Modeling and Analysis Fundamentals of Technology

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Abstract

This presentation shows fundamental elements for models that are ICT-technology related. Basic hardware functions are discussed: storage, communication and computing with fundamental characteristics, such as throughput, latency, and capacity. A system is build by layers of software on top of hardware. The problem statement is how to reason about system properties, when the system consists of many layers of hardware and software.

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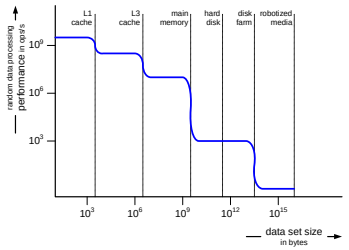


content of this presentation

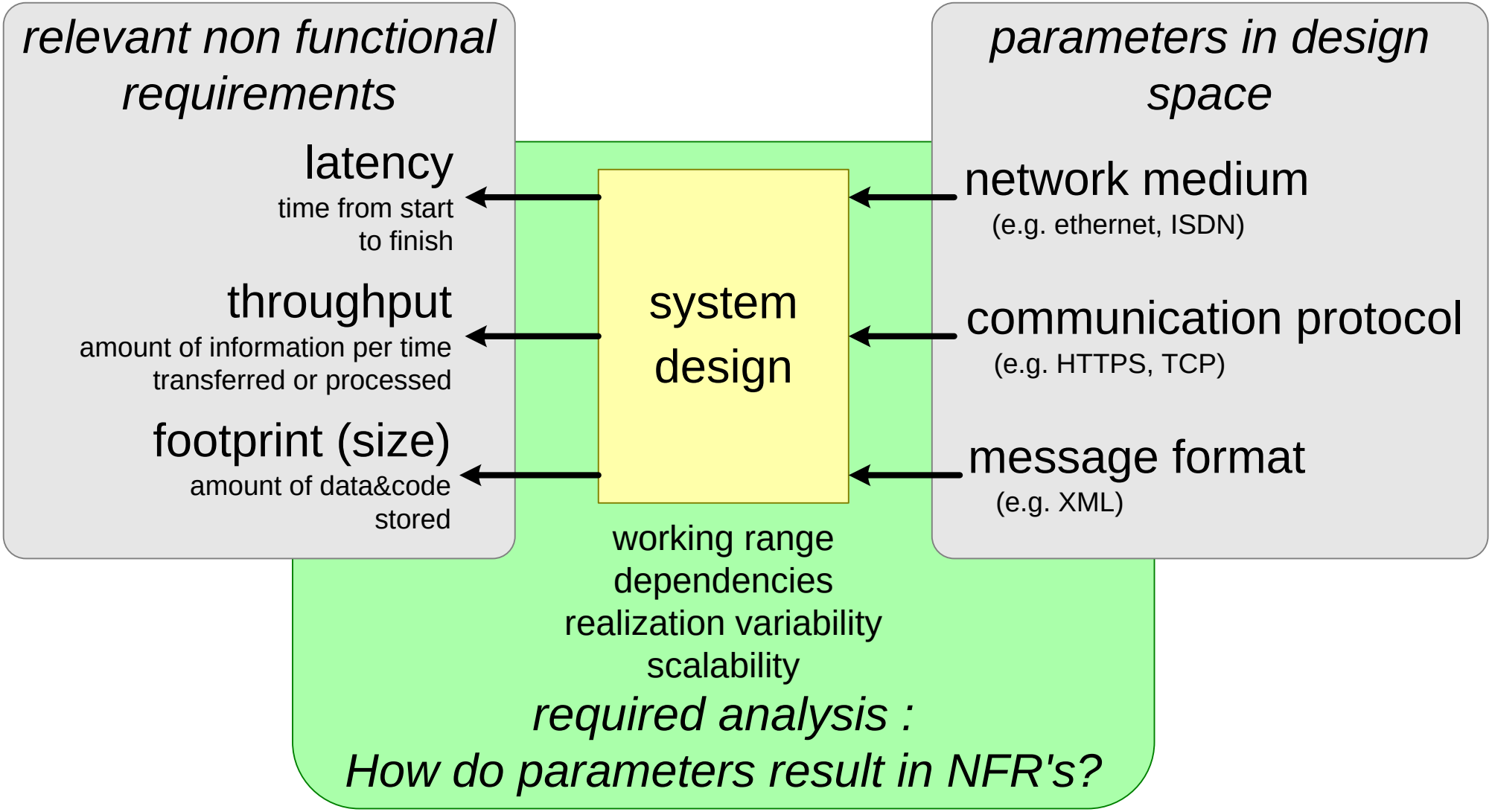
generic layering and block diagrams

typical characteristics and concerns

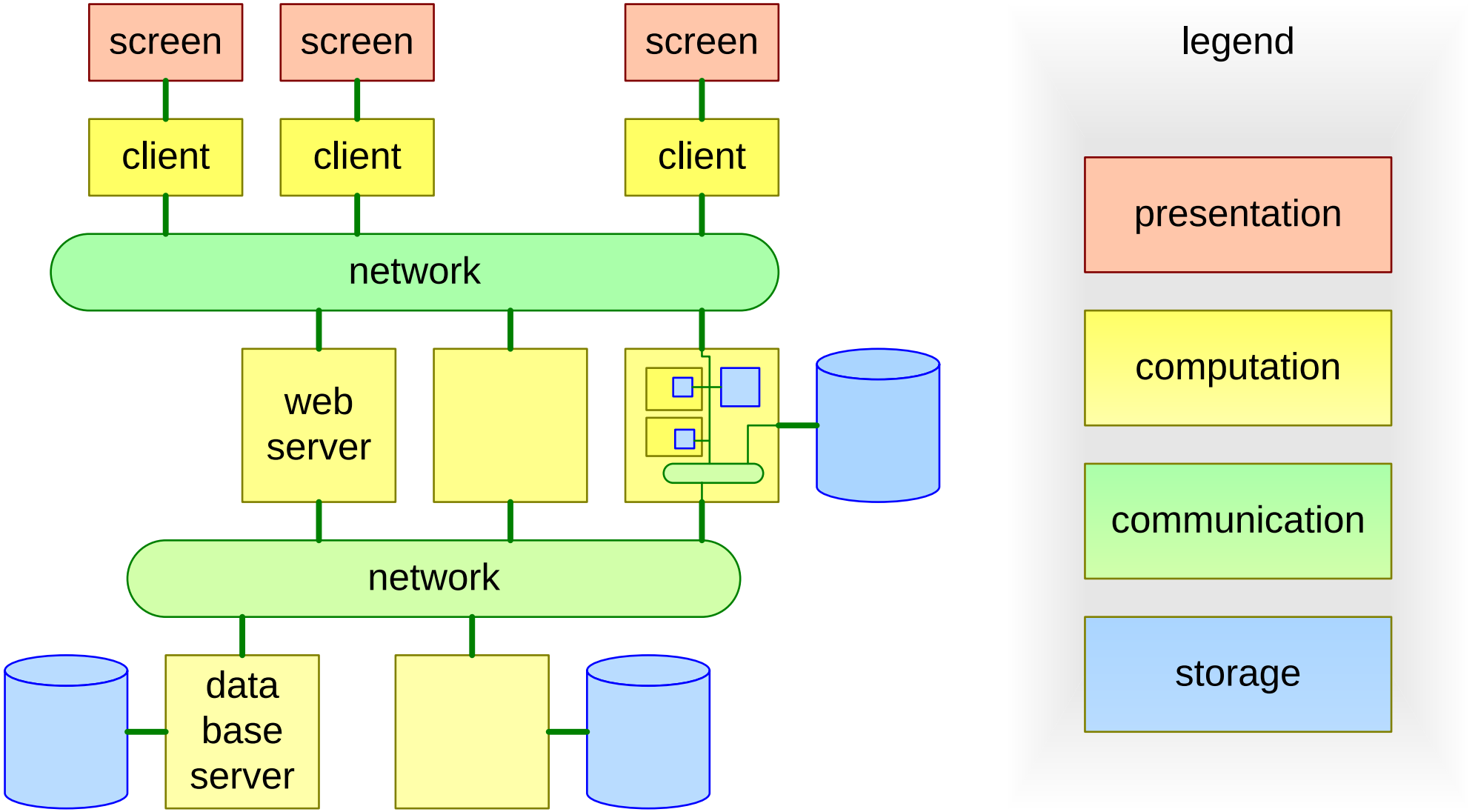
figures of merit

example of picture caching in web shop application

What do We Need to Analyze?



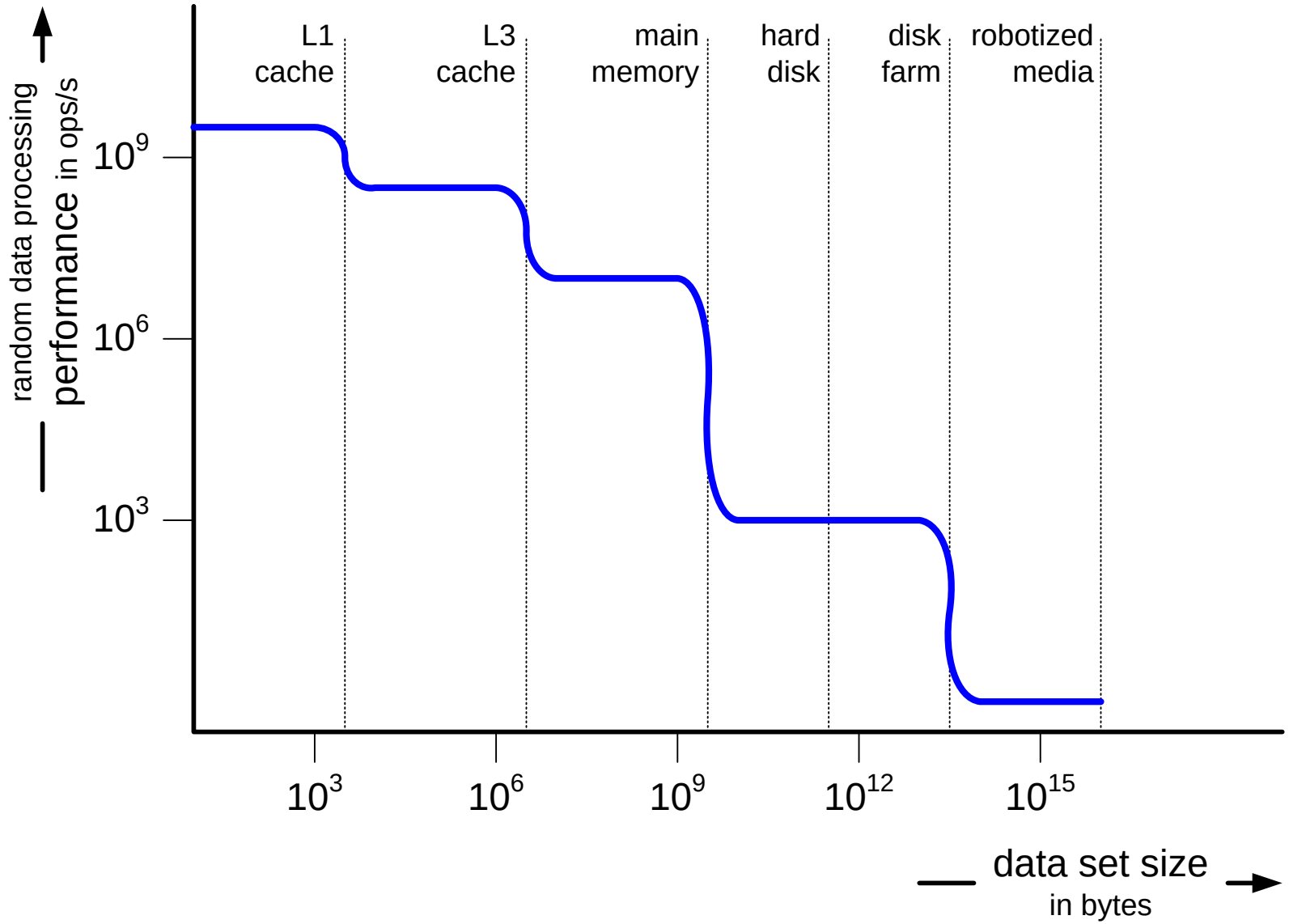
Typical Block Diagram and Typical Resources



