

Modeling and Analysis Fundamentals of Technology

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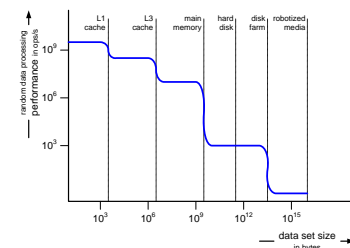
Abstract

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

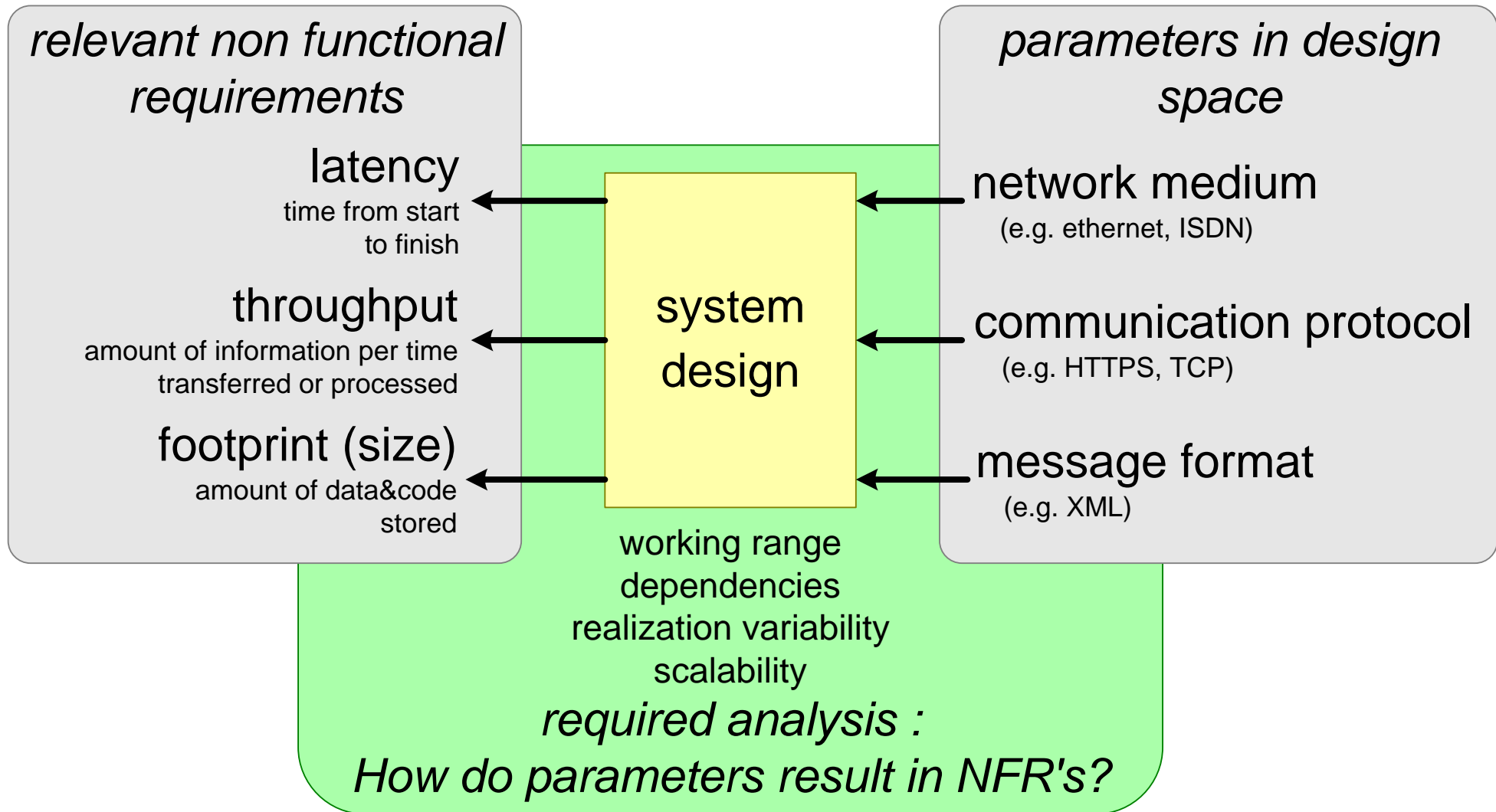
