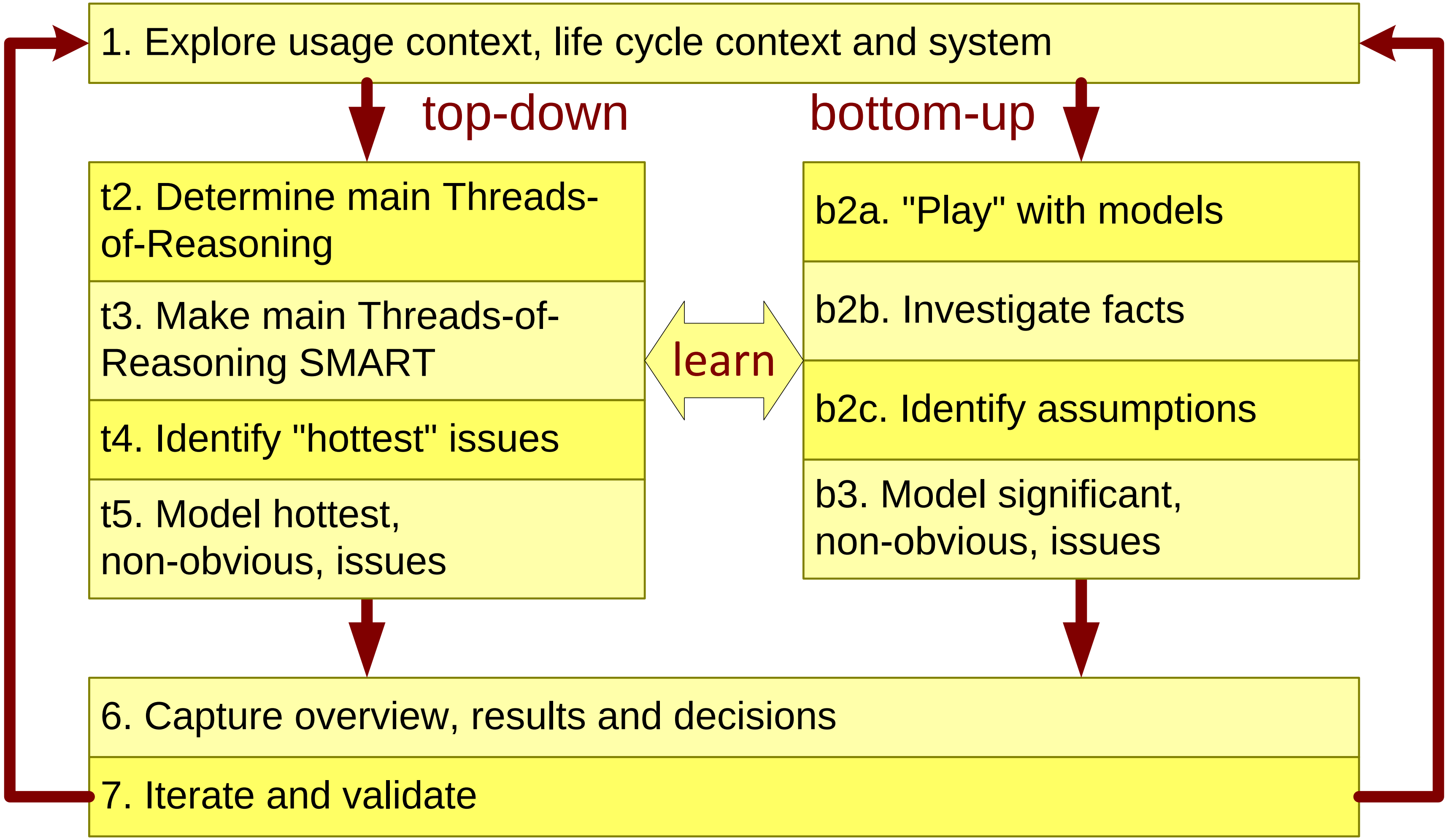
Example Graph for Web Shop



Relations: Decisions, Models, Inputs and Assumptions



Reasoning Approach



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

early in project

later in project

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

usage context

products&attributes
customers
personnel
order rate

functions
interfaces
price
performance

system

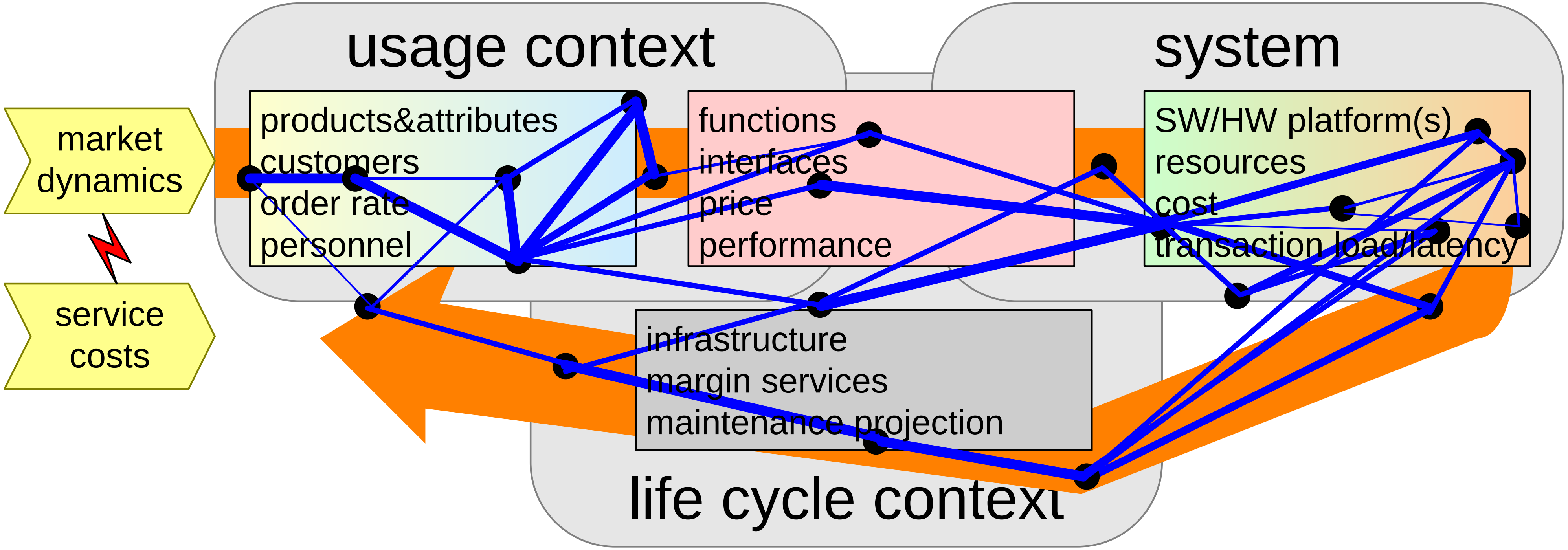
SW/HW platform(s)
resources
cost
transaction load/latency

