

Middleware and Web Services

Lecture 1: Introduction to Architectures

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Overview

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

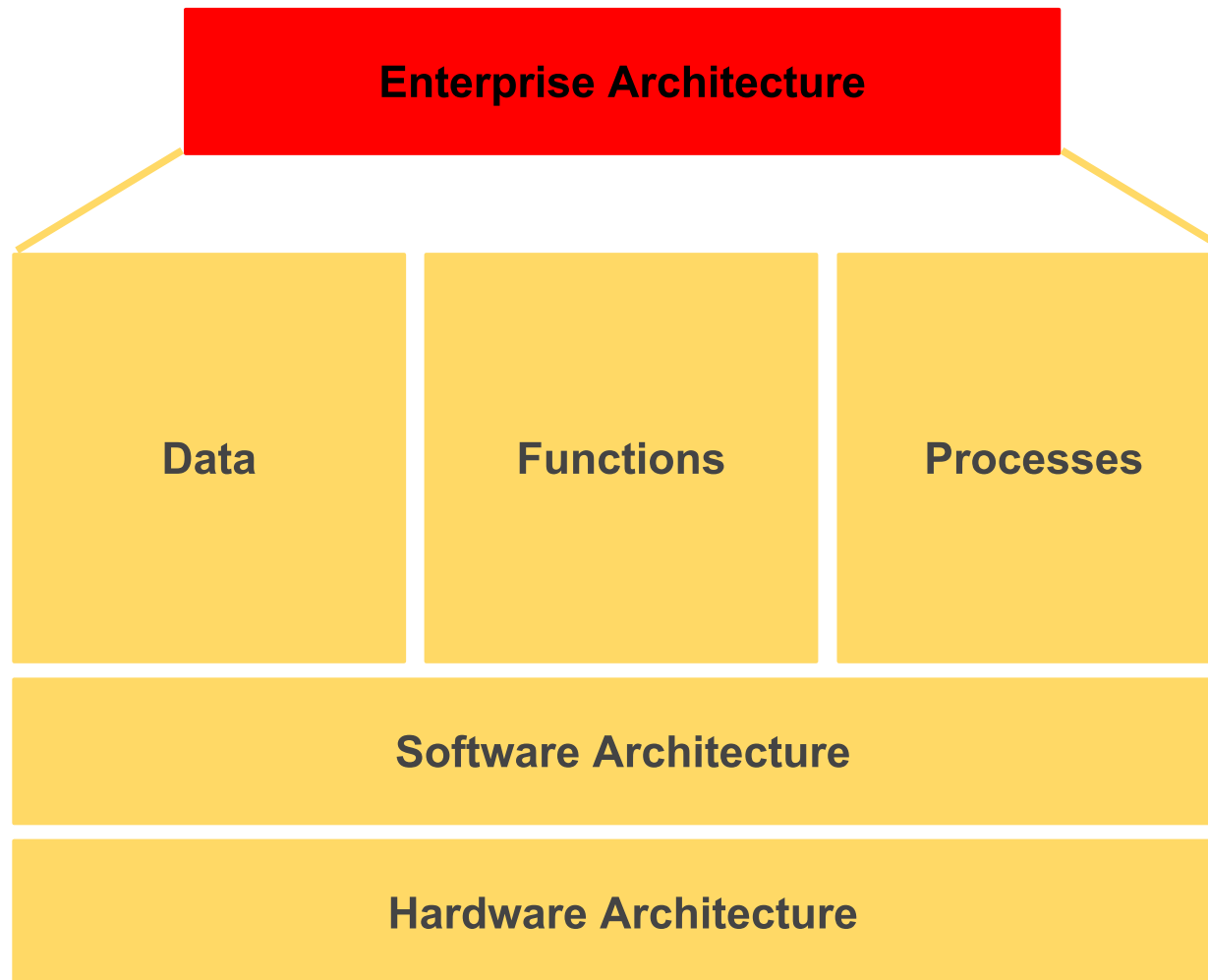
Global Architecture

- 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