generic layering and block diagrams

typical characteristics and concerns

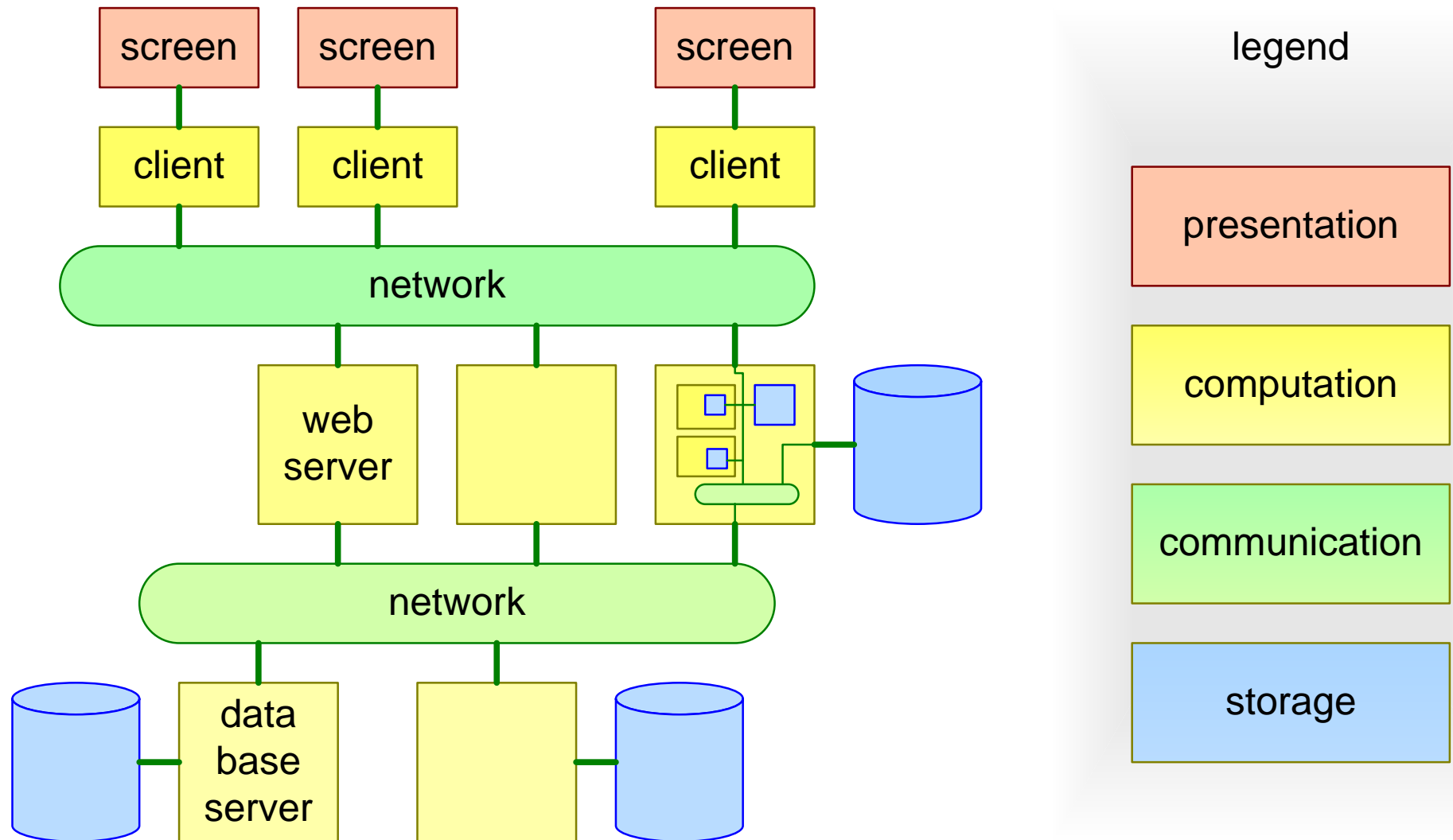
figures of merit

example of picture caching in web shop application

What do We Need to Analyze?