Hierarchy of Storage Technology Figures of Merit

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

Performance as Function of Data Set Size



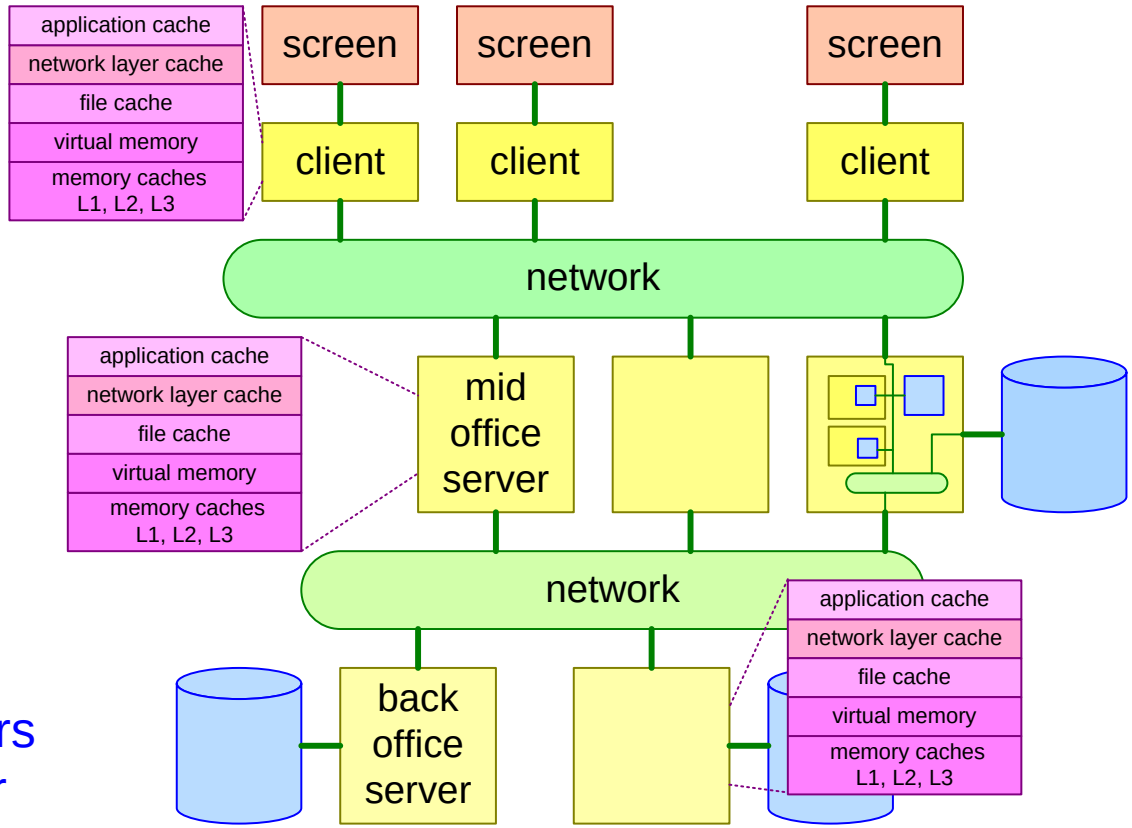
Communication Technology Figures of Merit

		latency	frequency	distance
on chip	*connection*	sub ns	n GHz	n mm
	network	n ns	n GHz	n mm
PCB level		tens ns	n 100MHz	n cm
Serial I/O		n ms	n 100MHz	n m
network	*LAN*	n ms	100MHz	n km
	WAN	n 10ms	n GHz	global

