Abstract

Today’s IT capabilities are seemingly limitless. From the point of view of last century we have amazing functionality available to consumers, businesses, governments et cetera. Technology advances have made this possible. At the same time we suffer from unwanted, unexpected incidents, ranging from slow or no response to loss or theft of sensitive data. The growth of systems and its complexity play a role. We will look at the role of the human creators of these systems and the available technology to discuss our concurrent progression and regression, and we will look at the role of the architect in particular.
Functionality is Limitless

financial transactions
anywhere, anytime
financial infrastructure

consumers

businesses
government
...

financial institutes
But Problems seem to be Pervasive

slow response, outages, human-less helpdesks, silly excuses (the computer could not...), identity-theft, lost privacy

financial transactions anywhere

financial institutes

"entrepreneurial" employees

late delivery of new products, poor scaling of new services, interference of features, ...

consumers

businesses government ...

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Do we Gain or do we Lose?

desired properties
functionality
performance

progression

not desired
failures
threats

regression

---time---
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question

gain or lose?

role of architect

Example

webshop

application

performance

technology

solution?

reference architecture

reflection on size and complexity

analysis

reflection

on size and complexity

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gain or lose?
Example, Case Webshop

Up-to-date information:
Bestsellers
What Other Customers Are Looking At Right Now
catalogue entries
main access through search
personalization
other advertisements
standard boilerplate
snapshot of www.amazon.com
Up-to-date information:
Bestsellers
What Other Customers Are Looking At Right Now

catalogue entries
standard boilerplate
snapshot of www.amazon.com

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Some Numbers: New Books per Year

new books per year

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Sales 1</th>
<th>Year</th>
<th>Sales 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td></td>
<td>206k</td>
<td>1996</td>
<td>107k</td>
</tr>
<tr>
<td>USA</td>
<td></td>
<td>172k</td>
<td>1996</td>
<td>68k</td>
</tr>
<tr>
<td>China</td>
<td></td>
<td>101k</td>
<td>1994</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td></td>
<td>12k</td>
<td>1996</td>
<td></td>
</tr>
</tbody>
</table>

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

product portfolio characteristics
selection depends on business
life cycle changes determined by business characteristics

sales info

O'Reilly
Addison Wesley
Springer
publisher

Amazon "long tail"

WH Smith

source: http://en.wikipedia.org/wiki/Long_tail
question gain or lose?

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Typical Block Diagram and Typical Resources
## Hierarchy of Storage Technology

### Figures of Merit

<table>
<thead>
<tr>
<th>Level</th>
<th>Technology</th>
<th>Latency</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Processor Cache</strong></td>
<td></td>
<td>sub ns</td>
<td>n kB</td>
</tr>
<tr>
<td></td>
<td><em>L1 cache</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>L2 cache</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>L3 cache</em></td>
<td></td>
<td>n MB</td>
</tr>
<tr>
<td><strong>Fast Volatile</strong></td>
<td></td>
<td>tens ns</td>
<td>n GB</td>
</tr>
<tr>
<td></td>
<td><em>Main Memory</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Persistent</strong></td>
<td></td>
<td>ms</td>
<td>n*100 GB</td>
</tr>
<tr>
<td></td>
<td><em>Disks</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Disk Arrays</em></td>
<td></td>
<td>n*10 TB</td>
</tr>
<tr>
<td></td>
<td><em>Disk Farms</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Archival</strong></td>
<td></td>
<td>&gt;s</td>
<td>n PB</td>
</tr>
<tr>
<td></td>
<td><em>Robotized Optical Media</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Tape</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Performance as Function of Data Set Size

random data processing
performance in ops/s

L1 cache
L3 cache
main memory
hard disk
disk farm
robotized media

10^3 10^6 10^9 10^{12} 10^{15}
data set size in bytes

10^9 10^6 10^3
random data processing
performance in ops/s

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<table>
<thead>
<tr>
<th></th>
<th>latency</th>
<th>frequency</th>
<th>distance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>on chip</strong></td>
<td>sub ns</td>
<td>n GHz</td>
<td>n mm</td>
</tr>
<tr>
<td><strong>network</strong></td>
<td>n ns</td>
<td>n GHz</td>
<td>n mm</td>
</tr>
<tr>
<td><strong>PCB level</strong></td>
<td>tens ns</td>
<td>n 100MHz</td>
<td>n cm</td>
</tr>
<tr>
<td><strong>Serial I/O</strong></td>
<td>n ms</td>
<td>n 100MHz</td>
<td>n m</td>
</tr>
<tr>
<td><strong>network</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LAN</strong></td>
<td>n ms</td>
<td>100MHz</td>
<td>n km</td>
</tr>
<tr>
<td><strong>WAN</strong></td>
<td>n 10ms</td>
<td>n GHz</td>
<td>global</td>
</tr>
</tbody>
</table>
Performance

question

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Impact of Picture Cache

The diagram illustrates the impact of picture cache on various components of an IT architecture, including:

- **Fast response**: Enhances the speed of responses to client requests.
- **Less load**: Reduces the workload on servers and networks.
- **Less server costs**: Decreases the expenses associated with server operations.