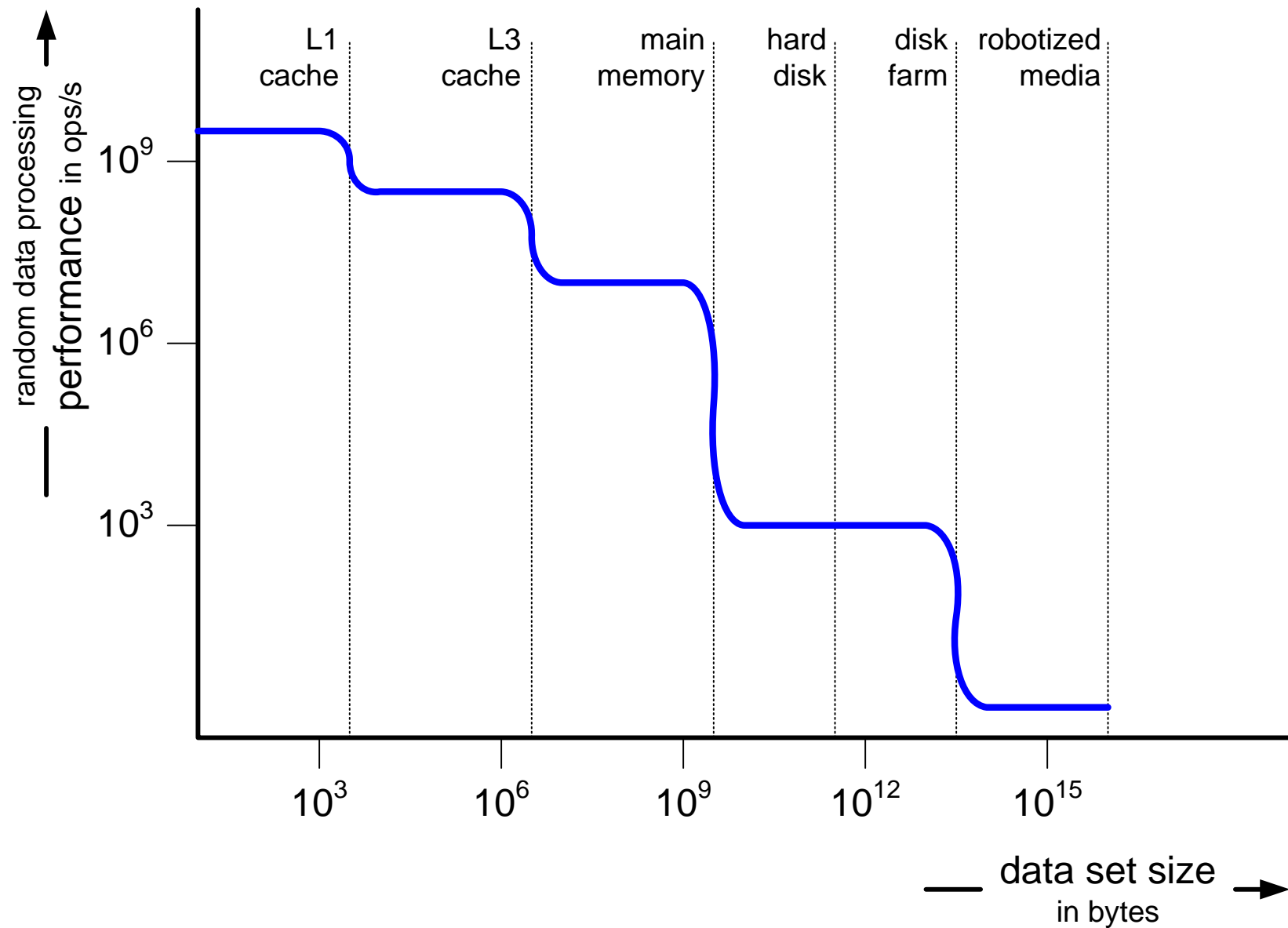
Typical Block Diagram and Typical Resources