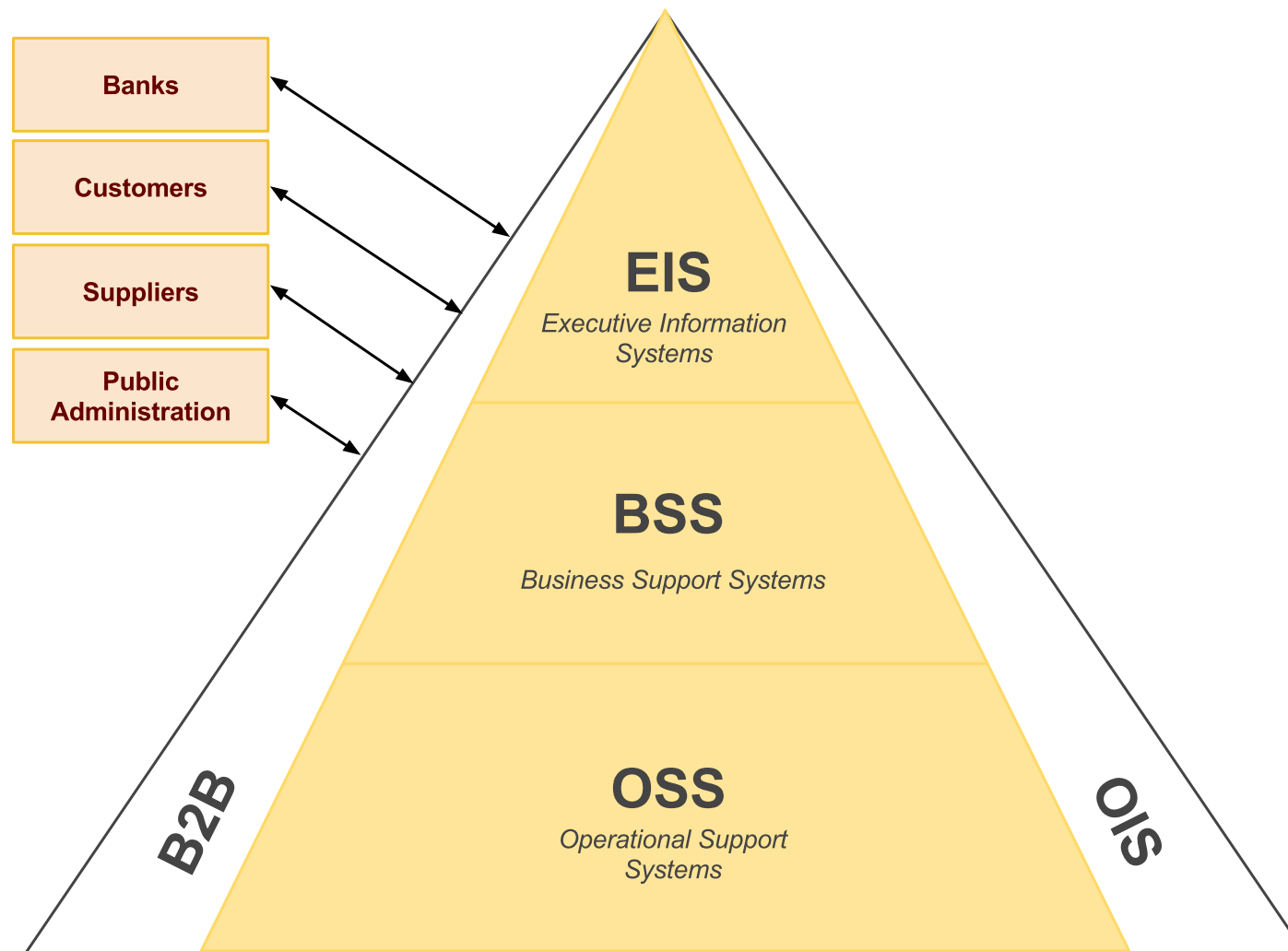
Enterprise Architecture



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)*

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 - *Integration*
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Process Classification Framework

