

Middleware Architectures 1

Lecture 1: Information System Architectures

doc. Ing. Tomáš Vitvar, Ph.D.

tomas@vitvar.com • @TomasVitvar • <https://vitvar.com>



Czech Technical University in Prague

Faculty of Information Technologies • Software and Web Engineering • <https://vitvar.com/lectures>



Modified: Sun Oct 06 2024, 20:11:10
Humla v1.0

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



Enterprise Architecture



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



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)*

Overview

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

Process Classification Framework



Order Process Example in Telco

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



- Involved applications
 - integrated applications



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



Overview

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

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



Lecture 1: Information System Architectures, CTU Winter Semester 2024/2025, @TomasVitvar

– 17 –

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

Lecture 1: Information System Architectures, CTU Winter Semester 2024/2025, @TomasVitvar

– 18 –

Overview

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

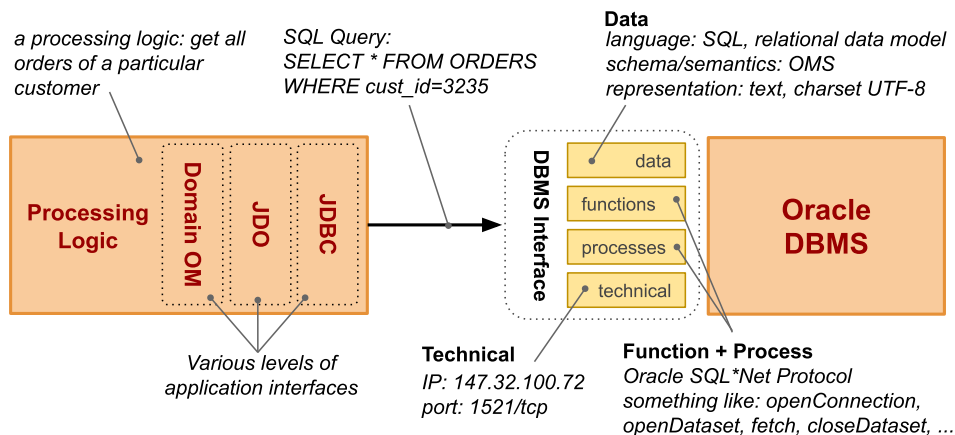
Separation of Concerns

- 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*

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.*

Complex Interfaces



- 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

Overview

- Architecture Overview
- Data, Functions and Processes
- Software Architecture
 - Types, Separation of Concerns, Interface
 - *Client/Server Architectures*

Monolithic Architecture



- 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



- 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



- 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*
 - *Limited, single app server scalability*

Multi-tier Client/Server Architecture



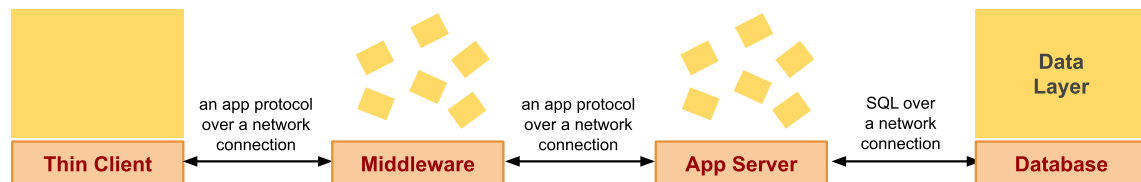
- Additional middleware layer
 - *provides value-added services for communications*
 - *individual servers or a compact solution (e.g., Enterprise Service Bus)*
- Drawbacks
 - *Monolithic apps are difficult to scale as a whole*
 - *Deployment overhead*
 - *A single technological environment for all app functions in the monolith*

Client/Server Architecture (microservices)



- Microservice architecture
 - *Middleware, app and DB monoliths are microservice architecture*
 - *Improved scalability and technology neutrality of app components*
- Service orchestration layer
 - *Kubernetes (K8s)*
 - *Large K8s cluster for all, middleware, app, DB*
 - *Separate K8s cluster*

Client/Server Architecture (microservices)



- Not-a-microservice Architecture
 - *Monoliths deployed to Kubernetes cluster*
 - *Improved Deployments (via container images)*
 - *Improved fail-over*
 - *Not cheaper (Kubernetes costs come into play)*

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, ...*