Hierarchy of Storage Technology Figures of Merit

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

Performance as Function of Data Set Size

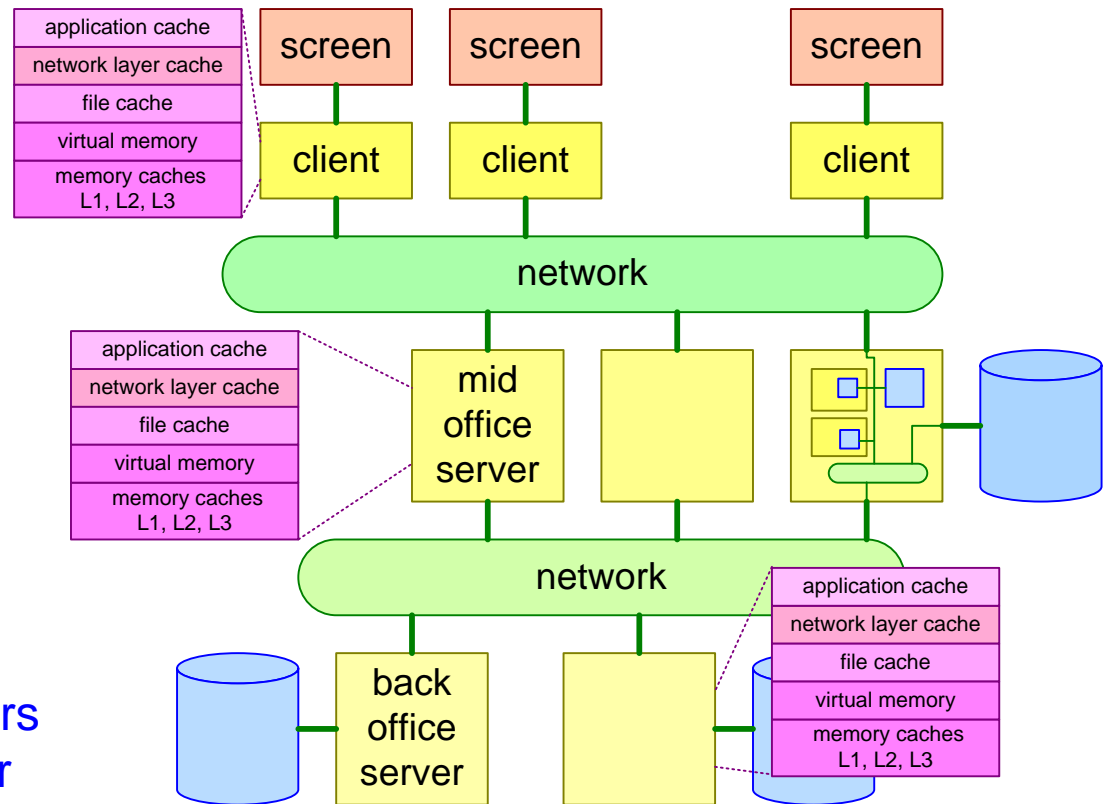


| | | latency | frequency | distance |
|------------|-------------------|---------|-----------|----------|
| on chip | <i>connection</i> | sub ns | n GHz | n mm |
| | <i>network</i> | n ns | n GHz | n mm |
| PCB level | | tens ns | n 100MHz | n cm |
| Serial I/O | | n ms | n 100MHz | n m |
| network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