infrastructure
margin services
maintenance projection

life cycle context

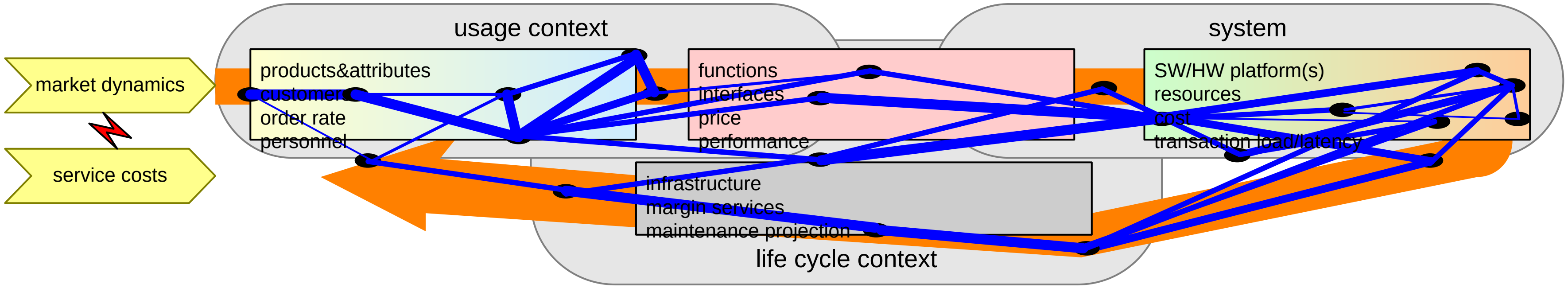
t2. Thread-of-Reasoning

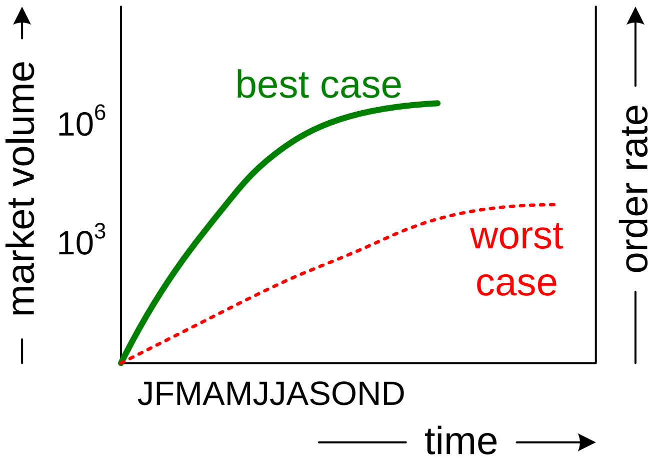
t2. Determine main Threads-of-Reasoning
Architecting and System Design e.g. http://www.gaudisite.nl/ModuleTORSlides.pdf

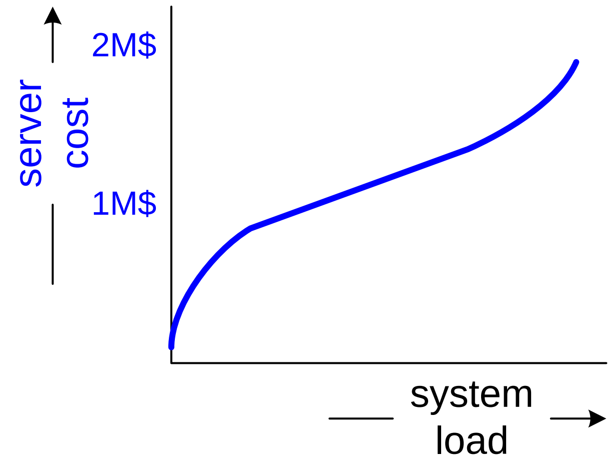


t3. Make main Threads-of-Reasoning SMART

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:

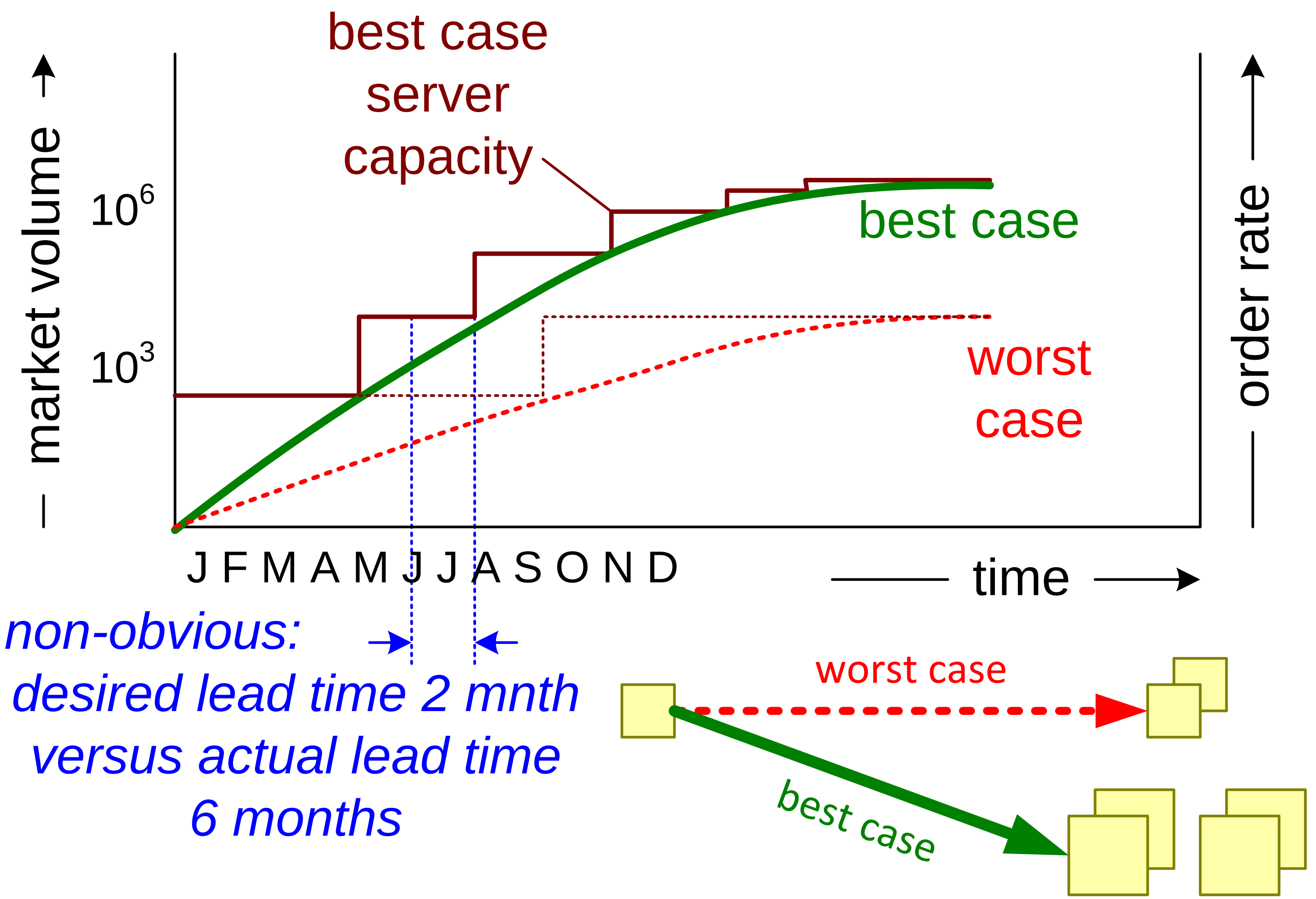
- highest (perceived) risk
- most important/valuable
- most discussed
- historic evidence
- urgency