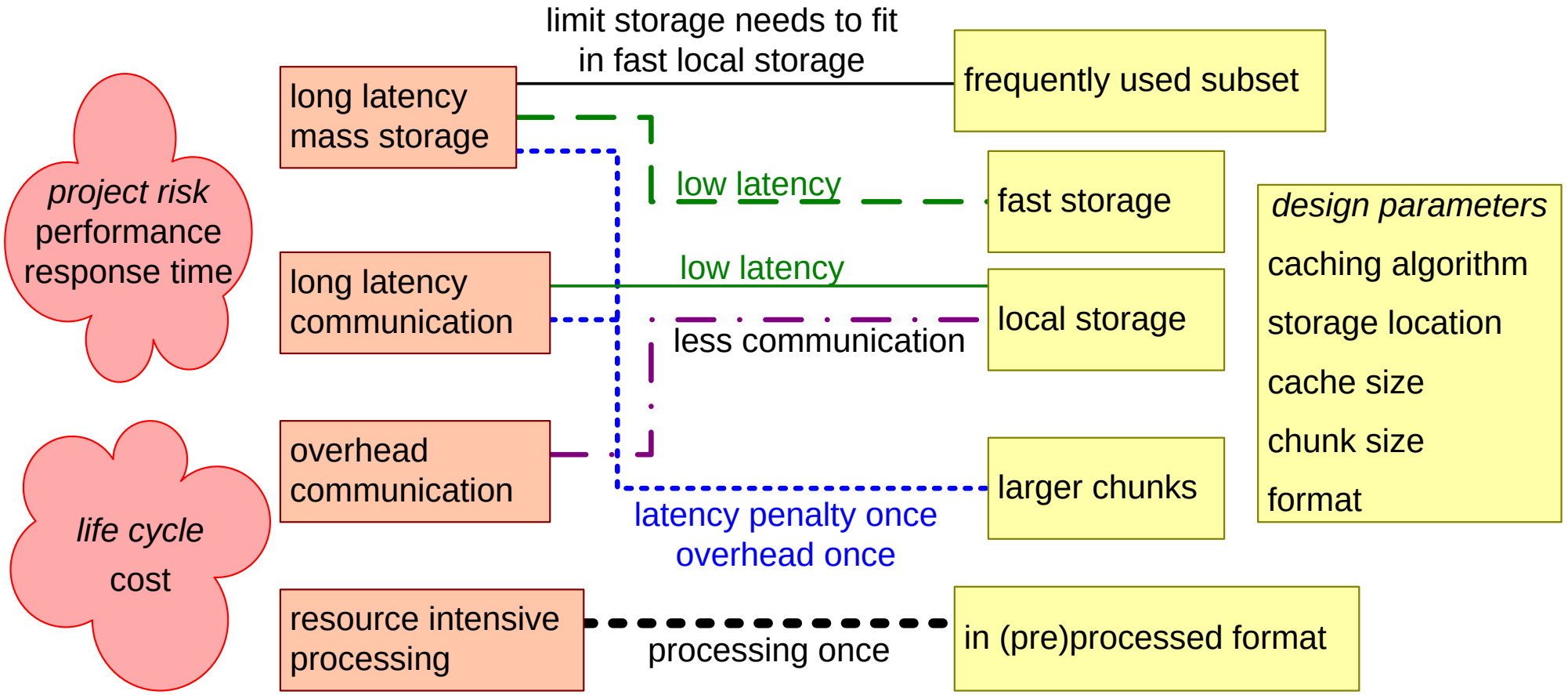
Multiple Layers of Caching

	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