Level 0
Business functions
Business functions of the enterprise

Manage Customer Service

Manage IT

Manage Financial Resources

Level 1
Process Groups
Defines groups of processes

Develop Customer Care

Manage Customer Service Operations

Assure Services

Level 2
Core Business Process
Defines roles and high-level functions

Manage Customer Service Requests

Perform CRM

Handle Orders

Level 3
Business Activity
Defines activities within a process, multiple roles

Establish Order

Close Customer Order

Complete Order

Level 4
Business Task
Tasks are executed by a single actor (human or system)

Sales Order Fulfillment

Provision Order

Bill Fulfillment Order

Level 5
Business Step

...

...

...

APQC
Process Classification
Framework (PCF)

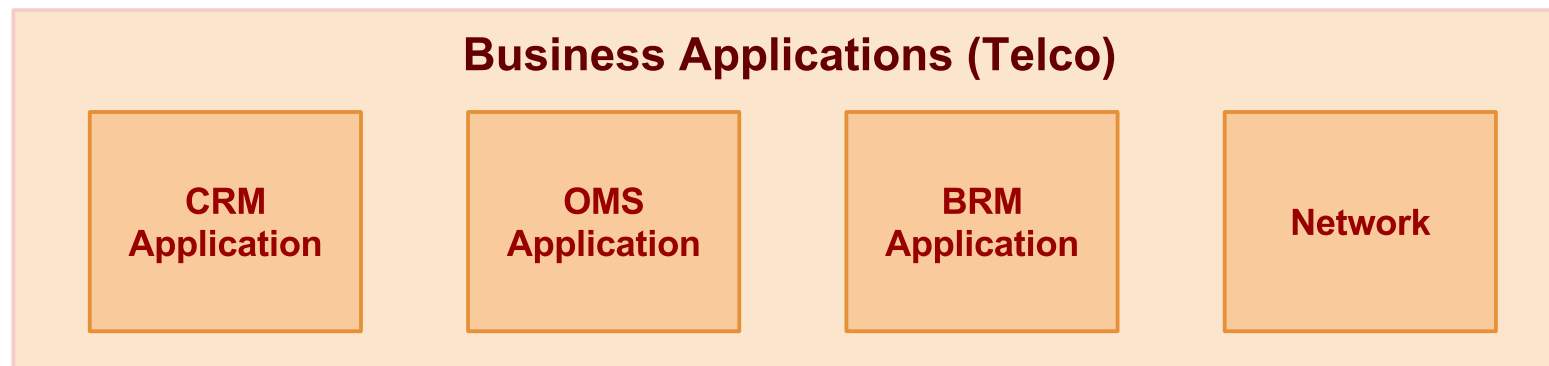
Organization's
Implementation specific

Order Process Example in Telco

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



- Involved applications
 - *integrated applications*



Syntax and Domain Semantics

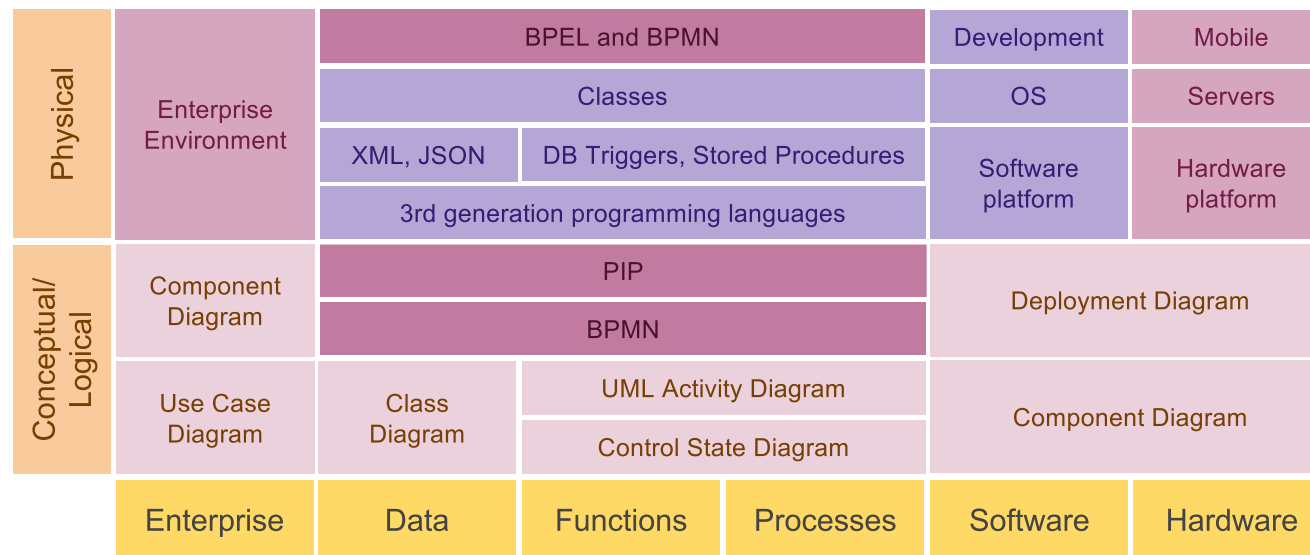
- Syntax
 - *Data format, representation, serialization*
 - *Various languages at various architectural levels: XML, JSON, Class/object models in a specific programming language, SQL, DB native structures, ...*
 - *They have formal grammars, can be checked for the correct syntax*
- Domain semantics
 - *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 of Representations

