Design Objectives and Design Understandability

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Abstract

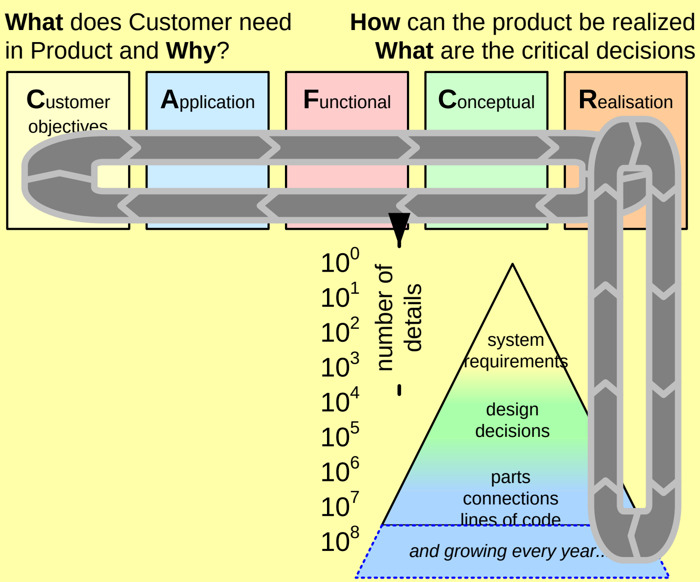
The complexity of systems limits the understanding by the architect of the impact of changes. Many objectives are pursued, from customer needs to implementation lessons learned, while designing a system. From architecting perspective *understandability* of the design is an important issue. Some design choices may create very efficient systems, but might be difficult to grasp. For example simple local autonomy might prove to be efficient and robust, but at the same time other system qualities are emerging and difficult to predict. We discuss the notion of understandability, illustrated by a number of design patterns.

September 6, 2020
status: planned
version: 0

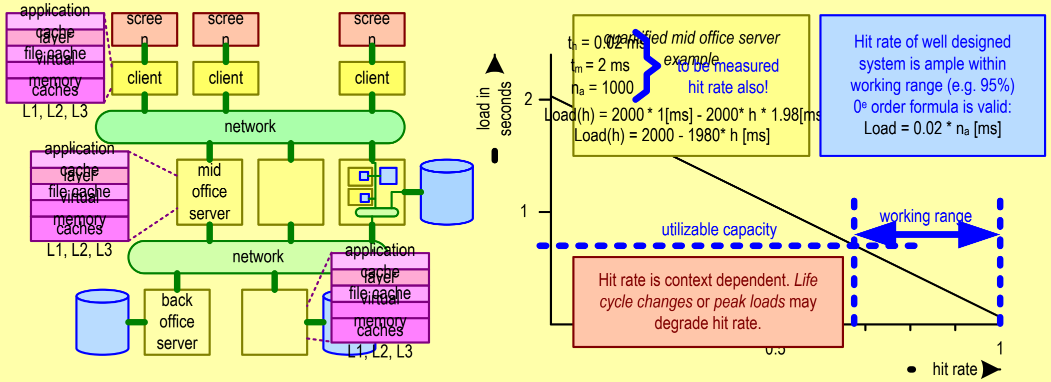
logo
TBD

Figure Of Contents™

1 performance example:
do we understand our design?



2 complexity of context
and system abstraction



3 cache example; impact of autonomous
low-level mechanism on performance

4 discussion and
conclusion

Image Retrieval Performance

application need:

at event 3*3 show 3*3 images instanteneous

design

design

Sample application code:

```
for x = 1 to 3 {
   for y = 1 to 3 {
         retrieve_image(x,y)
   }
}
```

or

alternative application code:

event 3*3 -> show screen 3*3

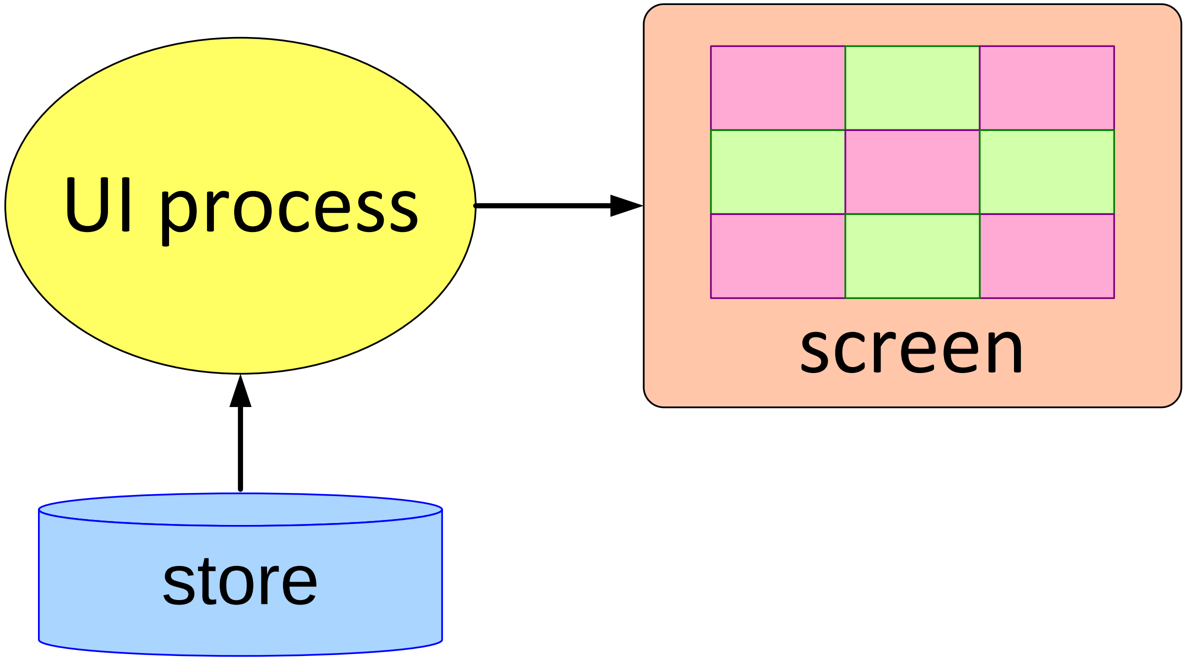
```
<screen 3*3>
    <row 1>
    <col 1><image 1,1></col 1>
    <col 2><image 1,2></col 2>
    <col 3><image 1,3></col 3>
  </row 1>
  <row 2>
    <col 1><image 1,1></col 1>
    <col 2><image 1,2></col 2>
    <col 3><image 1,3></col 3>
  </row 1>
  <row 2>
    <col 1><image 1,1></col 1>
    <col 2><image 1,2></col 2>
    <col 3><image 1,3></col 3>
  </row 3>
</screen 3*3>
```

Straight Forward Read and Display

What If....

Sample application code:

```
for x = 1 to 3 {
  for y = 1 to 3 {
        retrieve_image(x,y)
  }
}
```



What If....

Sample application code:

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for x = 1 to 3 {
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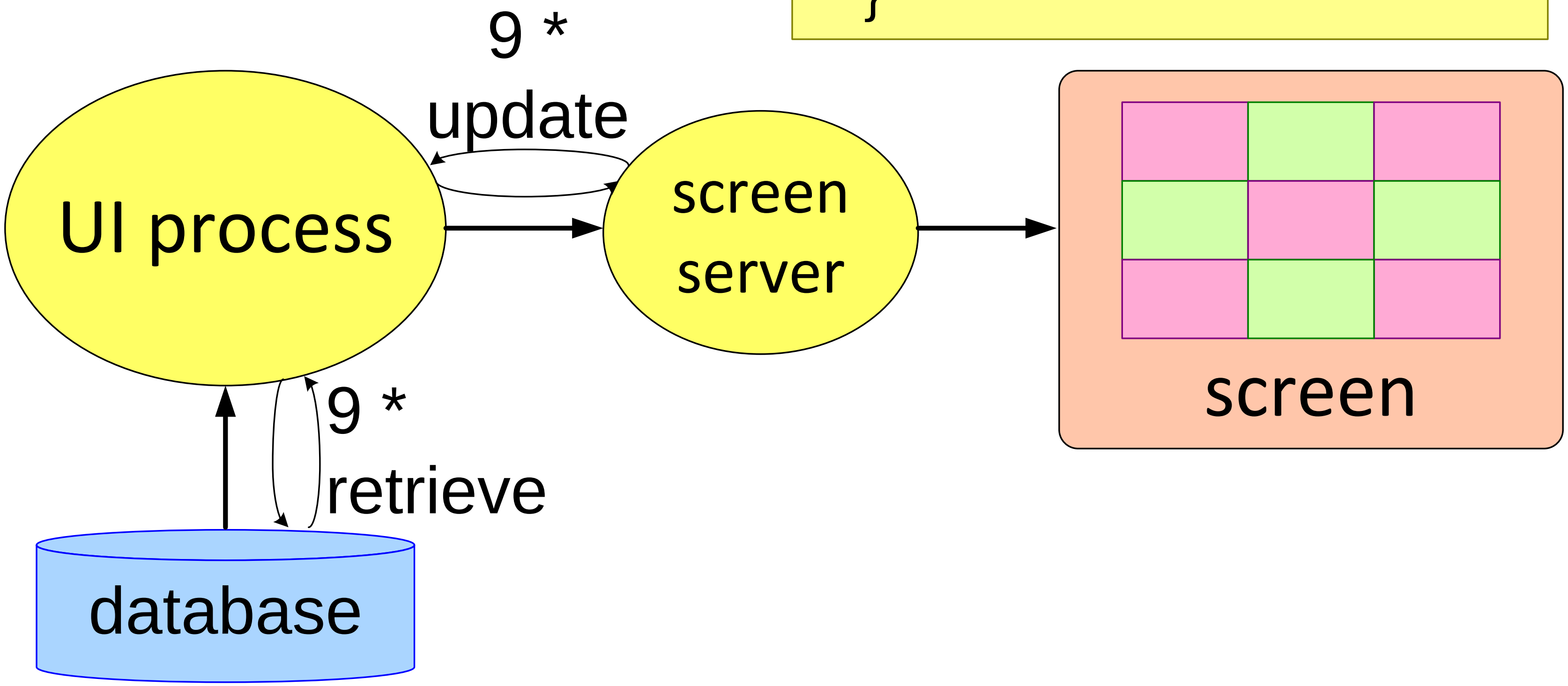
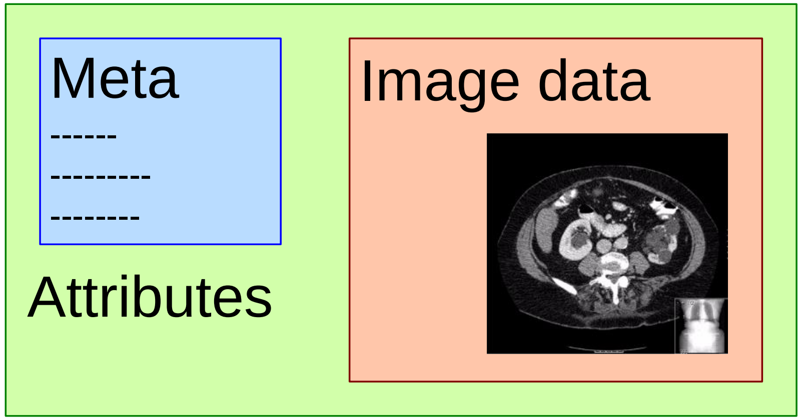