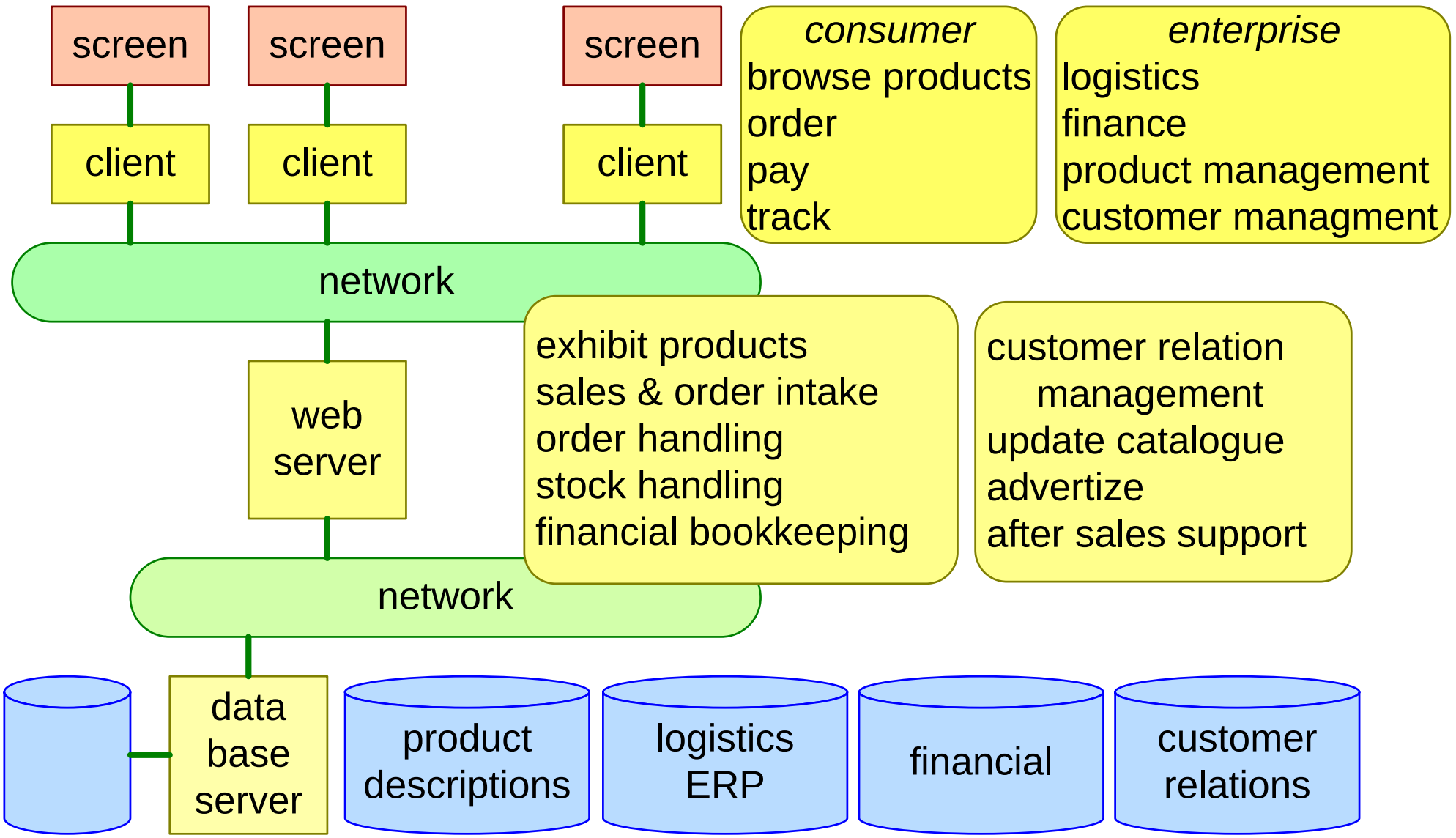
typical cache 2 orders of magnitude faster



