Architecture in Software and Systems Development

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Contents

What is architecture in software and systems development?
Software architecture
Enterprise architecture
Architecture: Dictionary definition

Main Entry: **architecture**
Function: *noun*

1: the art or science of building; *specifically*: the art or practice of designing and building structures and especially habitable ones
2 a: formation or construction as or as if as the result of conscious act <the architecture of the garden> b: a unifying or coherent form or structure <the novel lacks architecture>
3: architectural product or work
4: a method or style of building
5: the manner in which the components of a computer or computer system are organized and integrated

*From Merriam-Webster’s Collegiate Dictionary, 10th edition (Merriam-Webster 2002)*
Architecture?
Architecture?
Architecture?
Use of architecture in design

What were they describing in the previous examples? Why? For what purposes? To whom?
What is architecture?

Architecture is a metaphor in IT (and in many other areas)

- Metaphor: understanding an abstract phenomenon in terms of another, more concrete phenomenon

Understanding a virtual machine or abstract construction with common terms (in terms of a physical building)

Building architecture as the concrete phenomenon
Different architectures

Many architectures

• Software architecture
• Enterprise architecture
• Hardware architecture
• Network architecture
• Application architecture
• System architecture
• Business architecture
• ...

The terminology is not very clear

• People talk about “architecture” when they mean a specific kind of architecture
• People mix different architectures – even in designs
Essential “architectures” in this lecture

Software architecture
• The software architecture of a program or computing system is the structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them. (Bass, 2003)

Enterprise architecture
• Enterprise architecture is the organizing logic for business processes and IT infrastructure of a company. (Ross & al., 2006)
Reasons for architecture’s importance

Architecture enables

• Communication among stakeholders
  - A common abstraction of the system that all stakeholders can use
• Early design decisions
  - Architecture manifests the earliest decisions about a system
  - It enables early analysis of design decisions
• Transferable abstraction of a system
  - A small and understandable model of how a system is structured, how elements work together.
  - It may enable reuse of high-level designs
What is architecture related to? (examples)

**Specification of the system structure**
- Architecture is the basis for further design and implementation

**Basis for work division**
- Architecture may even define the organizational structure

**Basis for reuse**
- Also the use of third party products is specified by architecture

**Management of technological risks**
- Selection of tools and techniques

**Support of strategic decisions**

**Creation of common understanding between stakeholders**
Effects of a good architecture design

Better management of complexity

- Understanding technology and solutions

More effective reuse

- Understanding reusable services
- Standardized interfaces

Better quality

- Management of non-functional requirements, like performance, maintainability, security, ...
- Architecture has the most important role in meeting the non-functional requirements
What is included in architecture design?

Typical questions:
• How is the whole composed of parts?
• How are the parts associated to each other?
• What kind of “public” interfaces there are?
• How does the communication between the parts happen?
• What technologies, standards and ready-made components are used?
• How is it possible to confirm that non-functional requirements (e.g. performance) are met?
Who needs architecture and architecture descriptions?

Suggestions?

The role of a software architect/enterprise architect

• A technical leader
• Understands also the business domain
• A good communicator
• Negotiates, makes decisions and understands organizational politics
Identified stakeholder roles in architecture description

Customer
  Business responsible
  Technology responsible
Designer
  Chief designer
Project manager
  Technical project manager
Architect
  Chief architect
  Project architect
Customer management & marketing
  Account manager
  Salesman
General management
  Project steering group
  Department manager
  Team leader
System analyst
  Product engineer
Data administration
  Internal data administration
  Customer’s data administration
Product management
Other projects & organization
Other suppliers
  Subcontractors
  Suppliers of connecting systems
  Hardware vendors
User
  Known users
  Anonymous users
Testing & quality assurance
  Tester
  Quality manager
UI Designer
  Technical designer
  User experience team
Production organization
  At customer’s site
  At vendor’s site
  3rd party service
Support
  Technology management
  Authorities
  Process development
  Hardware integrator
  Documentation specialist
  Consultant

Smolander & Päivärinta, 2002
Architecture is an organizational concept

- Language
- Blueprint
- Architecture document
- Literature
- What are we doing and how does it work?
- It works this way!
- These things must be decided! Do we have enough money and other stuff?
- Decision
- What the heck is that?
Design and description of architecture

Many possibilities

- Free form pictures and descriptions
  - The most popular way
- UML diagrams
  - Deployment diagrams
  - Component diagrams
  - Composite structure diagrams (UML2)
  - Package/class diagrams
- Architecture Description Languages (ADL)
  - Not used widely in practice

For what reasons/uses is architecture described?