Meta Information Realization Overhead

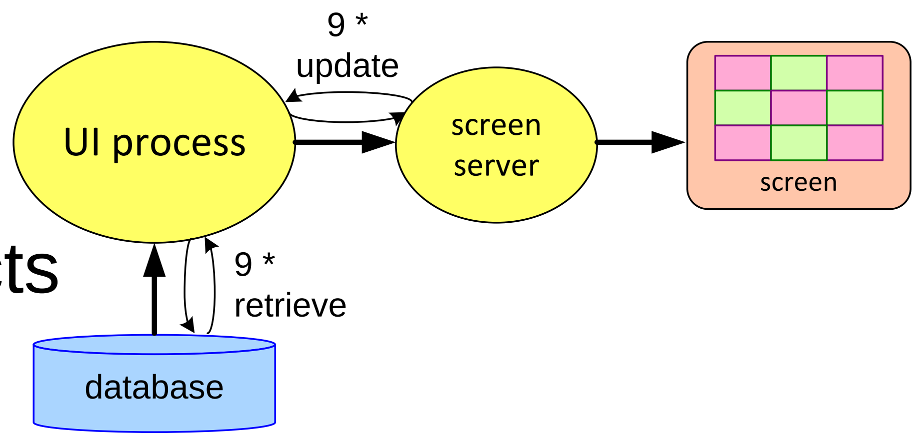
What If....



Sample application code:

```
for x = 1 to 3 {
  for y = 1 to 3 {
        retrieve_image(x,y)
  }
}
```

Attribute = 1 COM object
100 attributes / image
9 images = 900 COM objects
1 COM object = 80µs
9 images = 72 ms



What If....

Sample application code:

```
for x = 1 to 3 {
  for y = 1 to 3 {
        retrieve_image(x,y)
  }
}
```

- I/O on line basis (512^2 image)

$$9 * 512 * t_{I/O}$$

$$t_{I/O} \sim= 1ms$$

- . . .

Non Functional Requirements Require System View

Sample application code:

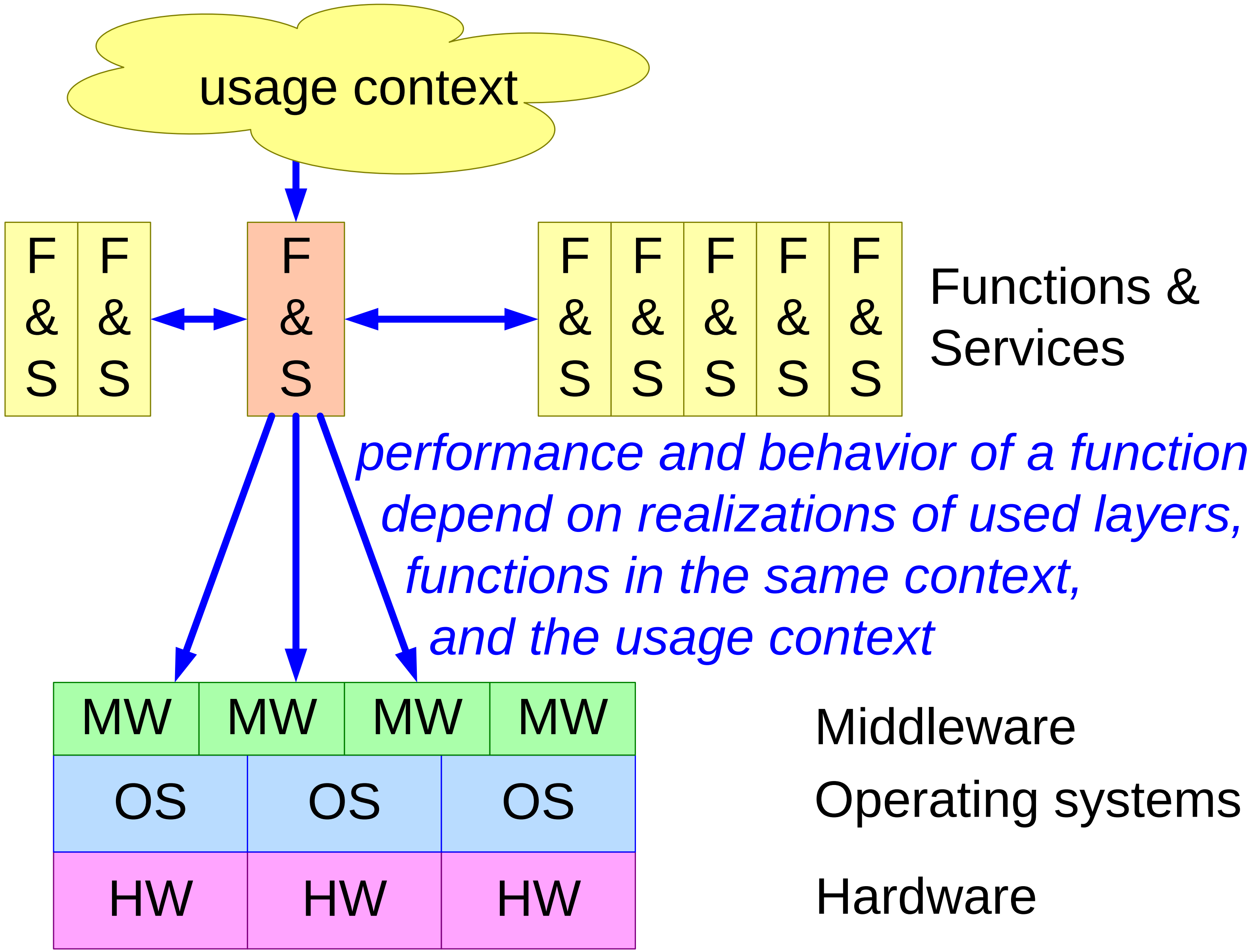
```
for x = 1 to 3 {
  for y = 1 to 3 {
        retrieve_image(x,y)
  }
}
```

can be:
- fast, but very local
- slow, but very generic
- slow, but very robust
- fast and robust
- ...

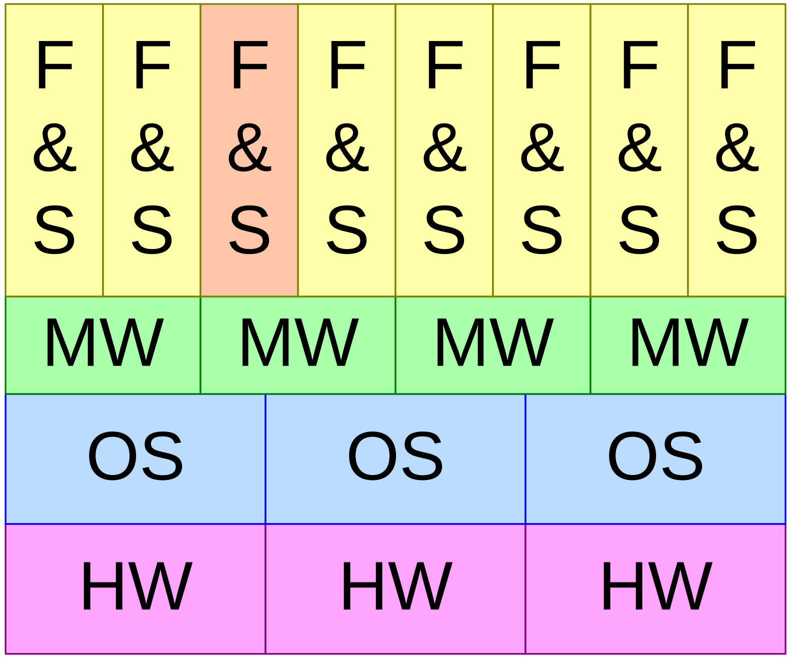
The emerging properties (behavior, performance) cannot be seen from the code itself!

Underlying platform and neighbouring functions determine emerging properties mostly.

Function in System Context



Challenge



Functions & Services

Middleware

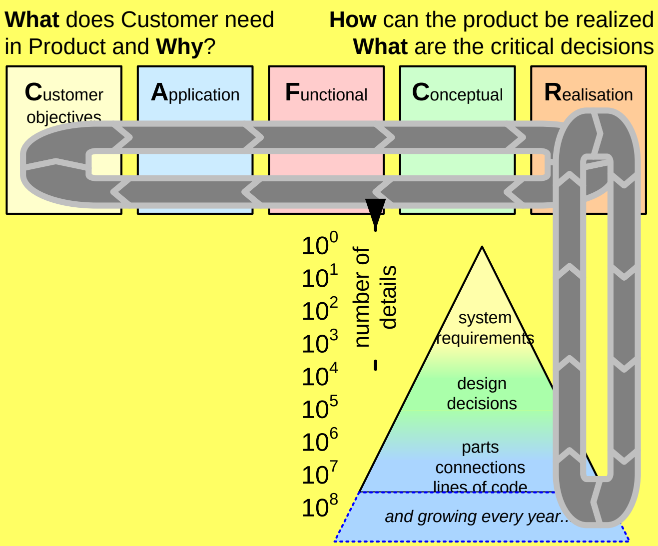
Operating systems

Hardware

Performance = Function (F&S, other F&S, MW, OS, HW)
MW, OS, HW >> 100 Manyear : very complex

Challenge: How to understand MW, OS, HW
with only a few parameters

1 performance example:
do we understand our design?