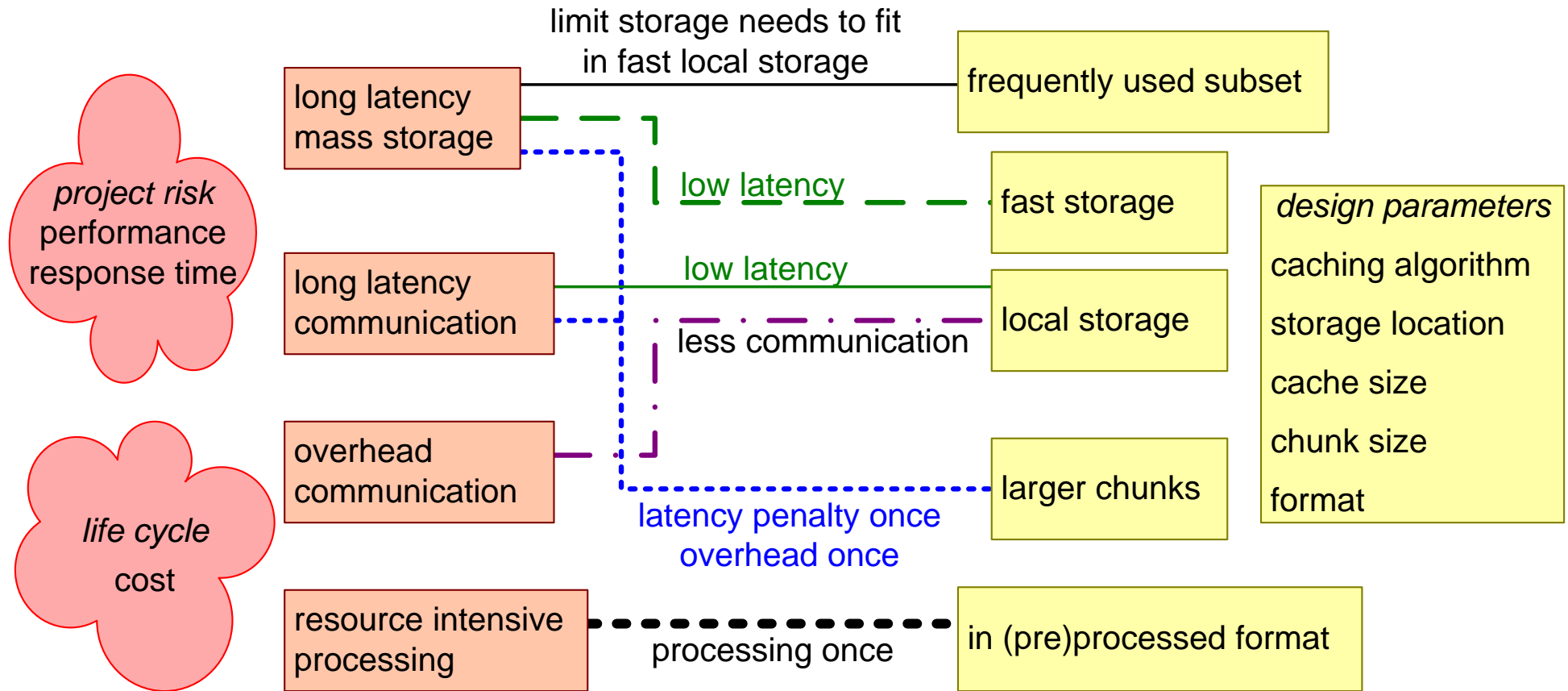
Multiple Layers of Caching

