Middleware and Web Services

Lecture 1: Introduction to Architectures

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Overview

- Architecture Overview
- Data, Functions and Processes
- Software Architecture

Global Architecture

- A **structure** and a **behavior** of system's parts
- Complexity – views on the global architecture
  - *basic architectural views (also called dimensions):*
    enterprise, data, functional, process, software, hardware.
- Development
  - *basic **methodology** and **actors**:*
    ~ analysis, design, implementation, testing, maintenance
    ~ end-user, architect, developer, administrator
  - *basic architectural **development levels**:*
    ~ conceptual, logical, physical.
- Global architecture and cloud computing
  - *data, functions, processes are application (domain) specific*
  - *software architecture defines a **software platform***
  - *hardware architecture defines an **infrastructure***

Views

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Enterprise Architecture

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Enterprise Architecture Levels

- Defines a structure of an enterprise system
  - *Abstracts from data, functions, processes, software, hardware*
  - *divides enterprise system into functional blocks – **applications***
    - → *Order Management System (OMS)*
    - → *Customer Relationship System (CRM)*
    - → *Billing and Revenue Management (BRM)*
  - *applications correspond to **domains** such as sales, finance, procurement, production, etc.*
- Enterprise architecture levels
  - *Operational Support Systems (OSS)*
  - *Business Support System (BSS)*
  - *Executive Information Systems (EIS)*
  - *Office Information Systems (OIS)*
  - *Integration*
    - → *Business-to-Business (B2B)*
    - → *Enterprise Application Integration (EAI)*

Enterprise Architecture Representation

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Organization Types

- Customer
  - *user needs: support for business processes*
  - *defines business requirements*
  - *roles: enterprise architect, developers, admins, users*
- Supplier (enterprise system/application provider)
  - *solutions and customization according to requirements*
  - *roles: technical and solution architects, developers, admins*
- Vendor (technology provider)
  - *product development according to market needs*
  - *roles: product managers, developers, reference users*

Architect Roles

- Technical Architect
  - *Technical architecture design*
  - *technology configurations, performance*
- Solution Architect
  - *Requirements gathering, analysis*
  - *Solution design (data, functions, process)*
- Enterprise Architect
  - *High-level enterprise architecture design*
    → *Applications, processes, data models*
  - *Should be aligned with industry standards*
    → *APQC – American Productivity & Quality Center (Process Classification Framework)*
    → *TM Forum – eTOM – Enhanced Telekom Operations Map (Business Process Framework)*

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  – *Integration*
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Process Classification Framework

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Order Process Example in Telco

- Order to Cash Process (O2C)
  - *end-to-end (E2E) order process*

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- Involved applications
  - *integrated applications*

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Syntax and Domain Semantics

- Syntax
  - *Data format, representation, serialization*
  - *Various languages at various architectural levels: XML, JSON, Class/object models in a specific programming language, SQL, DB native structures, ...*
  - *They have formal grammars, can be checked for the correct syntax*
- Domain semantics
  - *Meaning of terms in a domain they are being used*
  - *We understand meaning of terms:*
    → Through syntax by using the natural language
    *→ Through some **agreement** among users of the terms*
  - *Every applications can use different semantics*
    → Need to mediate data from one application to another

Simplified Order Type Example

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Overview of Representations

- Languages to realize architectures
  – *development levels* × *architectural views*

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Integrating Applications

- Intra-Enterprise Integration
  - *Applications exist in a specific area*
  - *Functions and data often overlap across areas*
  - *There is a need to integrate applications within enterprise:*
    - → *Applications need to share the same data that are often in different formats.*
    - → *Applications need to communicate – a result of one process may trigger another one.*
- Inter-Enterprise Integration
  - *Also called Business-to-Business Integration (B2B)*
  - *Automation support for communication and collaboration among enterprises*
  - *For example, B2B automates customers' orders processing, tracking orders, etc.*

Integration Example – O2C

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Integration Issues

- Key to integration = **interface**
  - *standards – data, functions, processes, technical aspects*
    → *enterprise standards, committee standards*
    → *unified environment from a single vendor*
  - *mediators*
    → *where standard do not work out*
- Data
  - *Message exchange formats, data representation*
    → *often standardized*
  - *Semantics of data*
    → *also standardized, more difficult*
- Functions and processes
  - *how apps' functionalities should be consumed and orchestrated, protocols, naming issues*
  - *A service concept*