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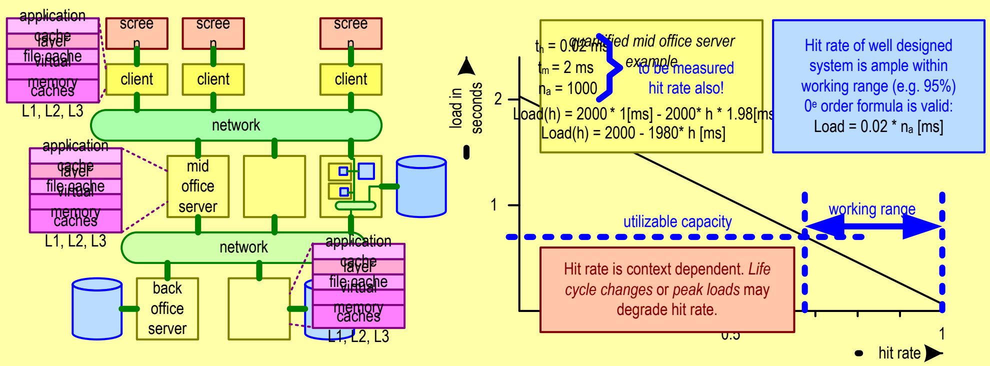

3 cache example; impact of autonomous
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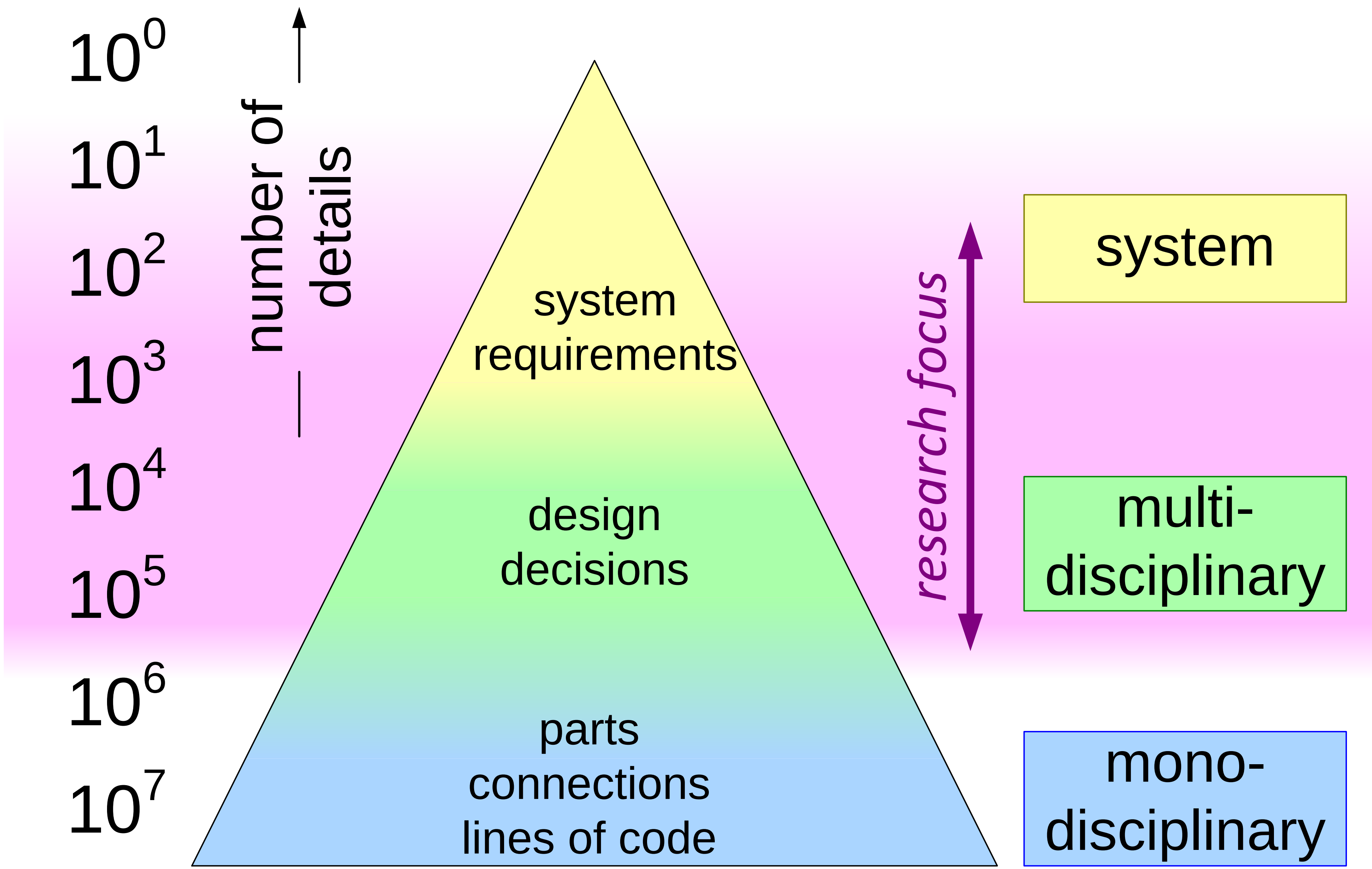
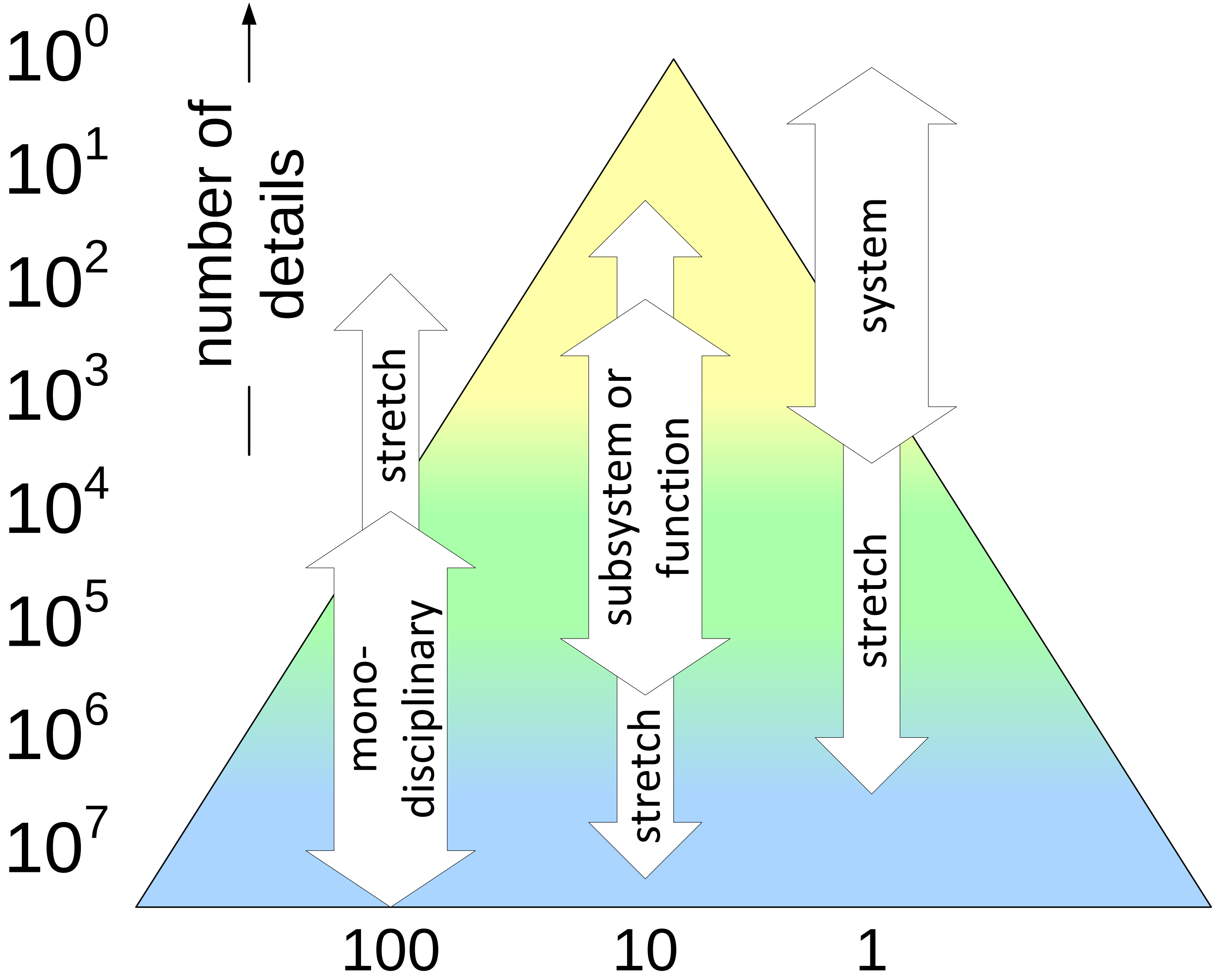
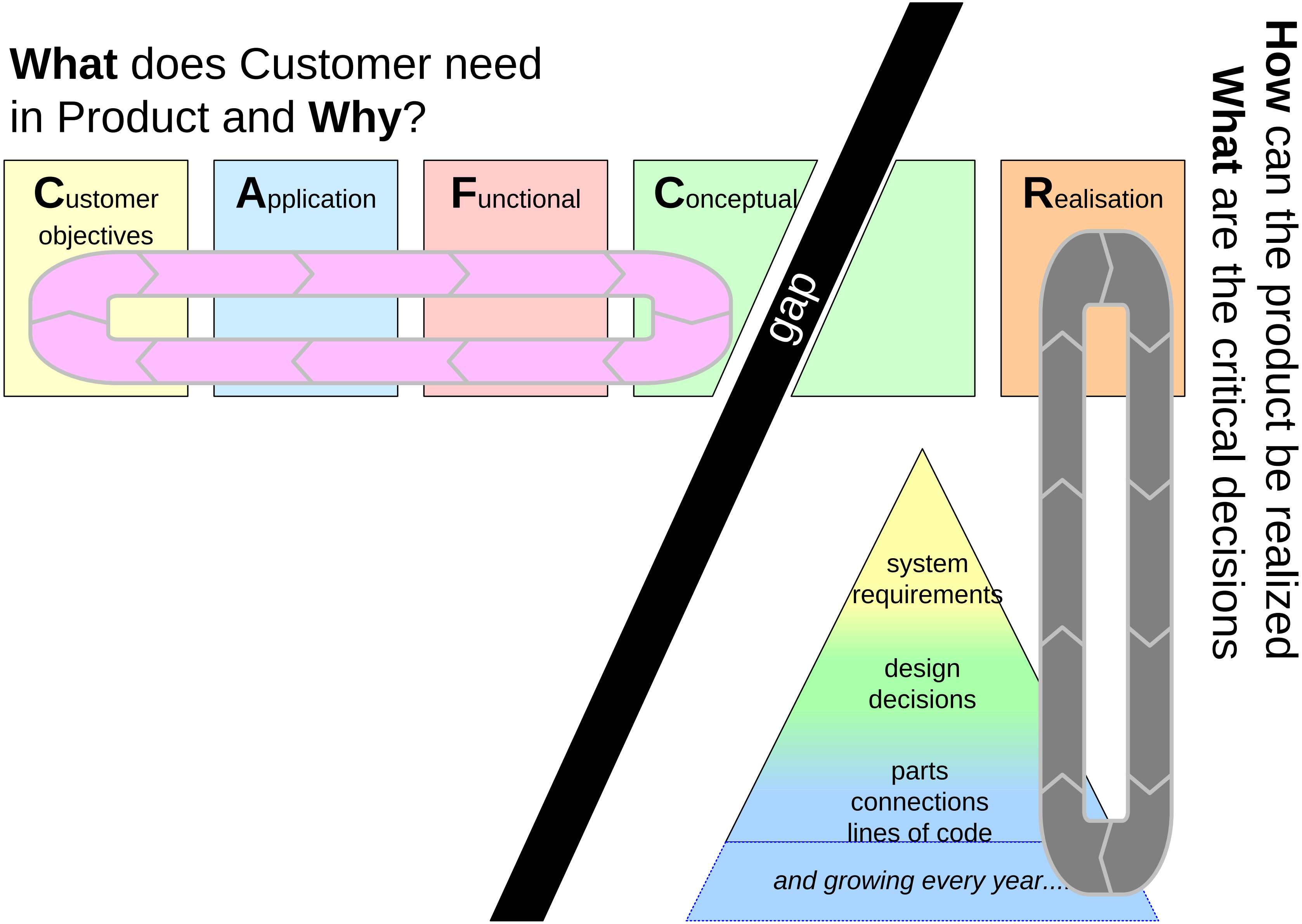
Exponential Pyramid, from requirement to bolts and nuts