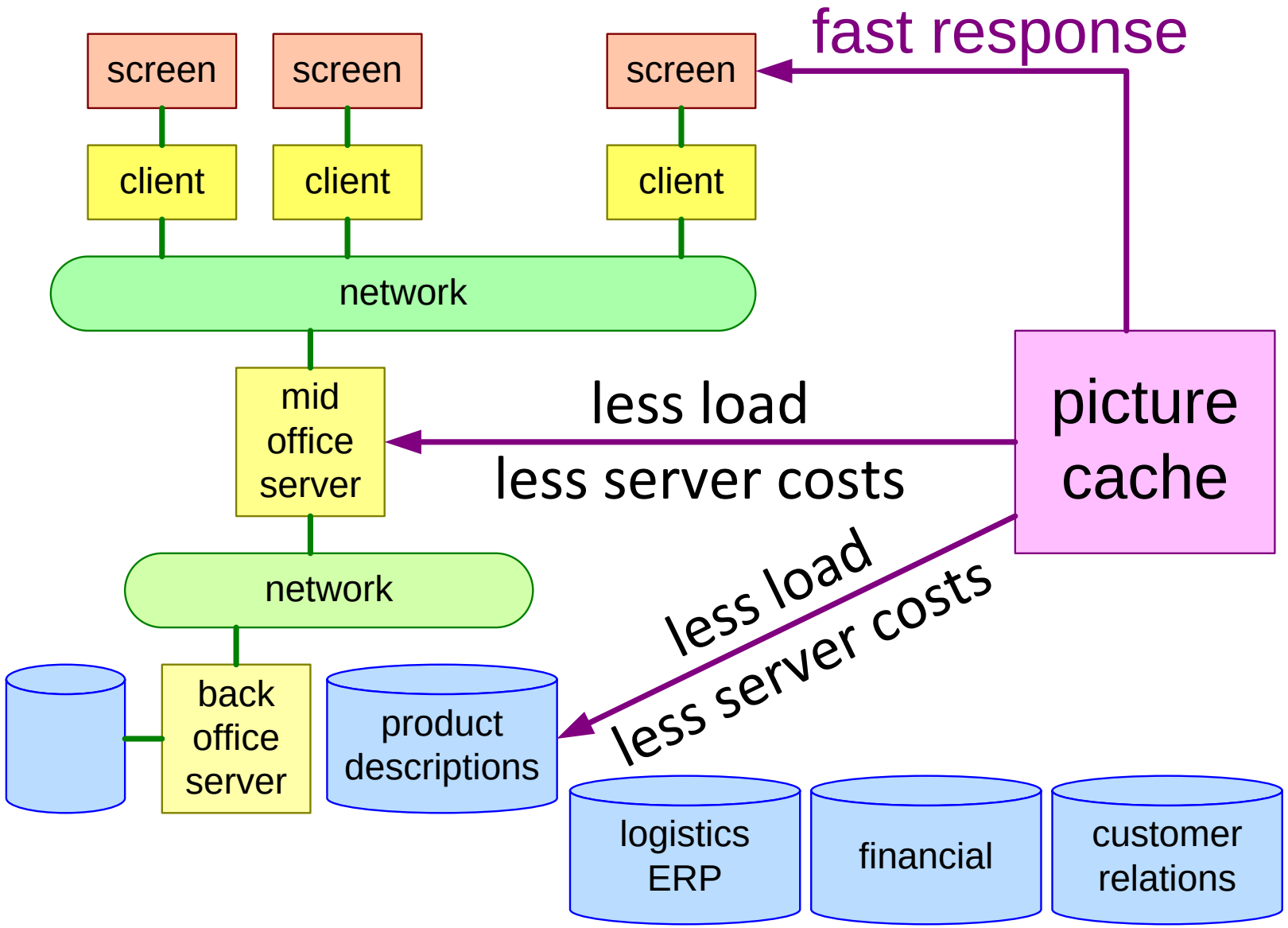
Why Caching?