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

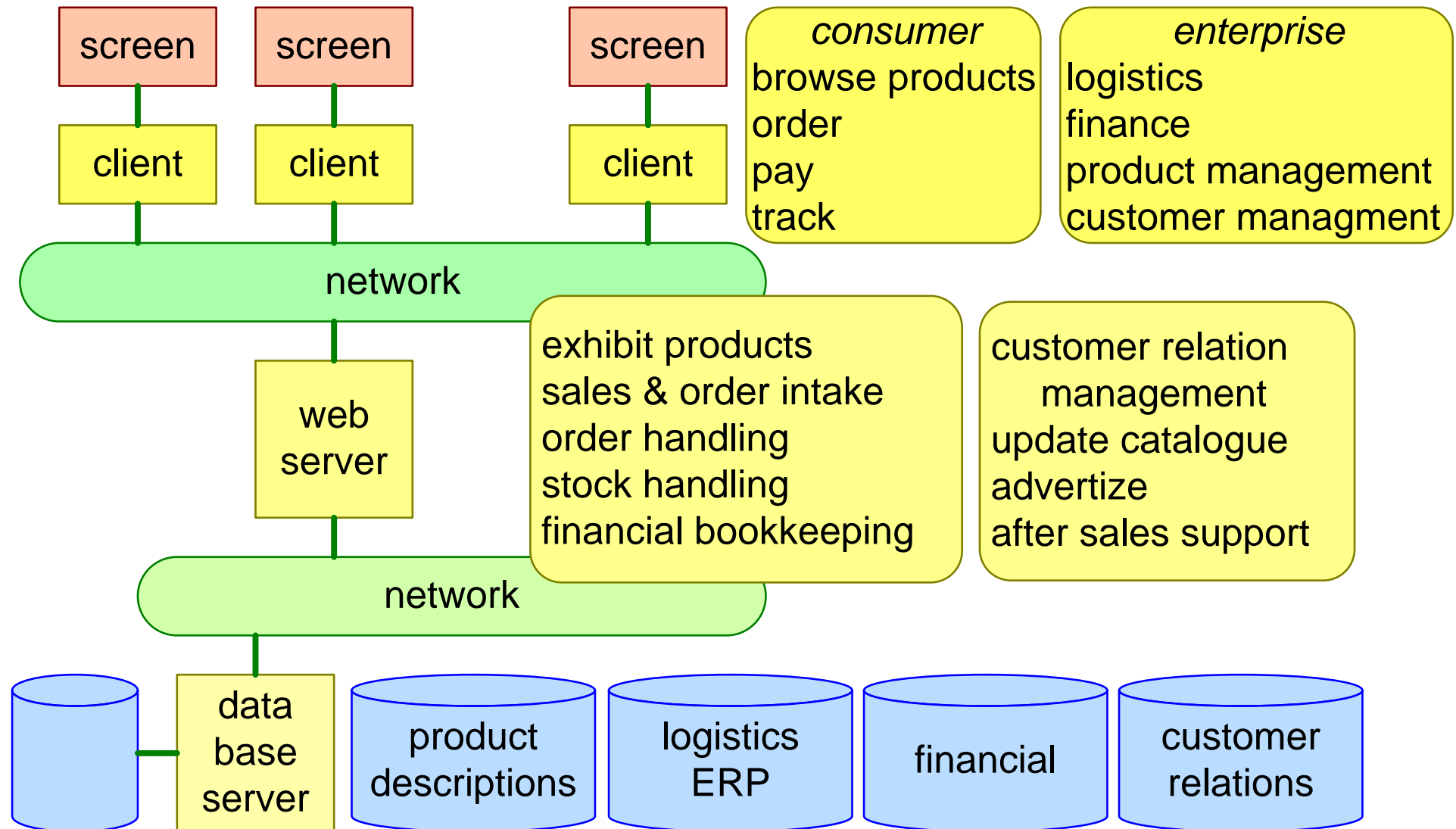

 typical cache 2 orders