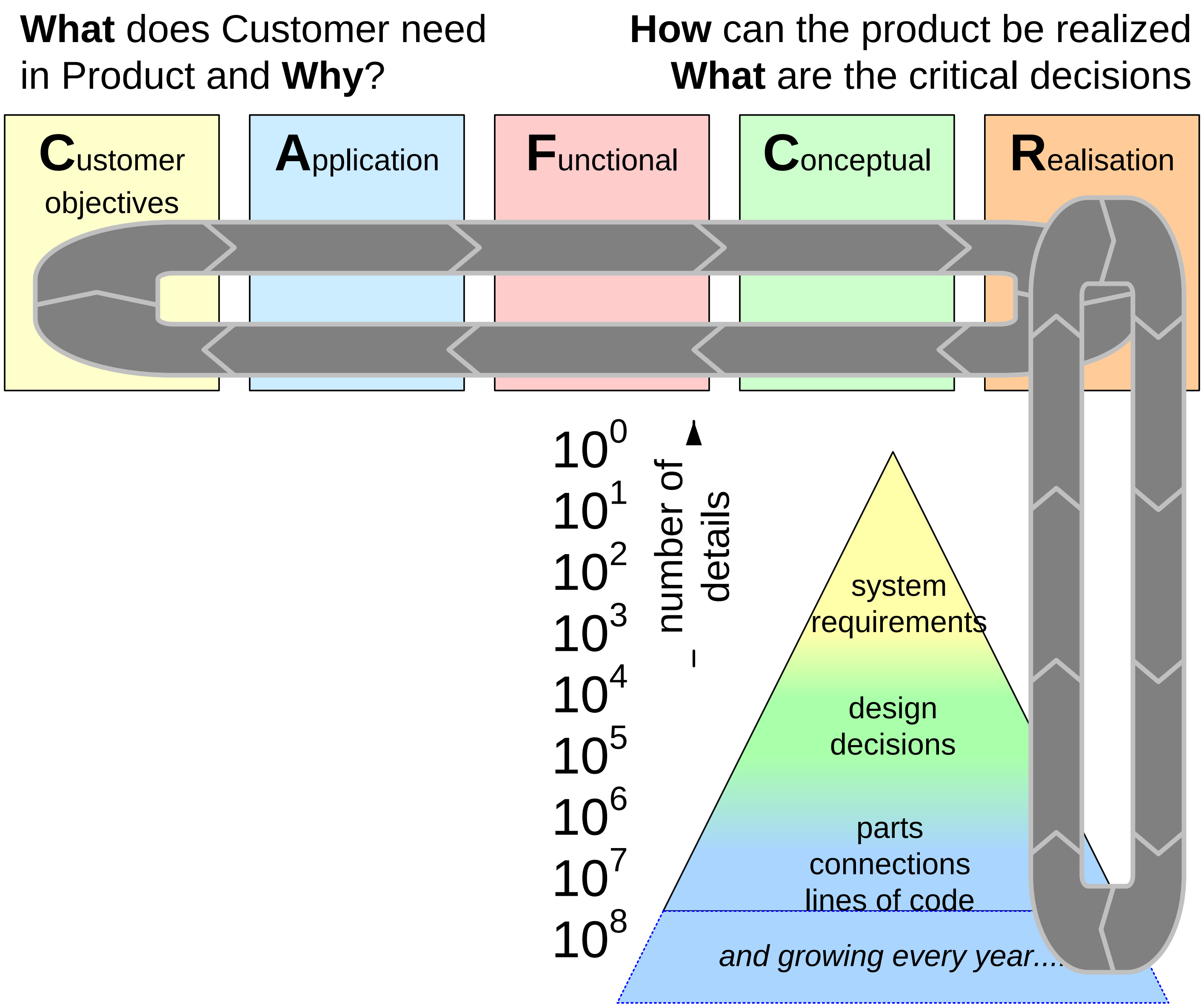
Major Bottleneck: Mental Dynamic Range



Organizational Problem: Disconnect



Architect: Connecting Problem and Technical Solution



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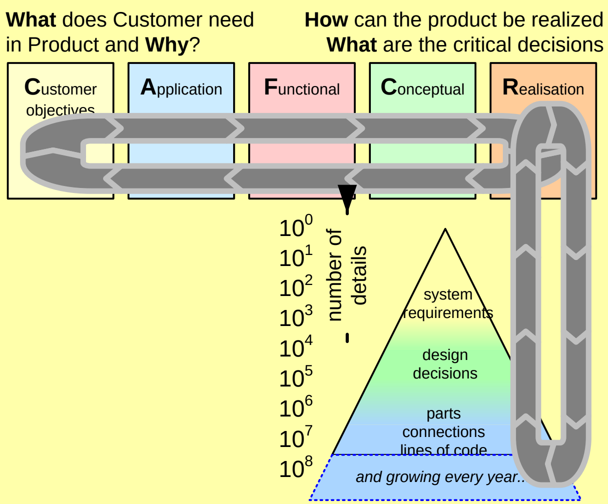

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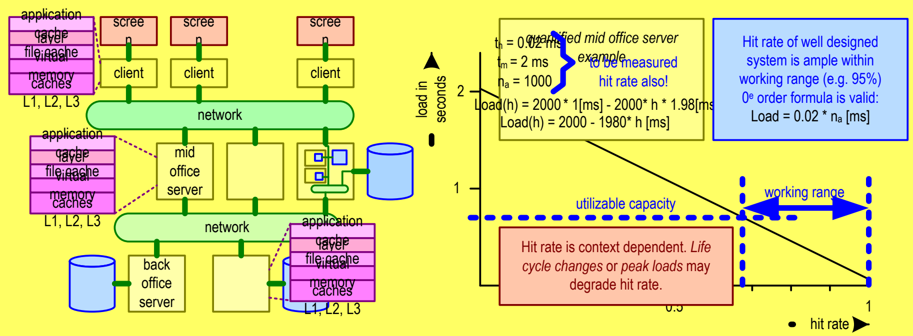