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  - *Types, Separation of Concerns, Interface*
  - *Client/Server Architectures*

Software Architecture Types

- Centralized – Client/Server (C/S)
  - *Central server, a bunch of clients*
  - *monolithic, **two–**, **three–**, **multi–tier** architectures*
  - *Single point of failure!*
    - → *when a server fails the whole system fails*
    - → *need for a scalable and **highly reliable** server-side solutions*
  - *Enterprise systems (mostly) use centralized solutions*
    - → *But, enhanced with peer-to-peer principles*
- Decentralized – Peer-to-Peer (P2P)
  - *Reliability*
    - → *when a node fails, other nodes take up its function*
  - *Scalability*
    - → *multiple nodes can share the load*
    - → *such as messaging systems in enterprise systems*

Separation of Concerns

- Separation of Concerns
  - *also called Separation of Layers*
  - *Concern – any piece of interest (part) in the application*
    → concerns should overlap in functionality as little as possible
  - *Basic application concerns: data manipulation, data integrity, application logic, user-interactions*
  - *Software architecture separates concerns into layers*
    → presentation, application, data
- **Interface**

  ~ agreement on "how layers should communicate"
  - *most important artifact in Separation of Concerns*
  - *If an interface is in place, application development and innovation can happen **independently** at each layer*

Software Architecture Layers

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Interface

- Definition
  - *Agreement (contract) between two or more layers during communication*
- May be achieved by
  - *Through standards (accepted or enforced),*
  - *Through a social agreement during design*
  - *A dominant position of a technology on the market*
- Interface includes subsets of domain architectures
  - *Subsets that are subject to communication between layers*
  - ***data** – defines communication language (syntax, semantics),*
  - ***functions** – defines entry points (operations),*
  - ***processes** – defines valid states and transitions between them*
  - ***technical details** – protocols, ports, IP addresses, etc.*

Interface Scope

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- Scope
  - *local: layer A and B on one machine*
  - *network: layer A and B on separated machines (client/server)*
- Application Programming Interface (API) ~ local scope
  - *OS/complex apps' interface for extension development*
- Web Services and Web API (network scope)
  - *Web API is a new term – API of Web Applications*

Complex Interfaces

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- More levels of interfaces
  1. *DBMS native interface*
  2. *JDBC – universal connectors for various DBMS systems*
  3. *JDO – mapping of Java classes to data objects*
  4. *Domain Object Model (OM) – app-specific (~API, SDK)*
     - *try to be as universal as possible; cover many technologies*

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Monolithic Architecture

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- All layers on a single machine
  - *usually non-portable apps; specific OS*
  - *first types of computer systems, typical for 90-ties*
  - *single-user only; standalone apps, minimal integration*
  - *technologies: third-gen programming languages, local storage systems*
- Drawbacks
  - *hard to maintain (updates, distribution of new versions)*
  - *data security issues*
  - *performance and scalability issues*

Two-tier Client/Server Architecture

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- Presentation and app layers separated with data
  - *Thick client – desktop application, OS-dependent*
  - *Data on a separate server (DBMS)*
  - *Multi-user system, all sharing a database*
  - *Storage system of high performance, transactions support*
  - *SQL technology; native OS desktop application*
- Drawbacks
  - *Thick client hard to maintain (reinstallation with every update)*
  - *No app logic sharing (only through copies)*
  - *Data-oriented integration (integrity in the app logic!)*

Three-tier Client/Server Architecture

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- All layers on separated machines
  - *Thin client – desktop application or interpreted code*
  - *Multi-user system, all sharing app logic and a database*
  - *App server of high performance, scalability*
- Drawbacks
  - *Spaghetti integration (see Lecture 0)*
  - *Limited, single app server scalability*

Multi-tier Client/Server Architecture

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- Additional middleware layer
  - *loose coupling, shift towards peer-to-peer architectures*
  - *provides value-added services for communications*
  - *individual servers or a compact solution (e.g., Enterprise Service Bus)*

Types of Middleware

- Scalability
  - *They help to achieve high performance through better scalability*
  - *Messaging Servers (message queues, publish/subscribe)*
  - *Load Balancers*
  - *Proxy servers, reverse proxy*
- Functional
  - *They help to achieve more flexible integration*
  - *Process servers*
  - *Repositories, registries of services/components*
  - *Mediators – data interoperability, process interoperability, technical interoperability (SOAP server)*
  - *Monitors for analytics of apps usages*
- Security
  - *Firewalls, Gateways, ...*