 of magnitude faster



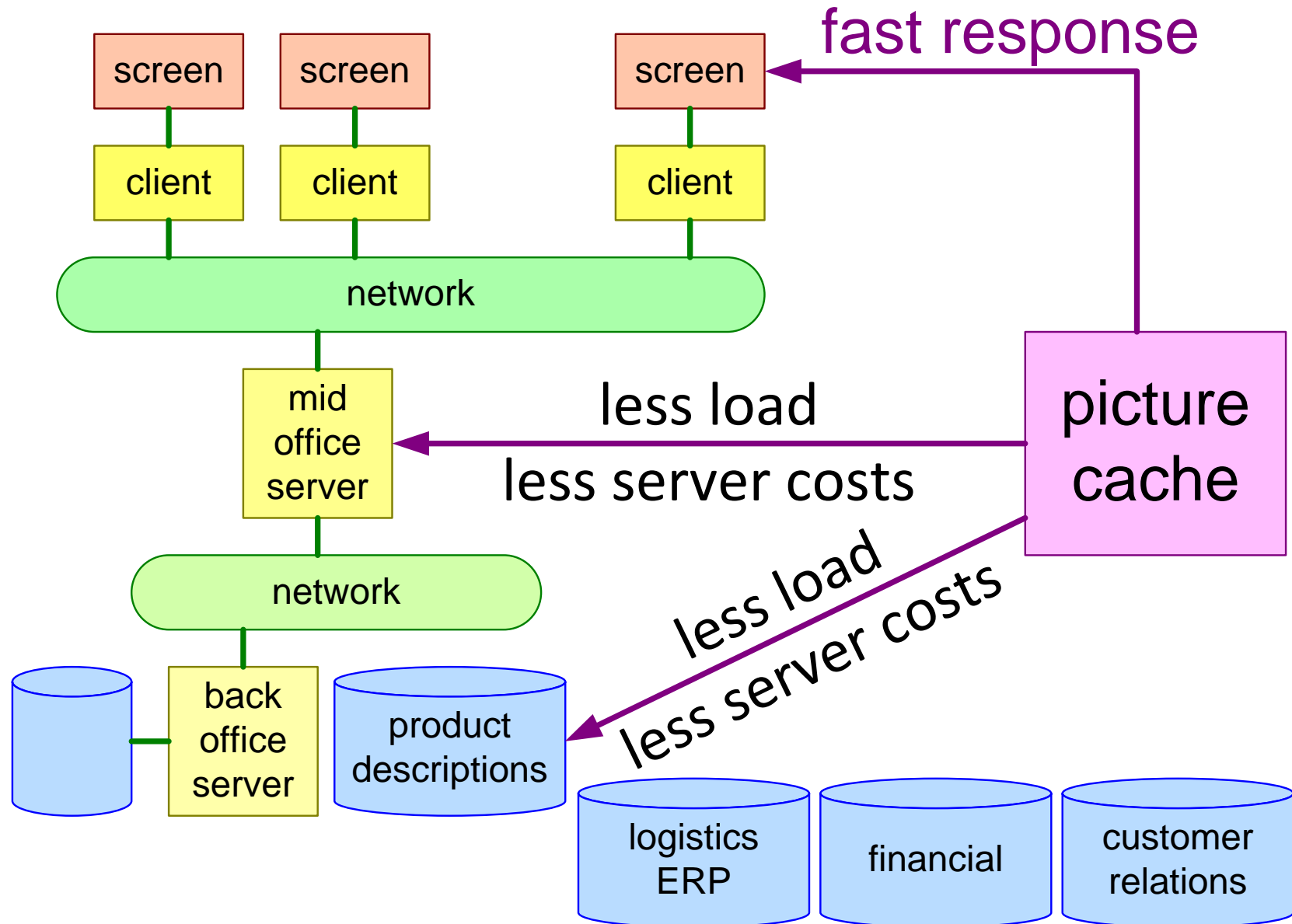
Why Caching?