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

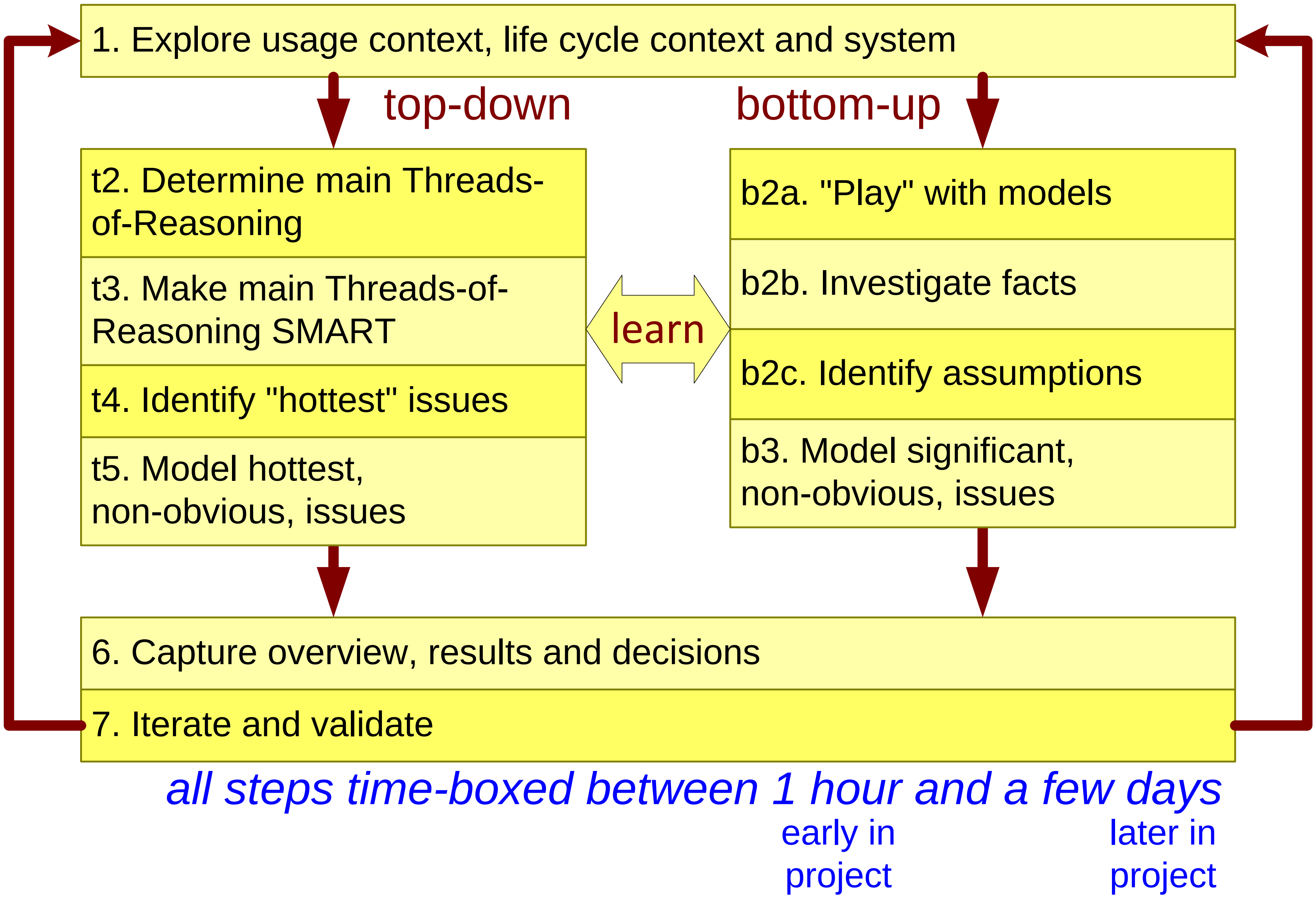
rank issues according to aggregated assessment

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

t5. Model hottest, non-obvious, issues



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



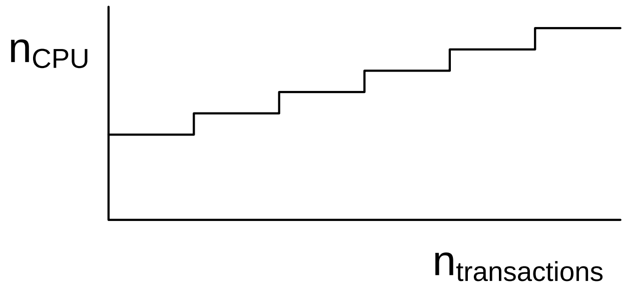
b2abc: Bottom-up

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

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

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

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



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

$1/t_{1\ transaction} = 4*10^6 / 60 / 64$

min to sec

cores

$t_{1\ transaction}$ ~= 1 ms

server load dominated by transactions

transaction load scales linear

TPC-C is representative

what is the effect of other TPC-C workload?

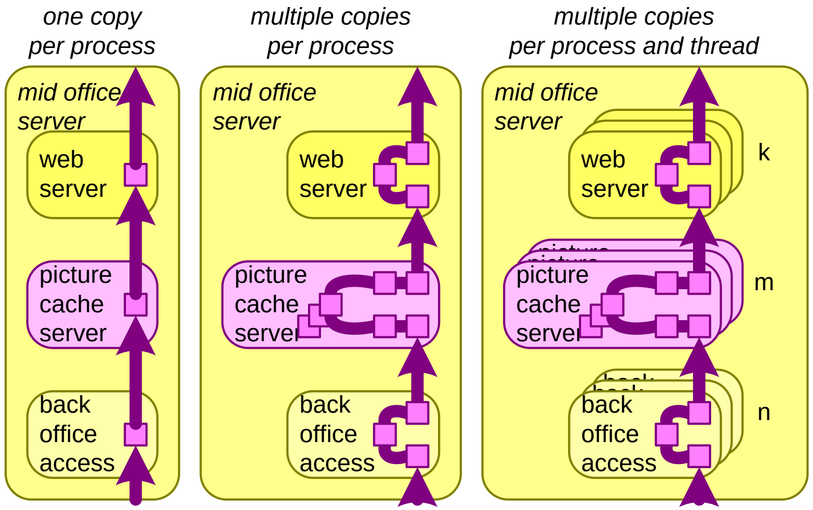
Bottom-up, more detailed steps

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

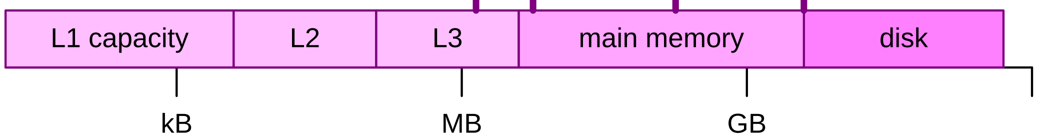


n	m	k	s	c	MB
1	1	1	1.E+05	10	1.5
2	4	10	1.E+05	20	5.3
2	4	1000	1.E+05	100	296.2
2	4	1000	1.E+06	100	2962.1

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 ⟺ learn ⟺ bottom-up

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?

order rate
(and evolution over time)
is highly speculative

needs input

induces risk

transactions
dominate
server load&cost

Example top-down and bottom-up

top-down:

what is impact of

catalogue size and changes?