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



Abbreviations

BPMN=Business Process Management Notation

BPEL=Business Process Execution Language

PIP=Partner Interface Process

UML=Unified Modeling Language

Legend

Architectural view

Example UML diagrams

Example implementation technologies

Development Level

Example Business Standards

Physical Operational Environment

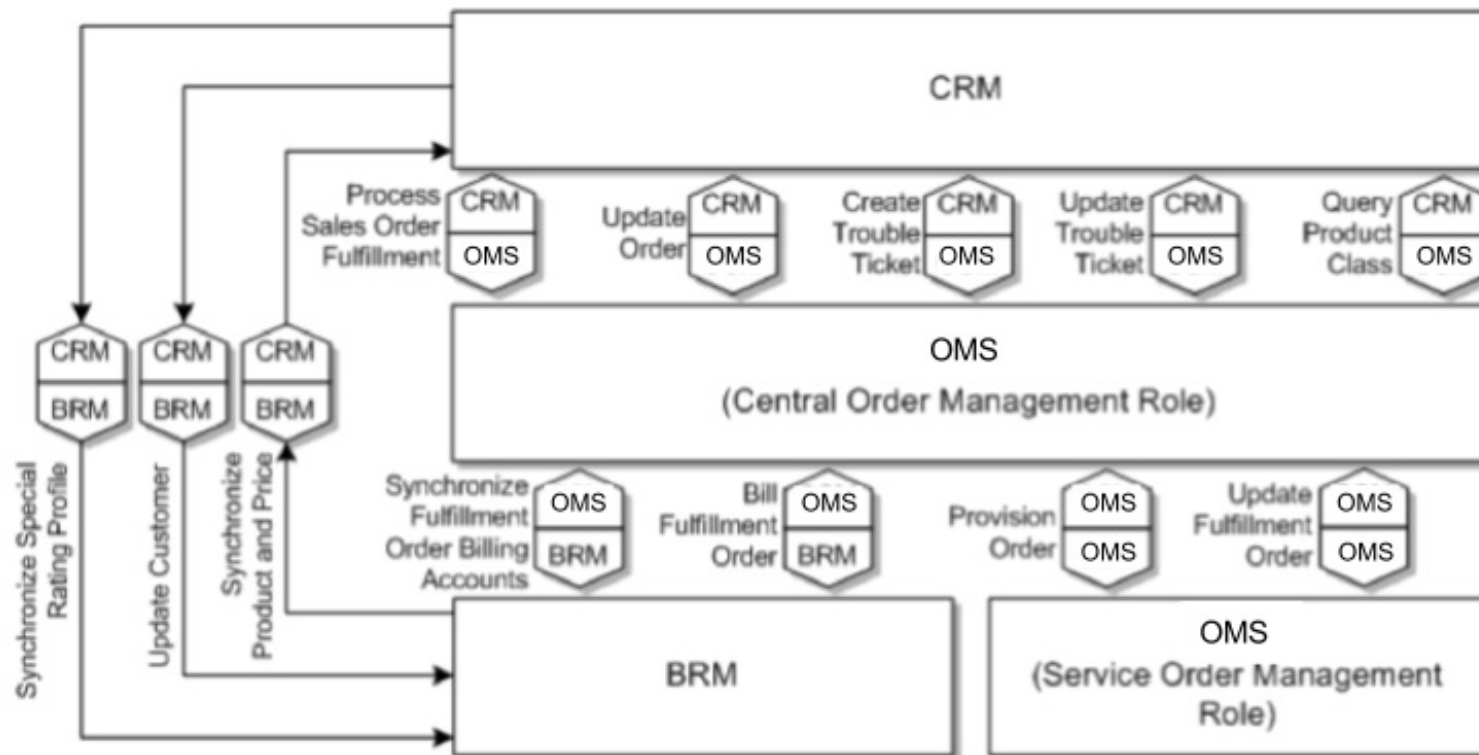
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Integrating Applications