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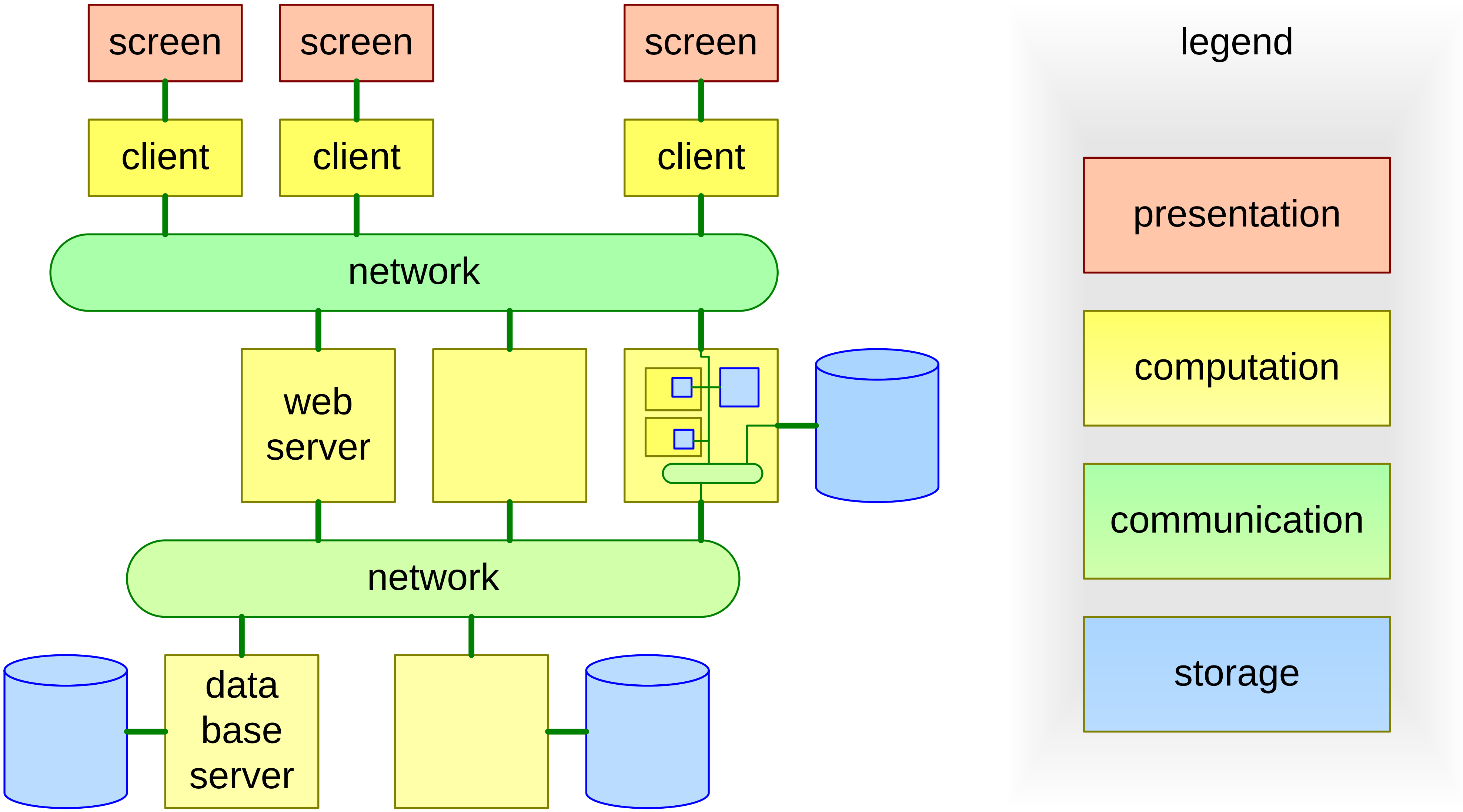
Typical Block Diagram and Typical Resources in IT



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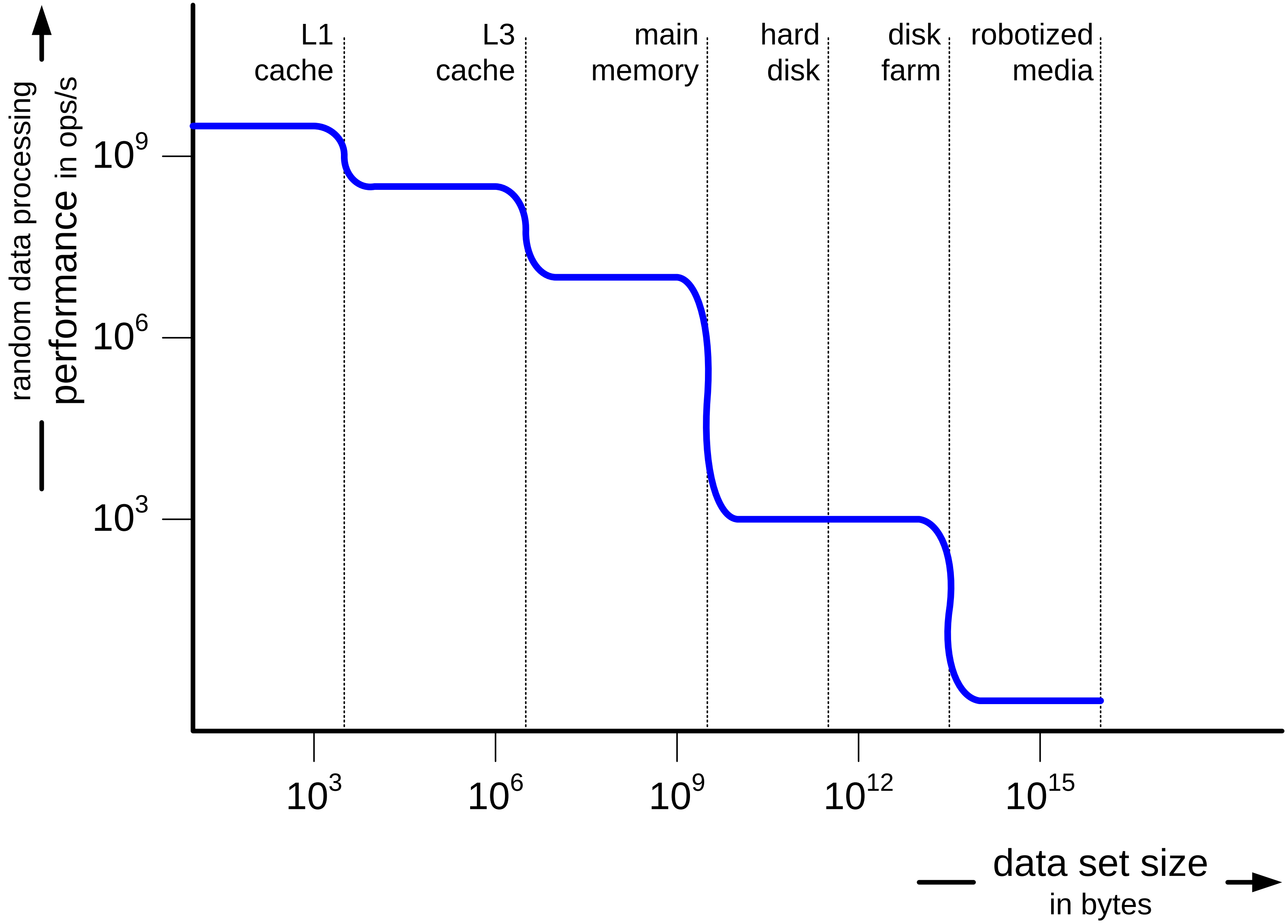
Hierarchy of Storage Technology Figures of Merit

		latency	capacity
processor cache	*L1 cache* *L2 cache* *L3 cache*	sub ns ns	n kB n MB
fast volatile	*main memory*	tens ns	n GB
persistent	*disks* *disk arrays* *disk farms*	ms	n*100 GB n*10 TB
archival	*robotized* *optical media* *tape*	>s	n PB

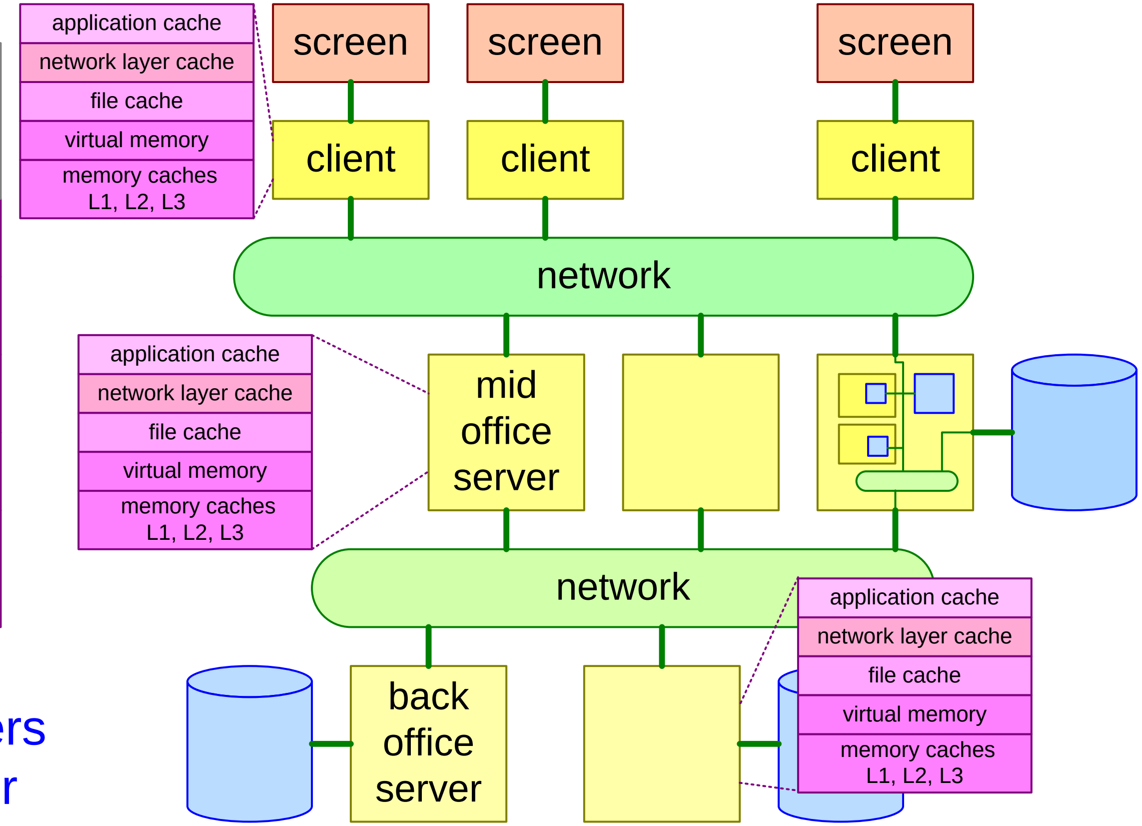
Performance as Function of Data Set Size