- The form should have relevance to uses
Summary of architecture in general

As a concept, architecture is quite fuzzy
• People mean many things when they speak about architecture
• They do not use the term consistently

In spite of this fuzziness (or perhaps because of), architecture is an important tool in
• Determining and fulfilling non-functional requirements
• Managing the complexity
• Work division
• Disseminating knowledge and information
• Making decisions about technology
Essential concepts

Software architecture
Enterprise architecture (EA)
Enterprise application integration (EAI)
• Middleware
Software architecture

Architecture of one software system, including its interfaces and use context

• Usually defines the components and connections between the components
• Typical elements
  - Subsystems
  - Layers
  - Modules
  - Components
  - Interfaces
  - Connections
Architectural requirements

Architecturally Significant Requirements are those that

• capture essential functionality of the system
• have broad coverage; exercise many architectural elements
• challenge the architecture
• highlight identified issues/risks
• exemplify stringent demands on the architecture (e.g. performance requirements)
• are likely to change
• involve communication and synchronization with external systems

Malan & Bredemeyer, 2002
Architectural decisions

Have a broad scope and high impact

- Priorities of the system
  - Business strategies, resources, opportunities, partners, ...
- Decomposition and composition of the system
  - Structural elements, component responsibilities, configurations, ...
- Fit to context
  - Interoperability, consistency, interfaces, ...
- Fit to organizational policies
  - Style, technology, principles, skills, design patterns, ...
## Possible structures of a software architecture

### Example

Bass & al., 1999

<table>
<thead>
<tr>
<th>Software structure</th>
<th>Units</th>
<th>Relation represented by the links</th>
<th>Useful for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module</td>
<td>Work assignments</td>
<td>Is a submodule of; shares secret with</td>
<td>Resource allocation and project structuring and planning; information hiding, encapsulation; configuration control</td>
</tr>
<tr>
<td>Conceptual</td>
<td>Functions</td>
<td>Shares data with</td>
<td>Understanding the problem space</td>
</tr>
<tr>
<td>Process</td>
<td>Programs</td>
<td>Runs concurrently with; may run concurrently with; excludes; precedes; etc.</td>
<td>Scheduling analysis; performance analysis</td>
</tr>
<tr>
<td>Physical</td>
<td>Hardware</td>
<td>Communicates with</td>
<td>Performance, availability, security analysis</td>
</tr>
<tr>
<td>Uses</td>
<td>Programs</td>
<td>Requires the correct presence of</td>
<td>Engineering subsets; engineering extensions</td>
</tr>
<tr>
<td>Calls</td>
<td>Programs</td>
<td>Invokes with parameters</td>
<td>Performance profiling; bottleneck elimination</td>
</tr>
<tr>
<td>Data flow</td>
<td>Functional tasks</td>
<td>May send data to</td>
<td>Traceability of functional requirements</td>
</tr>
<tr>
<td>Control flow</td>
<td>System states or modes</td>
<td>Transitions to, subject to the events and conditions labeling the link</td>
<td>With timing information, can be basis for automatic simulation and verification of timing and functional behavior</td>
</tr>
<tr>
<td>Class</td>
<td>Objects</td>
<td>Is an instance of; shares access methods of</td>
<td>In object-oriented design systems, producing rapid almost-alike implementations from a common template</td>
</tr>
</tbody>
</table>
Enterprise architecture

An enterprise wide design/structure including such elements as

- Business processes and strategies
- Information systems and IT applications
- Information and databases
- Technical infrastructure

May describe

- Current or “as-is” status
- Target or “to-be” structures
- A migration plan describing how to reach the target from the current
Enterprise architecture

Organizing logic for business processes and IT infrastructure

- Reflects the integration and standardization requirements of the company’s operating model
- Provides a long term view of a company’s processes, systems, and technologies

There are different stages in learning how to approach enterprise architecture in companies
Architecture through evolution

(understood with archeology)

(Picture: IBM, 2008)
Enterprise architecture: some key concepts

**Business processes**
- Tasks related to a particular issue
- Management, operational and supporting processes

**IT infrastructure**
- IT services offered by an organization
- Information systems, office tools, networks, etc.

**IT governance**
- The system by which the current and future use of IT is directed and controlled in an organization
Enterprise architecture / background: strategic fit

Henderson & Venkatraman, 1993
IT infrastructure

Enabling IT services in an organization
• Hardware and software infrastructure
• Service delivery and support
• Security management
• Application management
• Asset management

ITIL - Information Technology Infrastructure Library
• An industry standard for managing IT infrastructure
• Defines the procedures for IT management
IT governance

• "Specifying the decision rights and accountability framework to encourage desirable behaviour in the use of IT.“ (Weill & Ross, 2004)
• Management of IT infrastructure in an organization
• Focus on strategies, decision making and control
• Influence from corporate governance and auditing
  - Collapse of Enron, Sarbanes-Oxley act in US
Examples of areas related to IT governance

- Management of IT-based business services
- Management of business technology
- Enterprise architecture
- IT asset management
- IT portfolio management (initiatives, projects, ongoing services)
- IT security assessment
- IT service management
- Project governance
- Project management and Program management in the enterprise IT context
Enterprise application integration

EAI includes technologies and principles that enable implementation of enterprise architectures

A strategic approach to binding many information systems together

Shared services, shared data

Examples of integration technologies
- Web services
- Message-oriented middleware
- Service-oriented architecture (SOA)
- Business process models
- Database replication
- Federated databases
Enterprise integration and middleware

Middleware

• A glue that binds systems, subsystems and services together
• An essential component when designing enterprise architecture and integration
• At simplest a RPC call or a database connection
• At most complex an enterprise services bus providing integration services for the whole enterprise
Exercise

What do you describe when you are describing the architecture of
• A game for mobile phones
• An e-commerce site integrated to production and logistics
• A nation-wide social media community with public and commercial partners (with interfaces)

What are the
• Main entities/elements in the architecture?
• Targeted audience/stakeholders and their requirements for the descriptions?