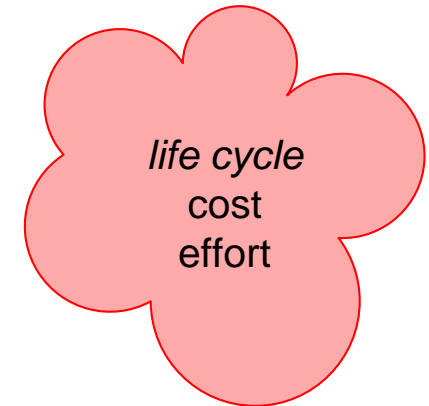
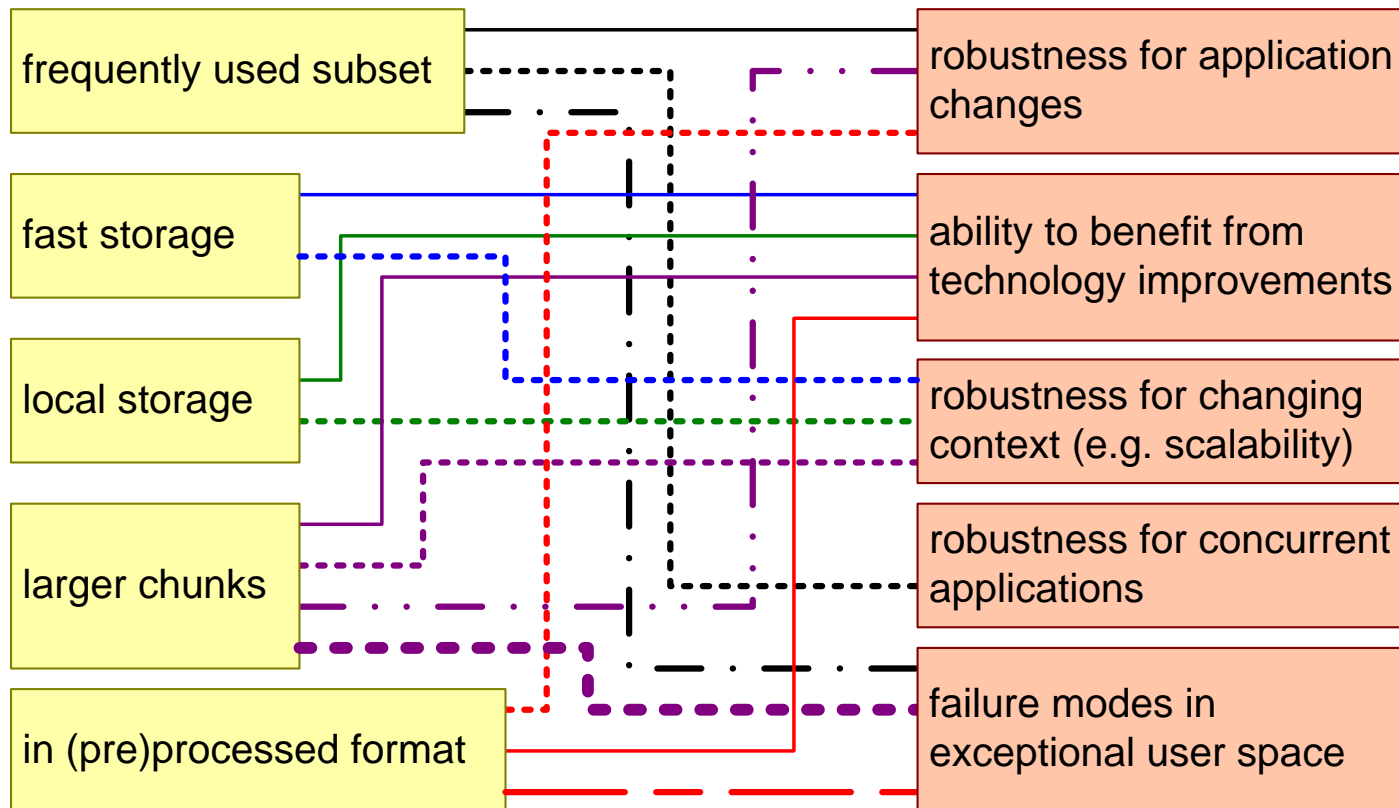
Example Web Shop



Impact of Picture Cache



Risks of Caching



Conclusions

Technology characteristics can be discontinuous

Caches are an example to work around discontinuities

Caches introduce complexity and decrease transparency

Techniques, Models, Heuristics of this module

Generic block diagram: Presentation, Computation, Communication and Storage

Figures of merit

Local reasoning (e.g. cache example)