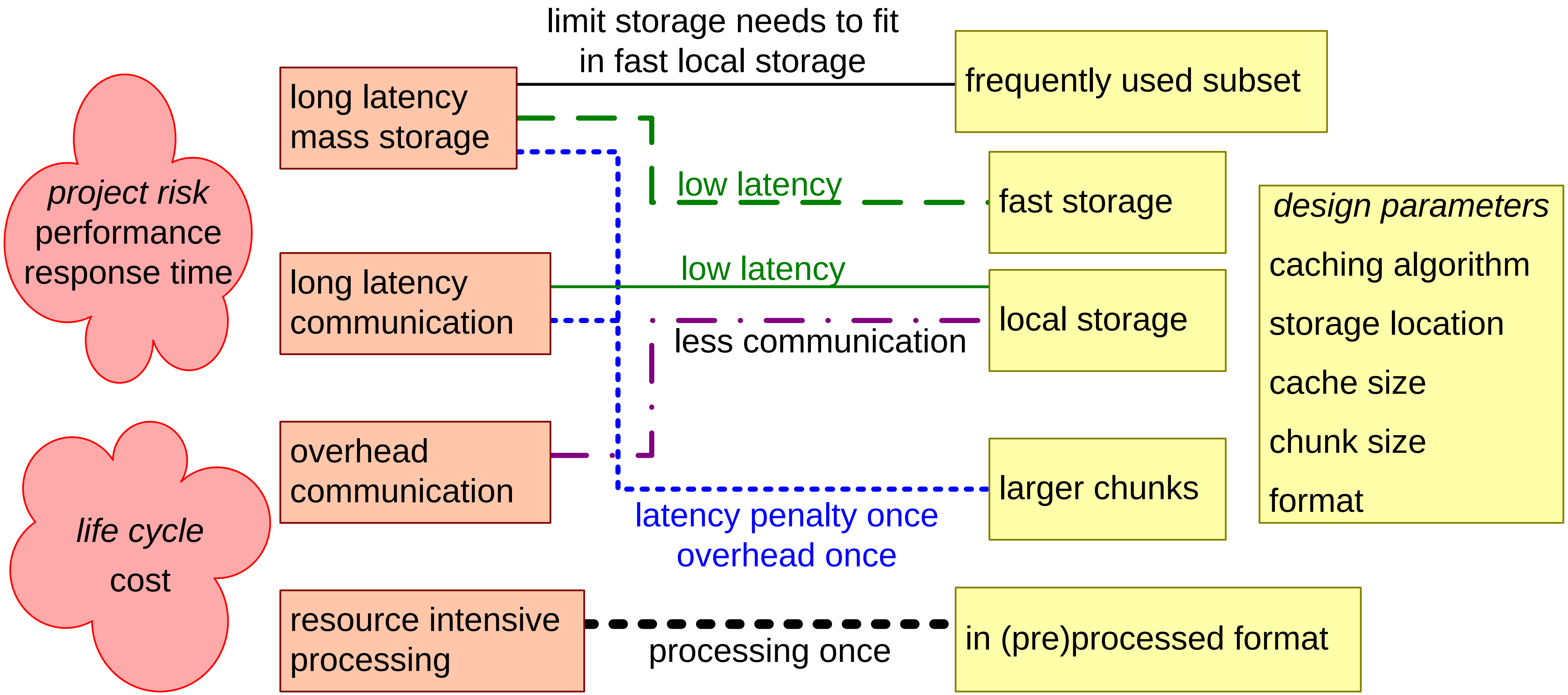
Multiple Layers of Caching

	cache miss penalty	cache hit performance
application cache	1 s	10 ms
network layer cache	100 ms	1 ms
file cache	10 ms	10 µs
virtual memory	1 ms	100 ns
memory caches L1, L2, L3	100 ns	1 ns

typical cache 2 orders of magnitude faster

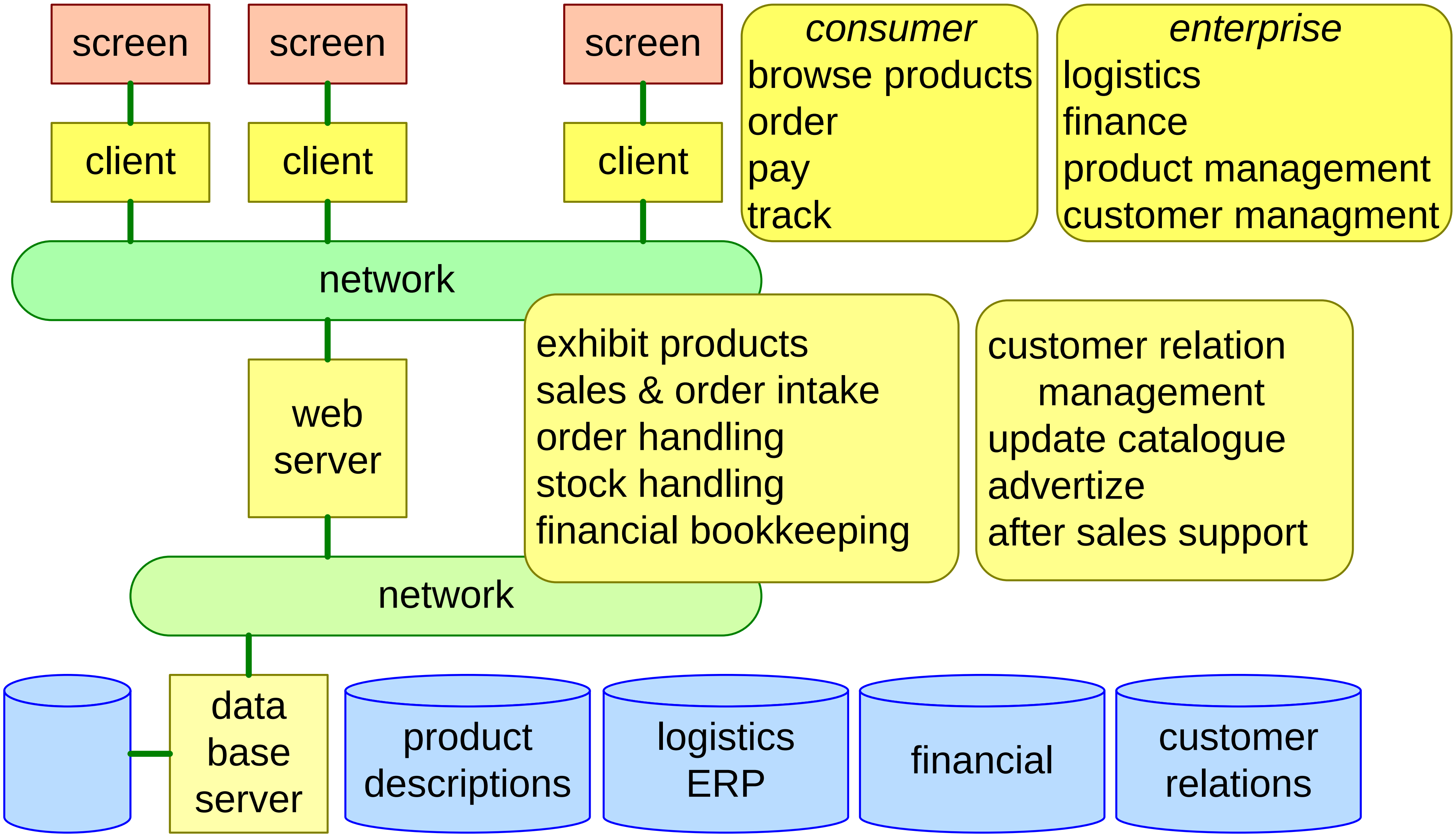


Why Caching?

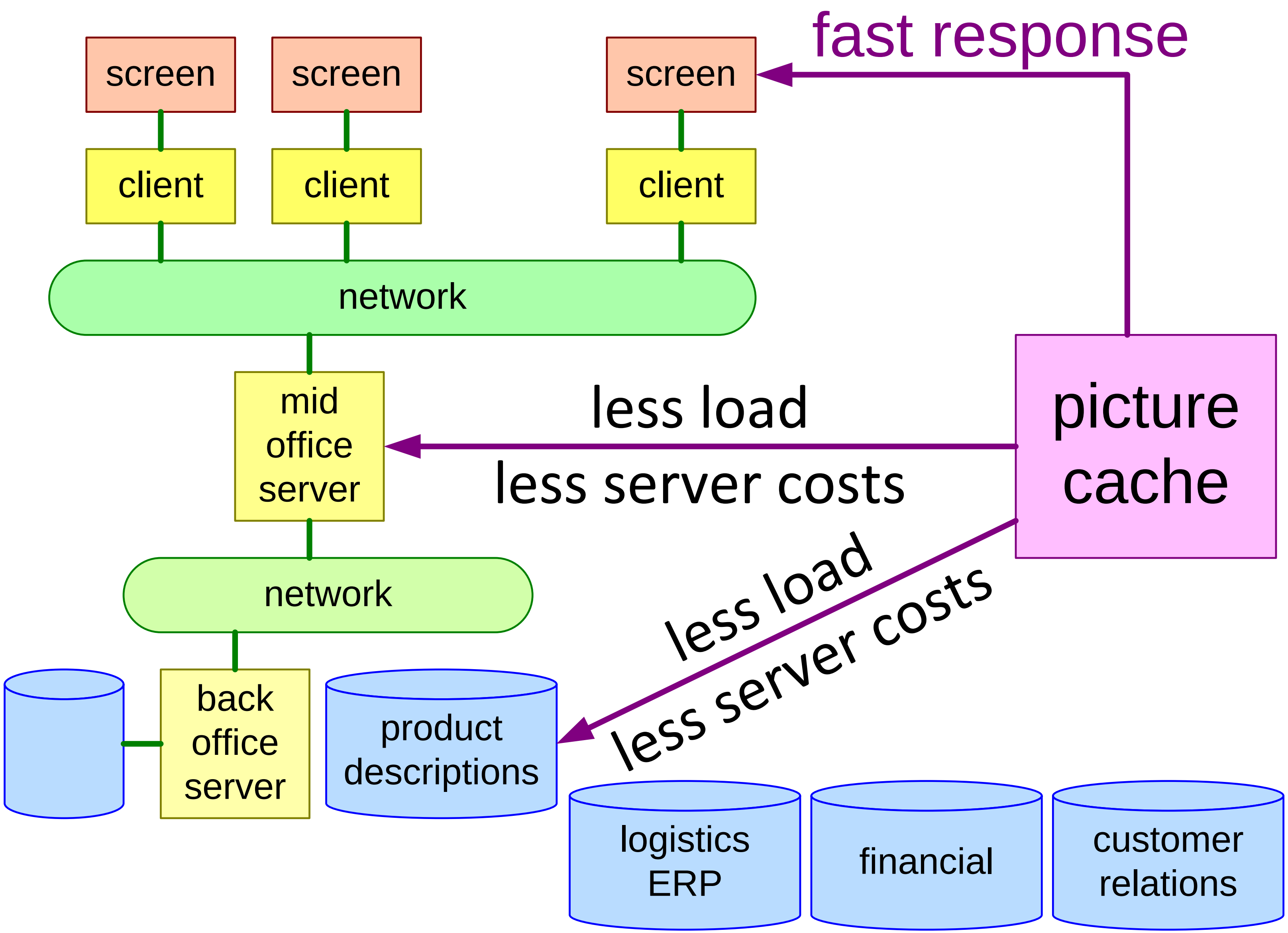


project risk
performance
response time
life cycle
cost
long latency
mass storage
long latency
communication
overhead
communication
resource intensive
processing
limit storage needs to fit
in fast local storage
low latency
low latency
less communication
latency penalty once
overhead once
processing once
frequently used subset
fast storage
local storage
larger chunks
in (pre)processed format
design parameters
caching algorithm
storage location
cache size
chunk size
format