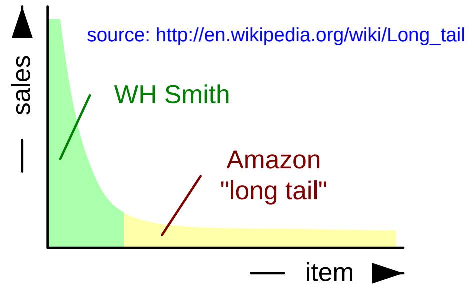
bottom-up:

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



source: http://en.wikipedia.org/wiki/Long_tail

	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

picture memory = 3 * n * s + 5 * m * s + c * s +3 * k * s

where

n = # back office access threads

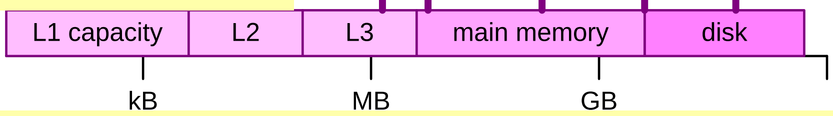
m = # picture cache threads

k = # web server threads

s = picture size in bytes

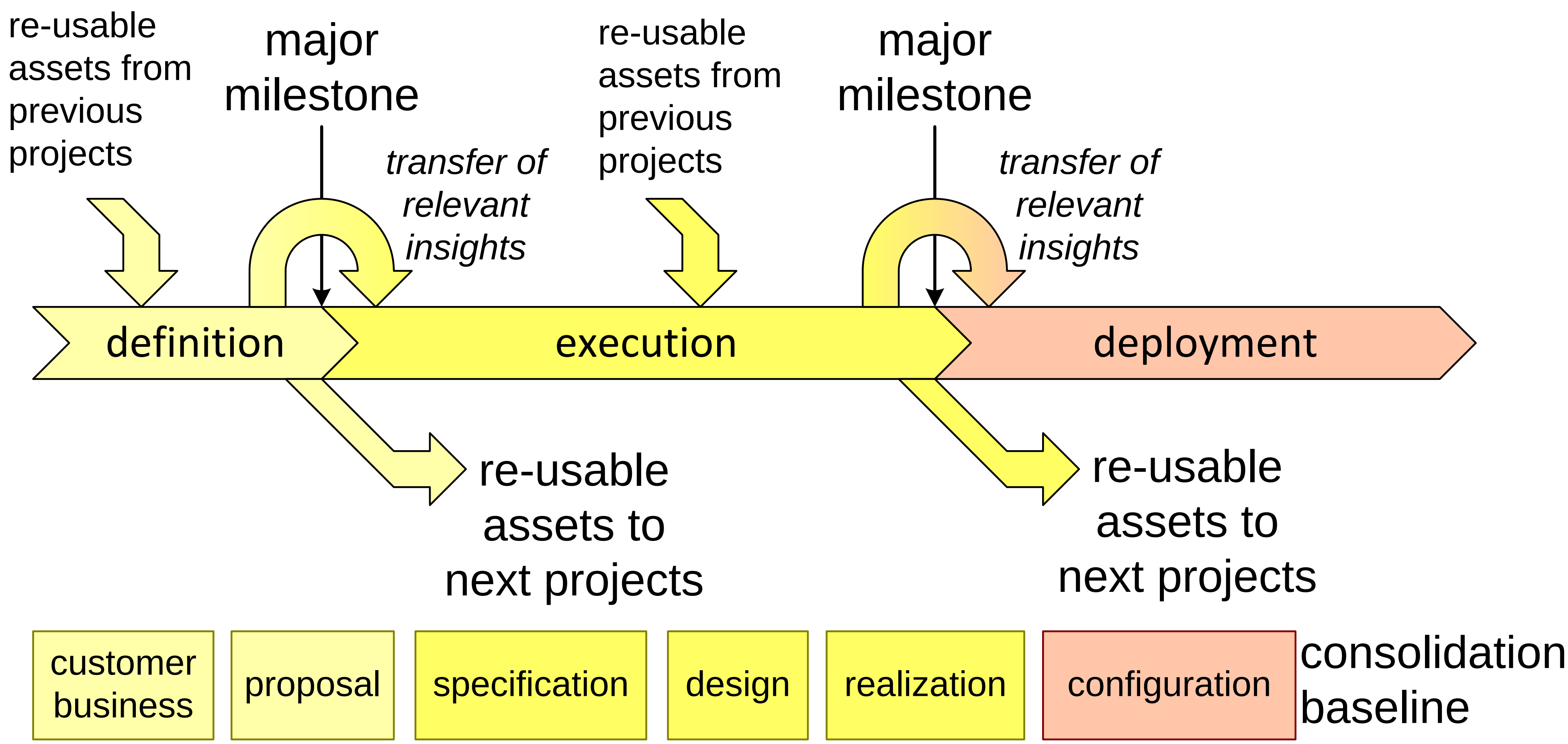
c = in memory cache capacity in # pictures