The diagram shows the flow of information from clients to the network, through picture cache, and to various server components such as logistics ERP, financial, and customer relations. The integration of product descriptions and mid-office server also plays a crucial role in this process.
## Multiple Layers of Caching

<table>
<thead>
<tr>
<th>Cache Type</th>
<th>Cache Miss Penalty</th>
<th>Cache Hit Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Cache</td>
<td>1 s</td>
<td>10 ms</td>
</tr>
<tr>
<td>Network Layer Cache</td>
<td>100 ms</td>
<td>1 ms</td>
</tr>
<tr>
<td>File Cache</td>
<td>10 ms</td>
<td>10 µs</td>
</tr>
<tr>
<td>Virtual Memory</td>
<td>1 ms</td>
<td>100 ns</td>
</tr>
<tr>
<td>Memory Caches L1, L2, L3</td>
<td>100 ns</td>
<td>1 ns</td>
</tr>
</tbody>
</table>

The diagram illustrates the hierarchy of caching layers, from the client to the network layer, with typical cache 2 orders of magnitude faster.

**Cache Miss Penalty**
- Application Cache: 1 s
- Network Layer Cache: 100 ms
- File Cache: 10 ms
- Virtual Memory: 1 ms
- Memory Caches L1, L2, L3: 100 ns

**Cache Hit Performance**
- Application Cache: 10 ms
- Network Layer Cache: 1 ms
- File Cache: 10 µs
- Virtual Memory: 100 ns
- Memory Caches L1, L2, L3: 1 ns
Why Caching?

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

### Frequently Used Subset
- Robustness for application changes

### Fast Storage
- Ability to benefit from technology improvements
- Robustness for changing context (e.g., scalability)

### Local Storage
- Robustness for concurrent applications

### Larger Chunks
- Failure modes in exceptional user space

### In (pre)processed Format

---

**Life Cycle**
- Cost
- Effort

**Project Risk**
- Cost
- Effort
- Performance
Size and Complexity

question gain or lose?

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RAPpyramid

Level of Abstraction Single System

- **static system definition**
- **monodisciplinary**
- **number of details**
- **system requirements**
- **multidisciplinary design**
- **static system definition**
- **monodisciplinary**

\[
\begin{array}{c}
\text{number of details} \\
10^0 \\
10^1 \\
10^2 \\
10^3 \\
10^4 \\
10^5 \\
10^6 \\
10^7 \\
\end{array}
\]
Number of Details in Today’s Services

- Society
- Enterprises
- Stakeholders
- Processes
- Systems
- Multi-disciplinary design
- Parts, connections, lines of code
- Suppliers
- Enterprise architects
- Information architects
- Employees in the field
- Outourced

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PRSITdiabolo
Reference Architecture

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Reference Architecture as Solution?

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some context details are essential

some technical details are essential
1.1 One of several prerequisites for architecture creative synthesis is the definition of **5-7 specific key drivers** that are critical for success, along with the rationale behind the selection of these items.

2.1. The essence of a system can be captured in about **10 models/views**.

2.2. A **diversity** of architecture descriptions and models is needed: languages, schemata and the degree of formalism.

2.3. The level of **formality** increases as we move closer to the implementation level.

from http://www.architectingforum.org/bestpractices.shtml
Possible useful visualizations

actual figures and references to their use at http://www.gaudisite.nl/figures/<name>.html

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RAPvisualizations
Ideal Structure does not exist
Synthesis, Integration, Relation oriented

1. Functional Decomposition
2. Construction Decomposition
3. Allocation
4. Infrastructure
5. Choice of integrating concepts
Checklist for RA content

customer context

- business
- financials
- stakeholders
- benefits, concerns
- concept of operations

technical architecture

- key performance parameters
- product features, functions
- core technologies
- critical resources
- design issues
- dominant patterns

relations guidance

business architecture

- business model
- life cycle
- stakeholders
- benefits, concerns
Role of Architect

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architect

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Tasks of Architect

- Society
- Enterprises
- Enterprises
- Stakeholders
- Processes
- Systems
- Multi-disciplinary design
- Parts, connections, lines of code

Arrows indicate:
- Select data
- Guide sales, deployment
- Understand
- Fitness
- Overview
- Design
- Realization

Graph shows the number of details from 10^12 to 10^0, with society at the top and parts, connections, lines of code at the bottom.
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LWAstakeholdersArchitecture

---

**Stakeholders**

- Customer
  - being informed
  - functionality
  - performance
  - timely available
  - acceptable cost
- Open
- Suppliers
  - implementation
  - decoupling
  - solution freedom
- Feedback Responsiveness
  - guidance
  - understandability
  - accessibility
  - product feasibility
- Solution Freedom Communicable
  - acceptable cost
- Business manager
  - bottomline
  - future growth
- Evolution
  - guidance
  - understandability
  - accessibility
  - product feasibility
- Engineers

---
Gain or Lose?

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Conclusion
Loss Scenario

Desired properties:
- Functionality
- Performance

Not desired:
- Failures
- Threats

Progression:
- Complexity
- Size
- Tech capabilities

Regression:
- Understanding
- Overview

Status of IT Architecting: Progression or Regression?

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PRSIITlossScenario
Gain Scenario

desired properties
functionality
performance

not desired
failures
threats

time

progression
regression

complexity
size
tech capabilities
architecting skills

=understanding
=overview

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PRSIT_gainScenario
We need to improve architecting skills to gain.
Reference Architecture Primer

Webshop case is part of System Modeling and Analysis

All about Architecting: System Architecting