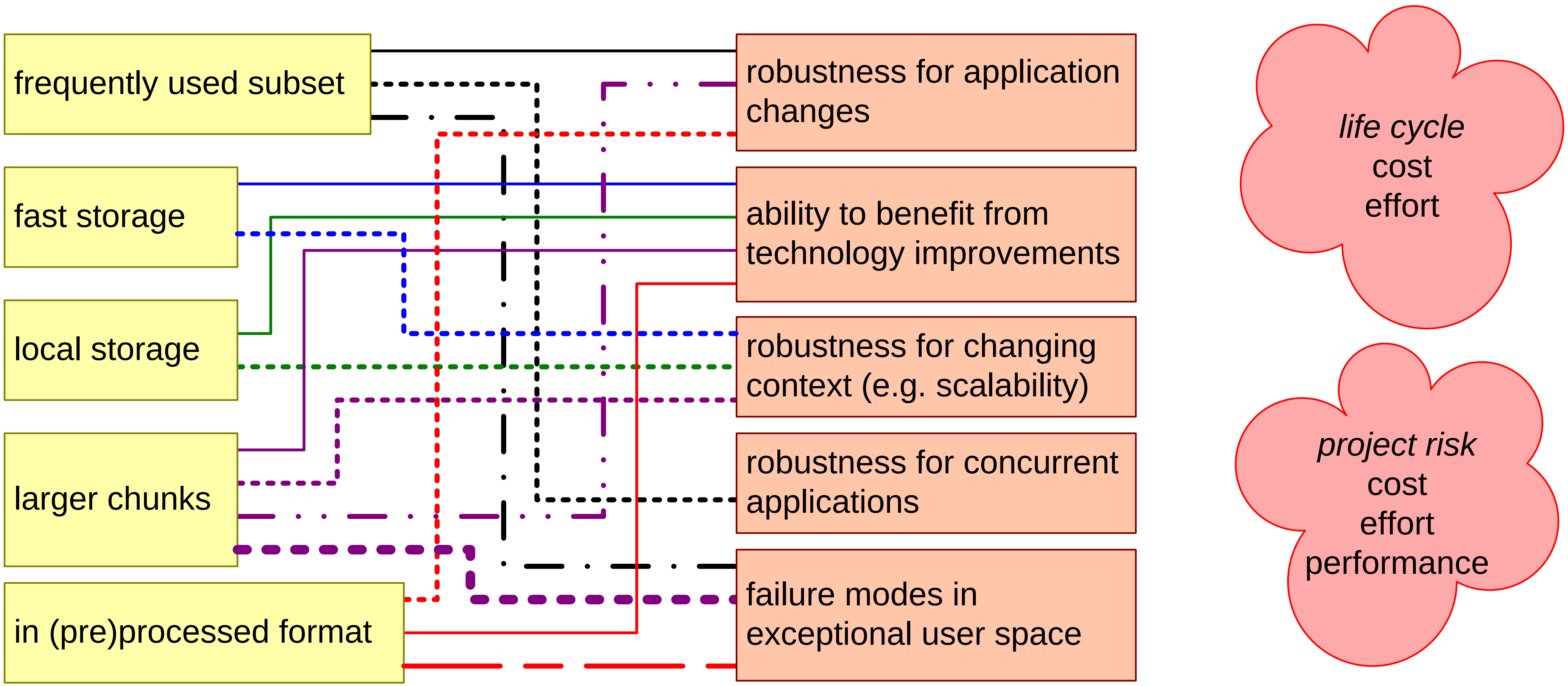
Example Web Shop



Impact of Picture Cache



Risks of Caching



Zero Order Load Model

zero order web server load model

$$Load = n_a * t_a$$

n_a = total requests

t_a = cost per request

First Order Load Model

first order web server load model

$$Load = n_{a,h} * t_h + n_{a,m} * t_m$$

$n_{a,h}$ = accesses with cache hit

$n_{a,m}$ = accesses with cache miss

t_h = cost of cache hit

t_m = cost of cache miss

$$n_{a,h} = n_a * h$$

$$n_{a,m} = n_a * (1-h)$$

n_a = total accesses

h = hit rate

$$Load(h) = n_a * h * t_h + n_a * (1-h) * t_m \quad = n_a * t_m - n_a * h * (t_m - t_h)$$