memory use
- product browsing only
- pictures only
- single server

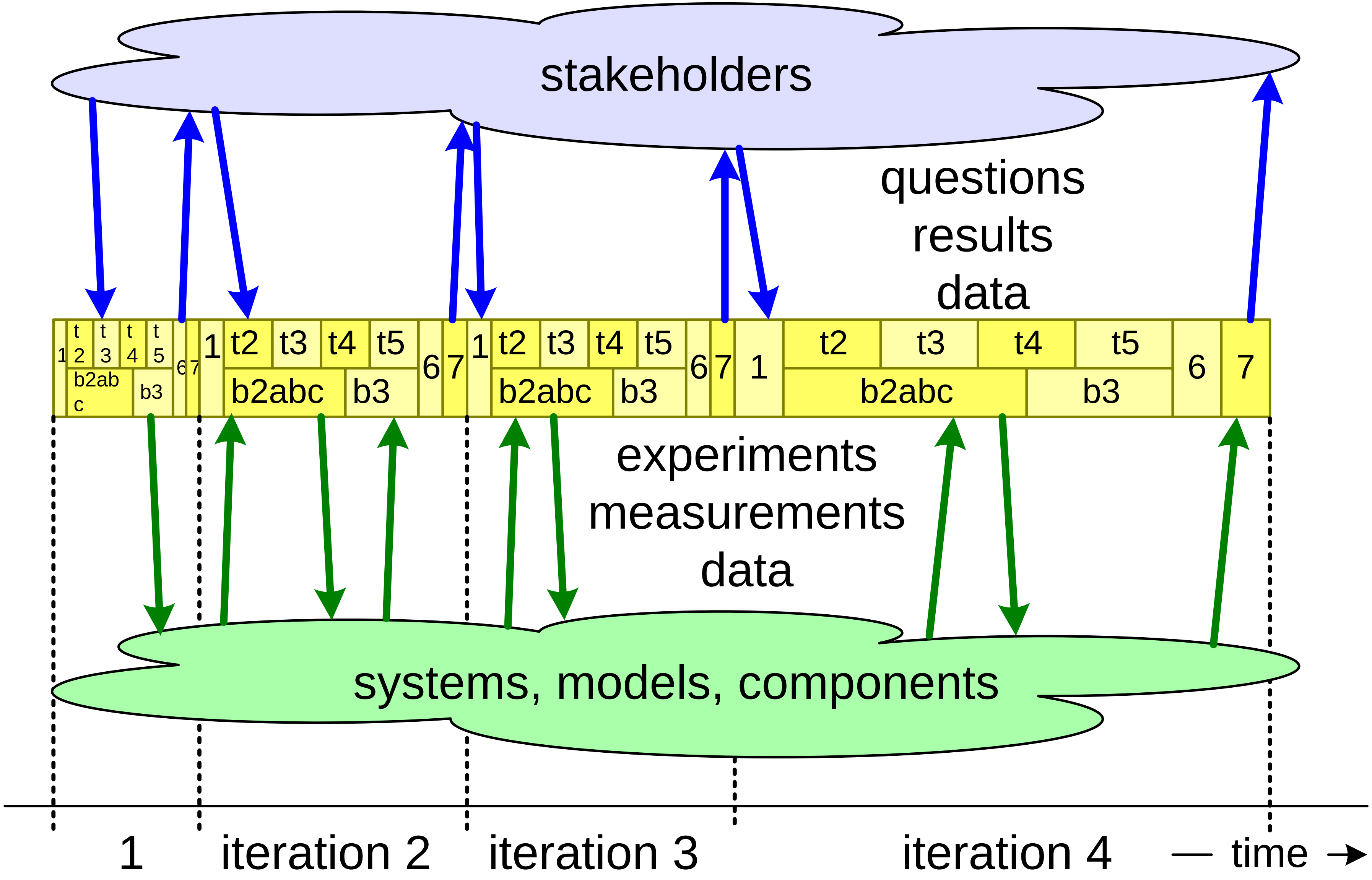


What is the performance impact of memory use on other processing?

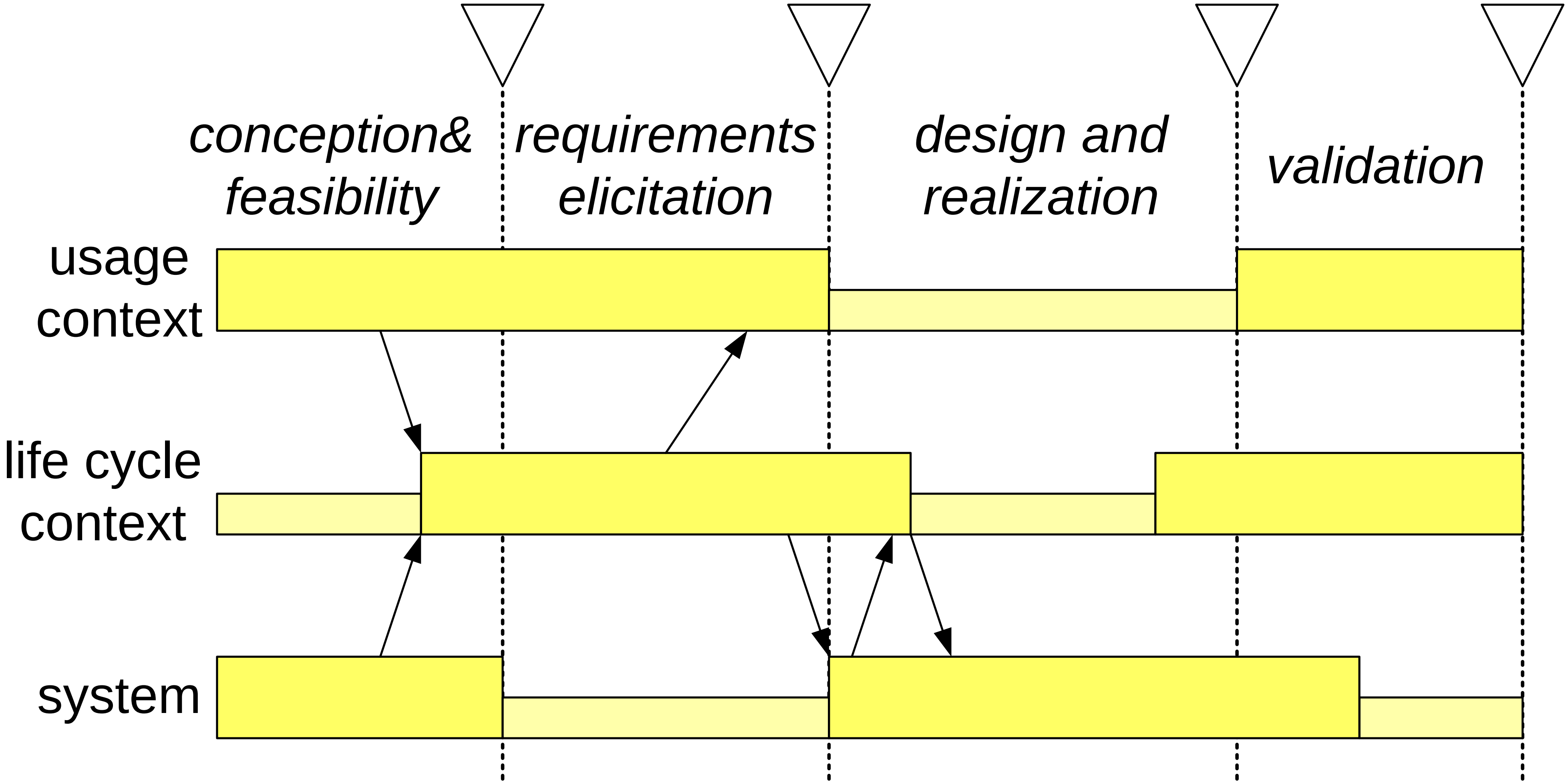
6. Capture overview, results and decisions