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

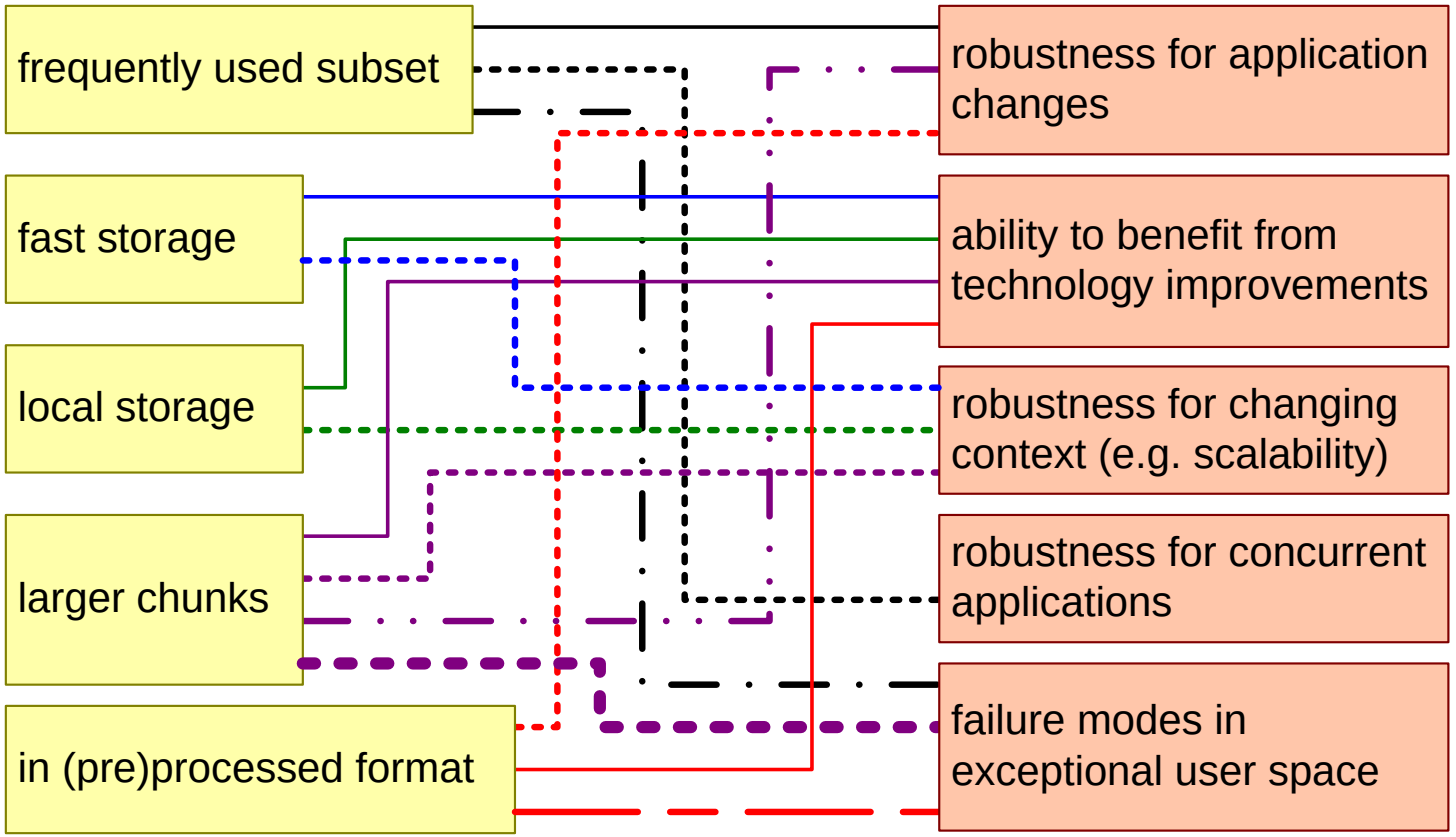
Example Web Shop



Impact of Picture Cache



Risks of Caching



life cycle
cost
effort

project risk
cost
effort
performance

Summary

Conclusions

Technology characteristics can be discontinuous

Caches are an example to work around discontinuities

Caches introduce complexity and decrease transparancy

Techniques, Models, Heuristics of this module

Generic block diagram: Presentation, Computation, Communication and Storage

Figures of merit

Local reasoning (e.g. cache example)