Quantification: From Formulas to Insight

quantified mid office server example

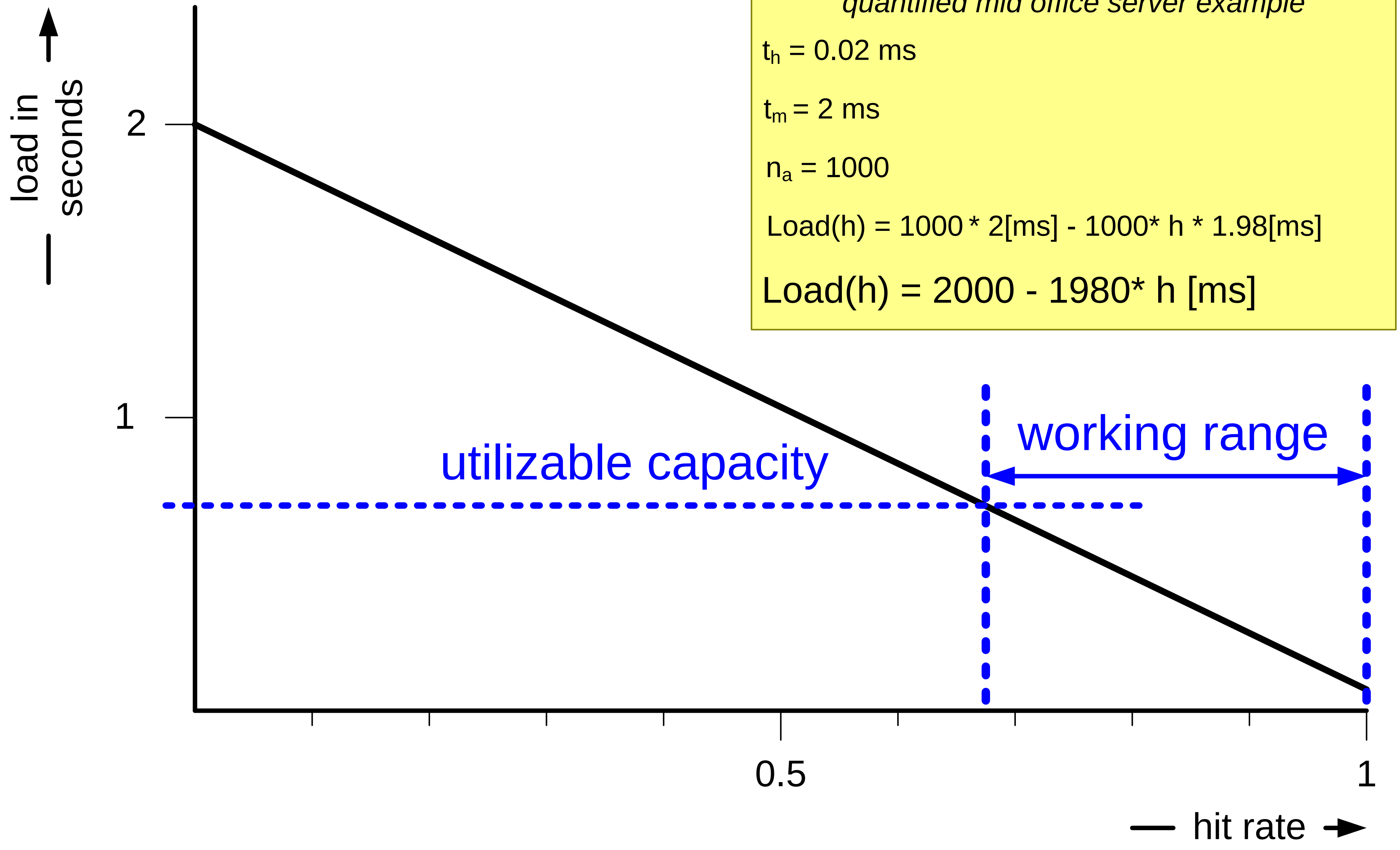
t_h = 0.02 ms

t_m = 2 ms

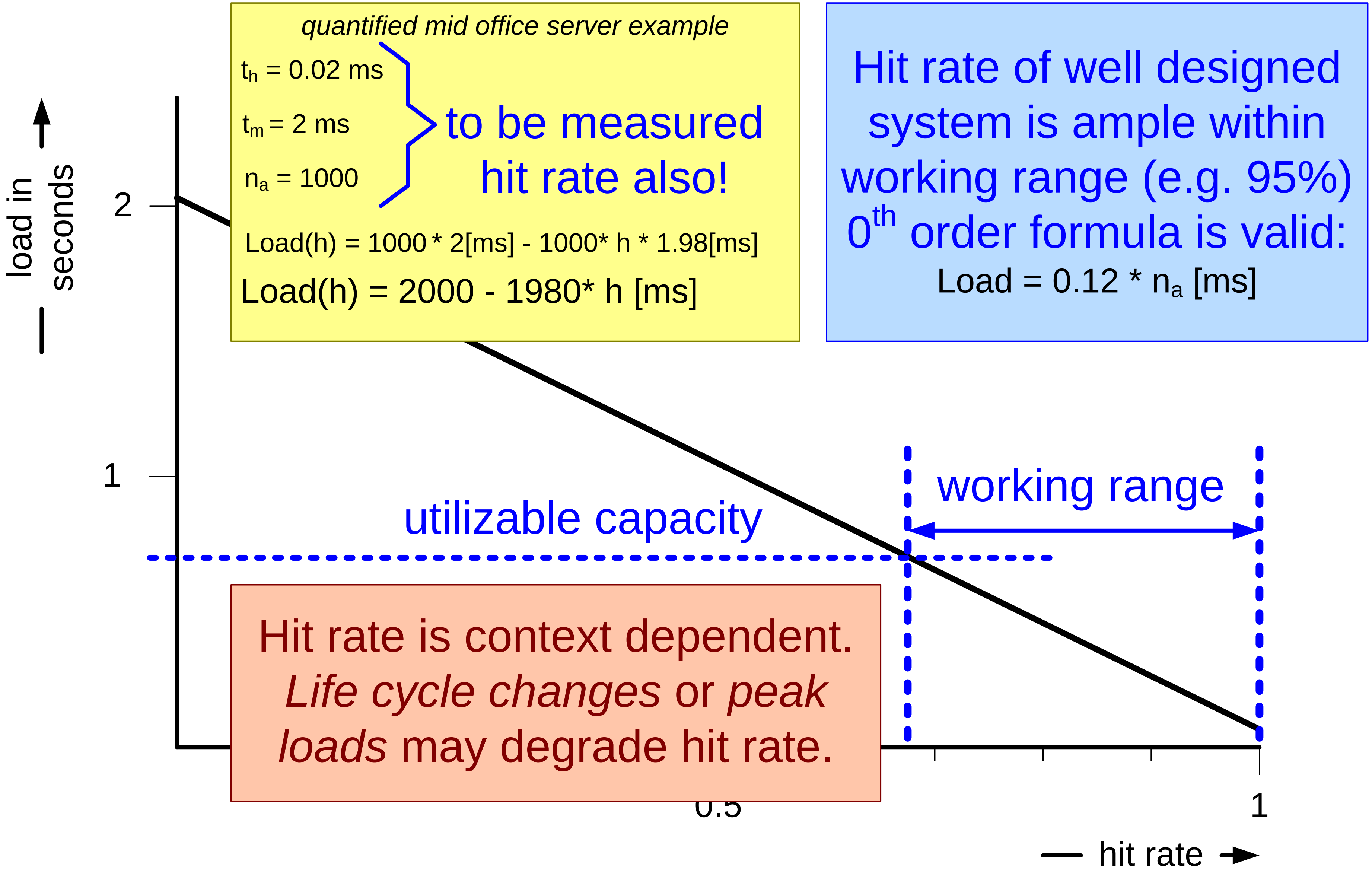
n_a = 1000

Load(h) = 1000 * 2[ms] - 1000* h * 1.98[ms]

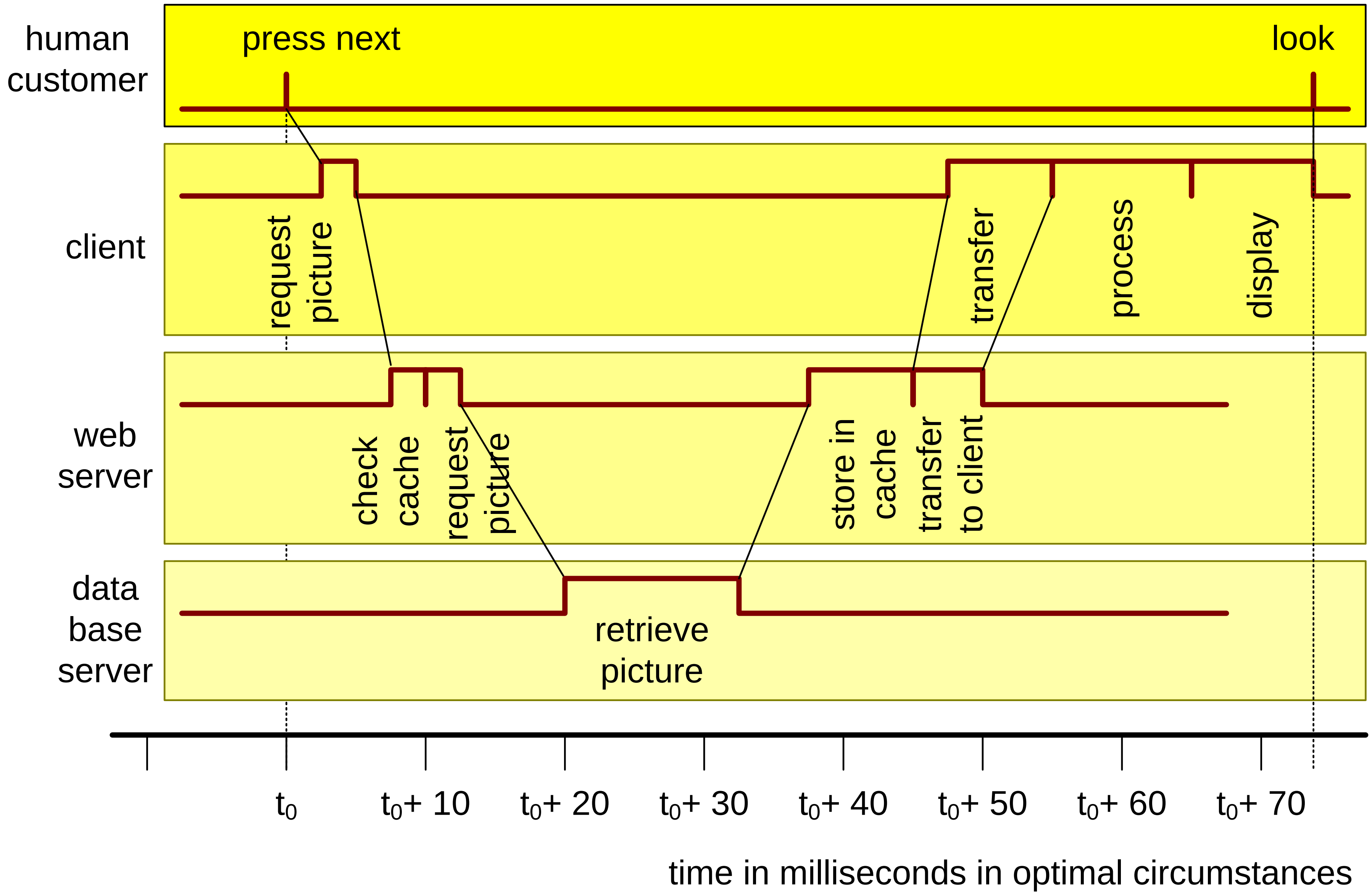
Load(h) = 2000 - 1980* h [ms]



Hit Rate Considerations



Response Time



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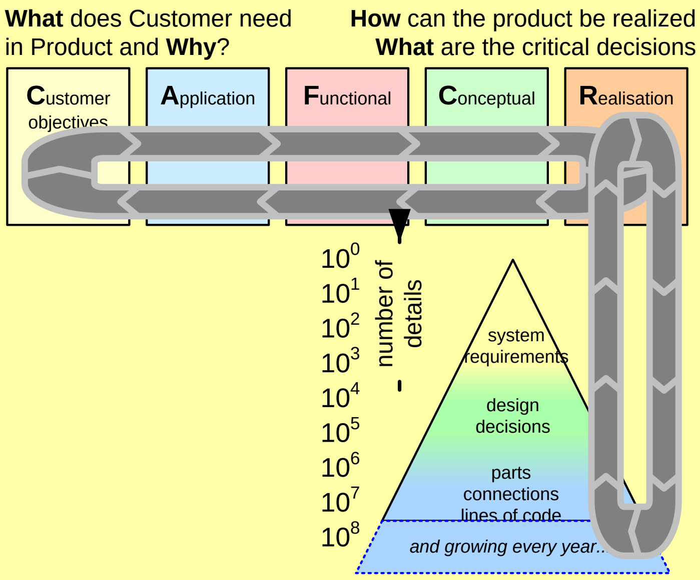

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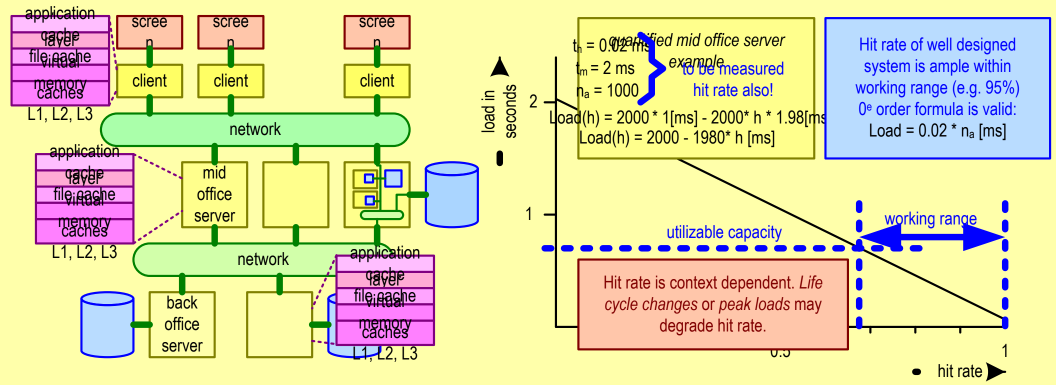

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Some *Understandability* Propositions

central full control does not imply understandability

delegated autonomous behavior does not imply understandability

a few simple rules can create very complex behavior

understanding does not imply determinism or predictability

valid abstractions facilitate understanding

simulations provide numbers, not understanding

only humans understand!

Conclusions

control, *predictability*, and *determinism* are illusions

simple rules can create *complex* non-understandable systems

challenge: to *model* systems at "right" *abstraction* level