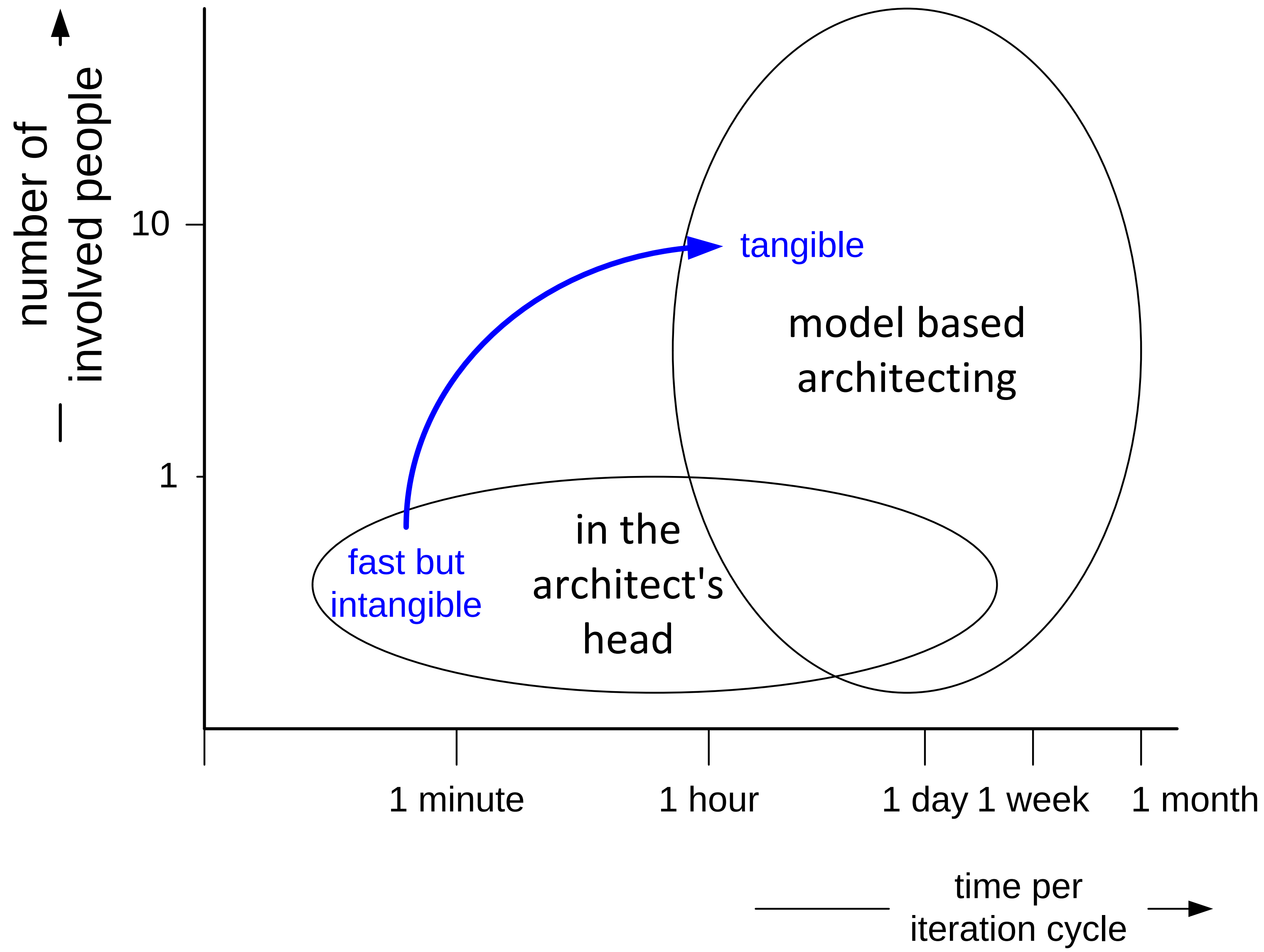
7. Iterate and Validate



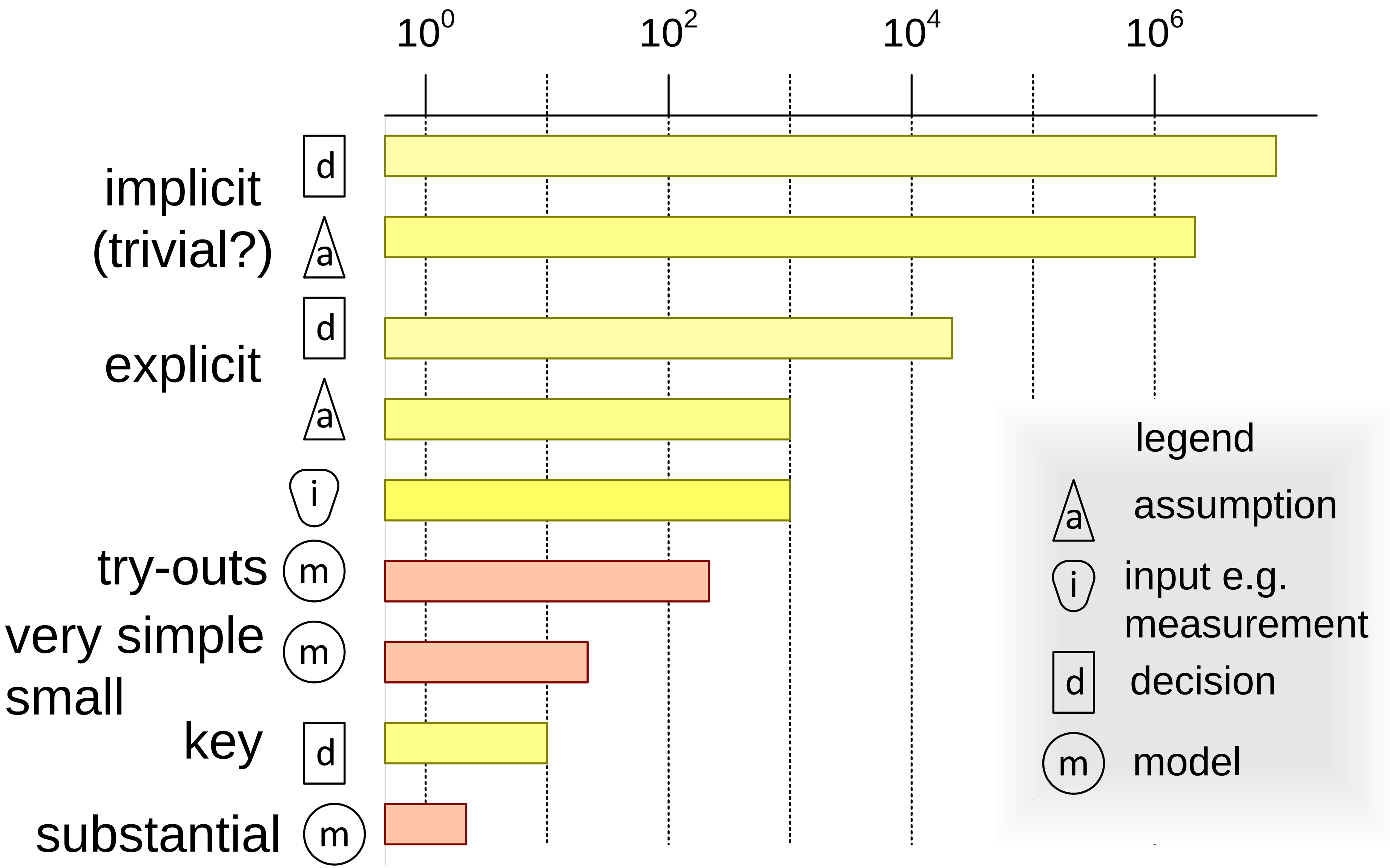
Focus is Shifting during Project



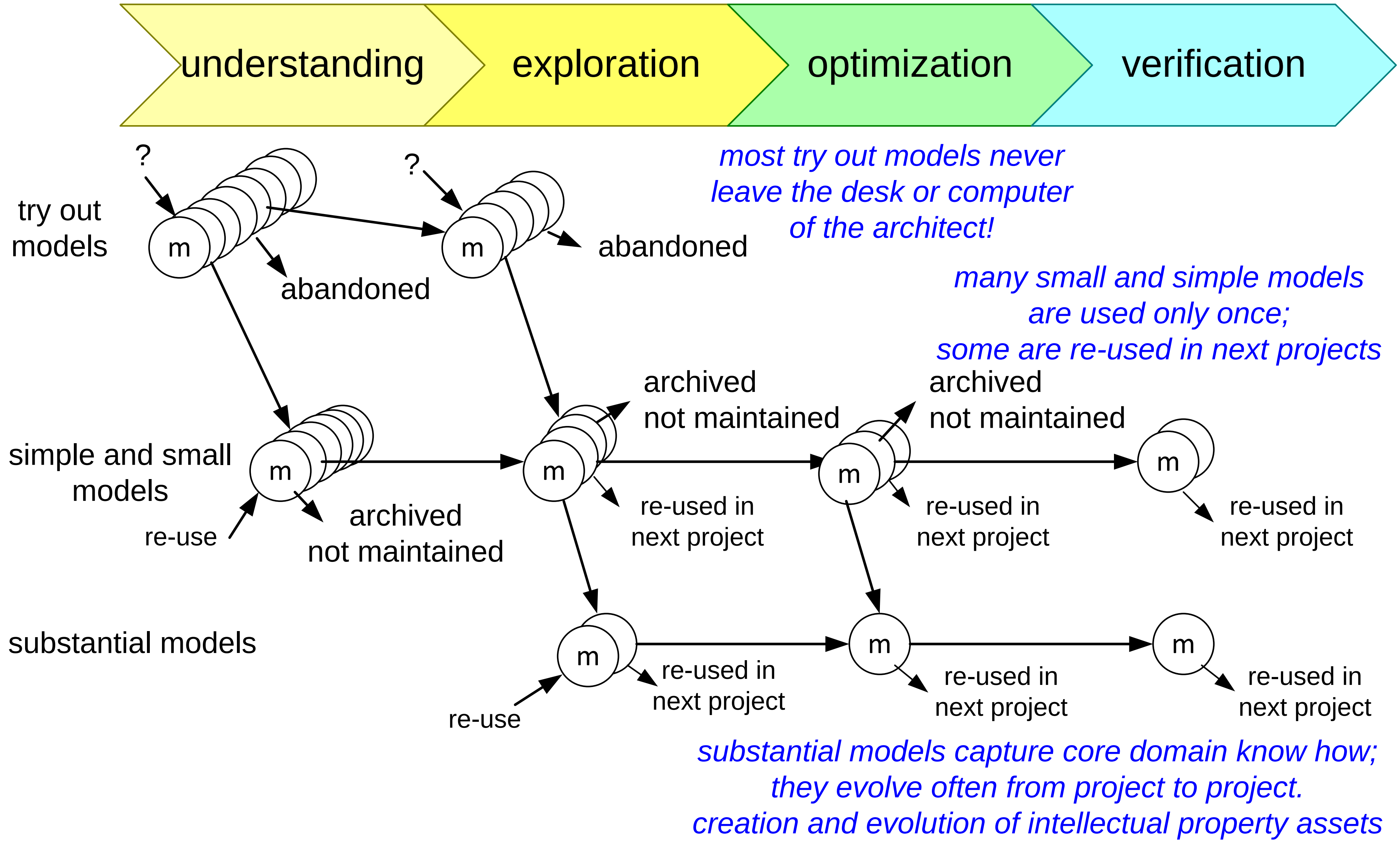
Models Support Communication



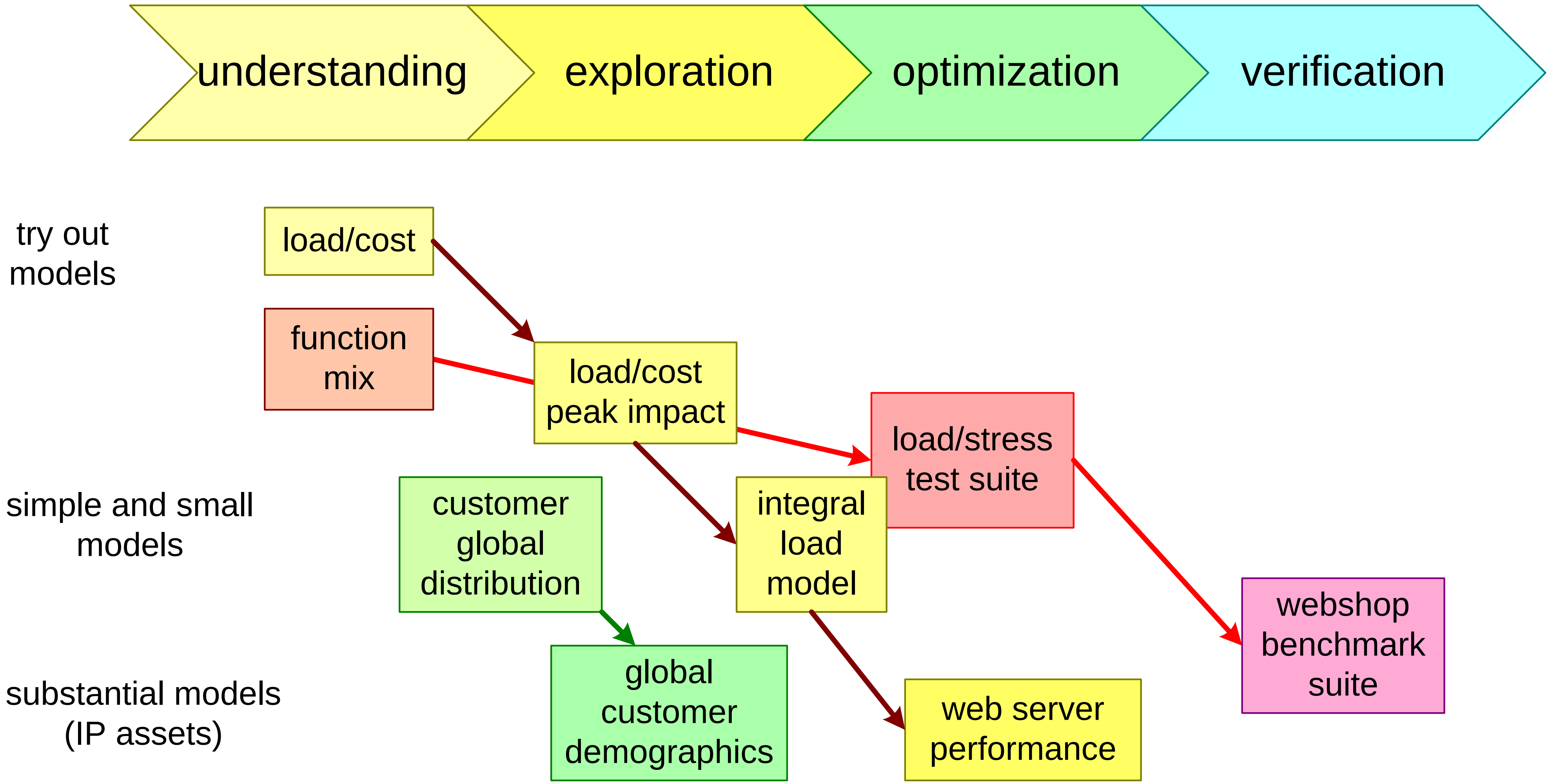
Frequency of Assumptions, Decisions and Modeling



Life Cycle of Models



Examples of Life Cycle of Models



version: 0.6
September 1, 2020
MAREmodelLifeCycleExample

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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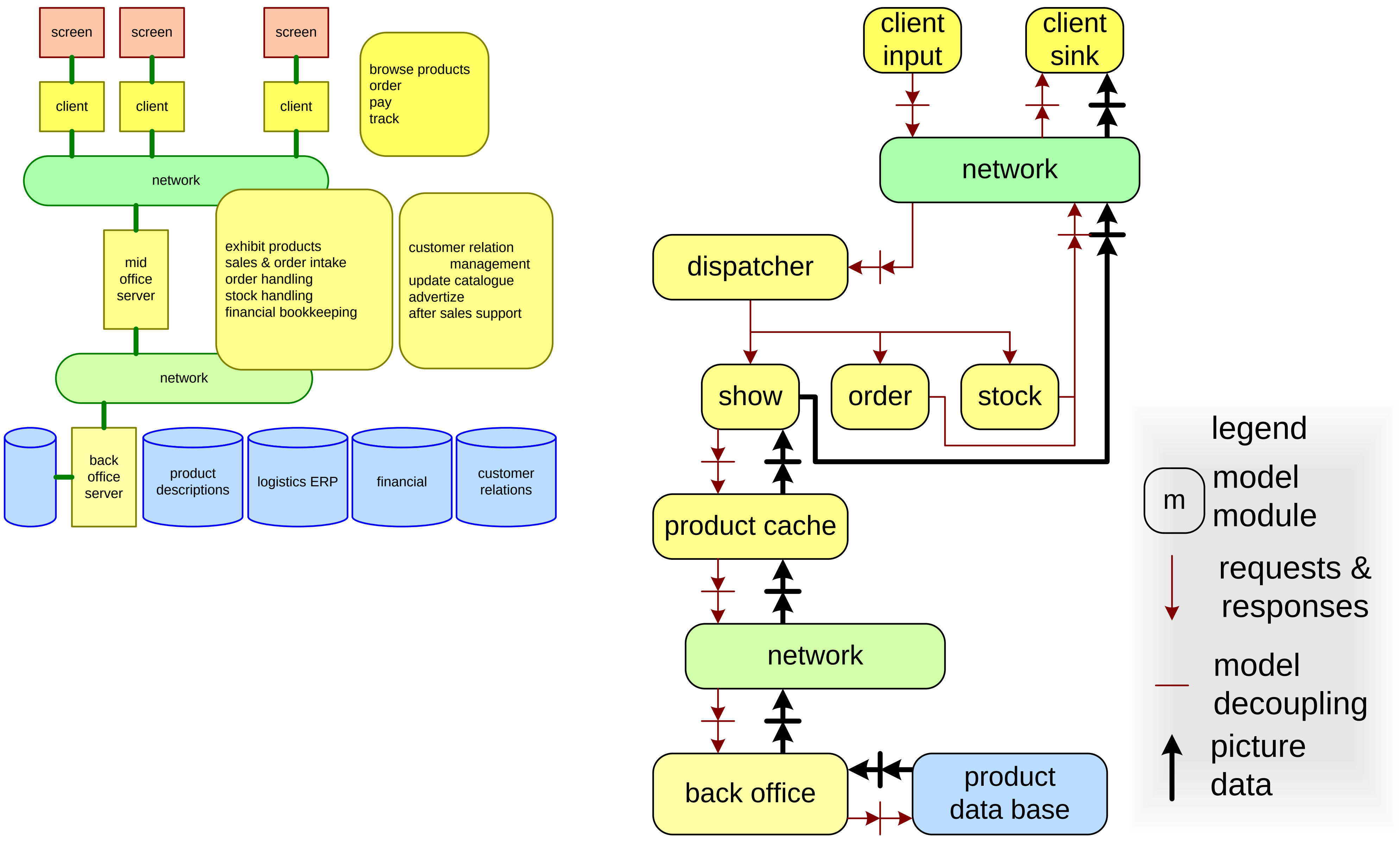
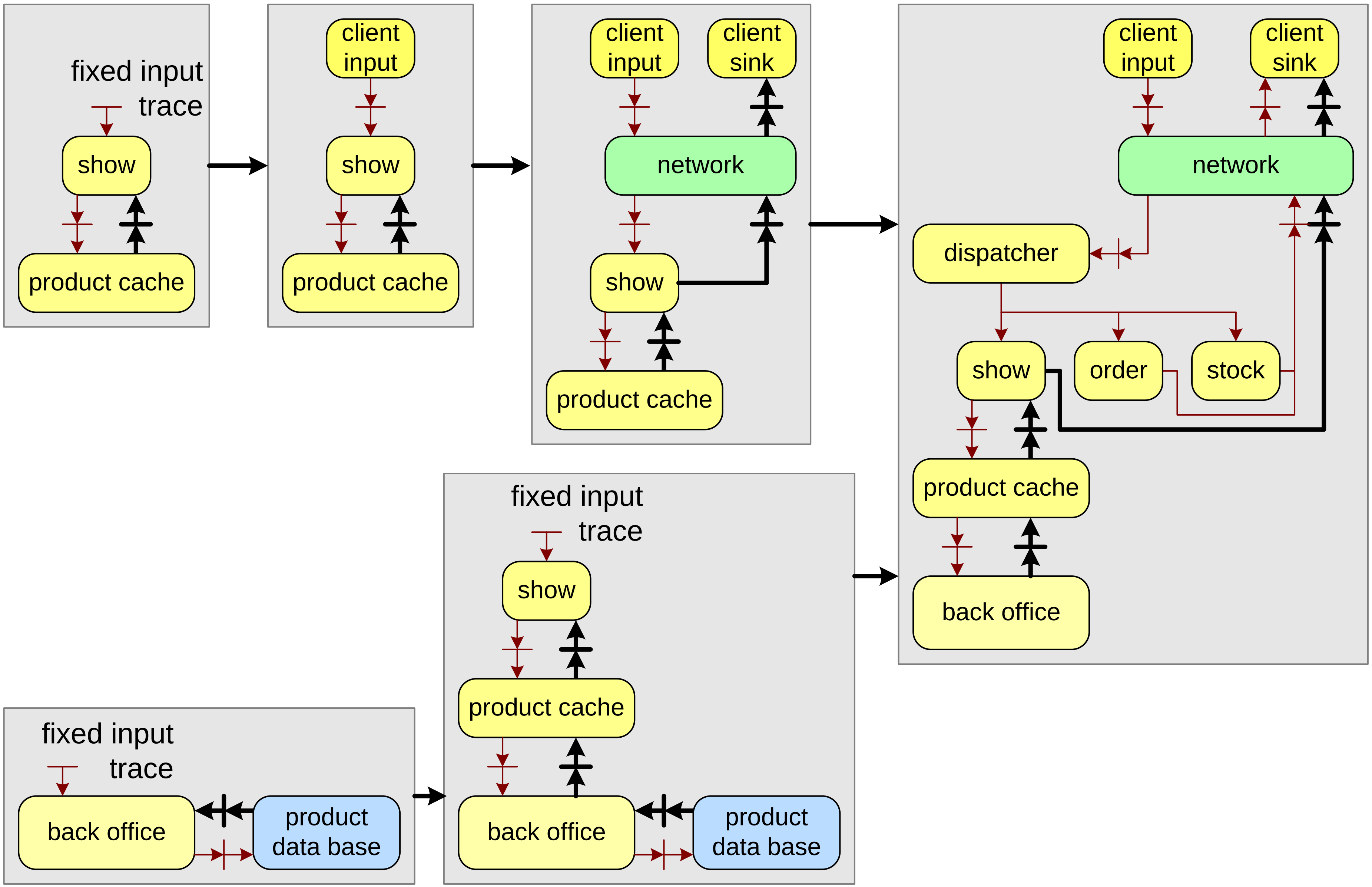
status: planned
version: 0

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?