- 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



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*

Overview

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

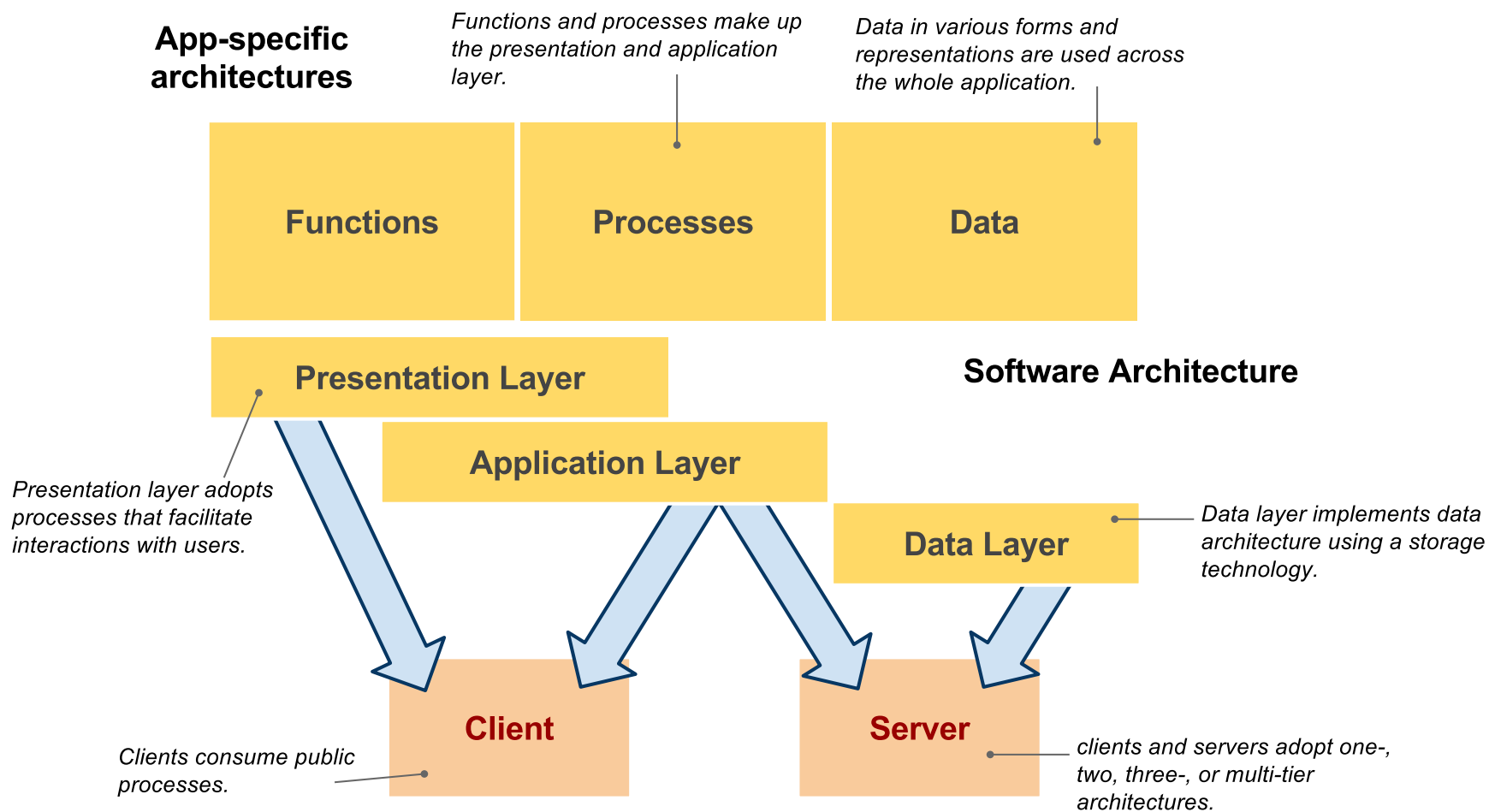
Software Architecture Types

- 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*

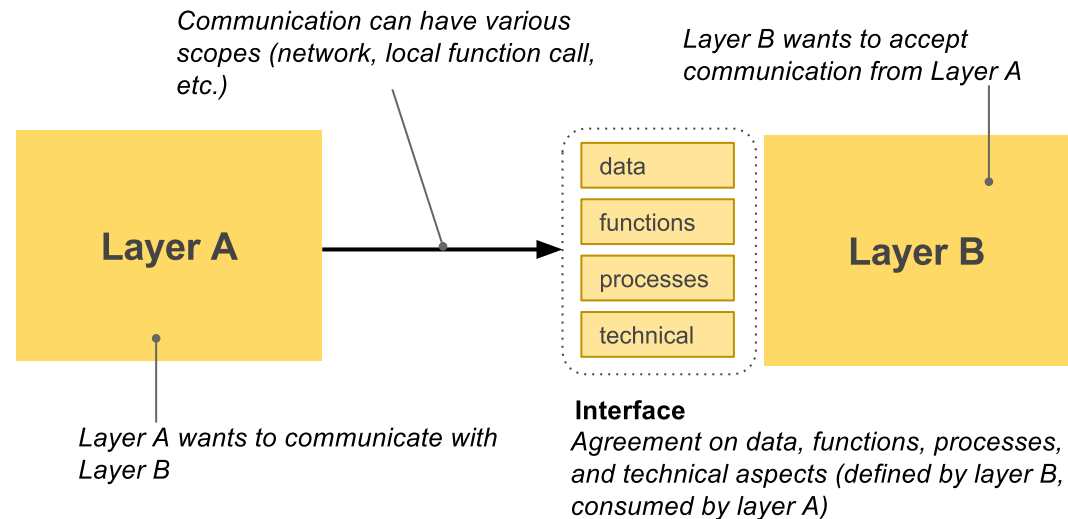
Software Architecture Layers



Interface

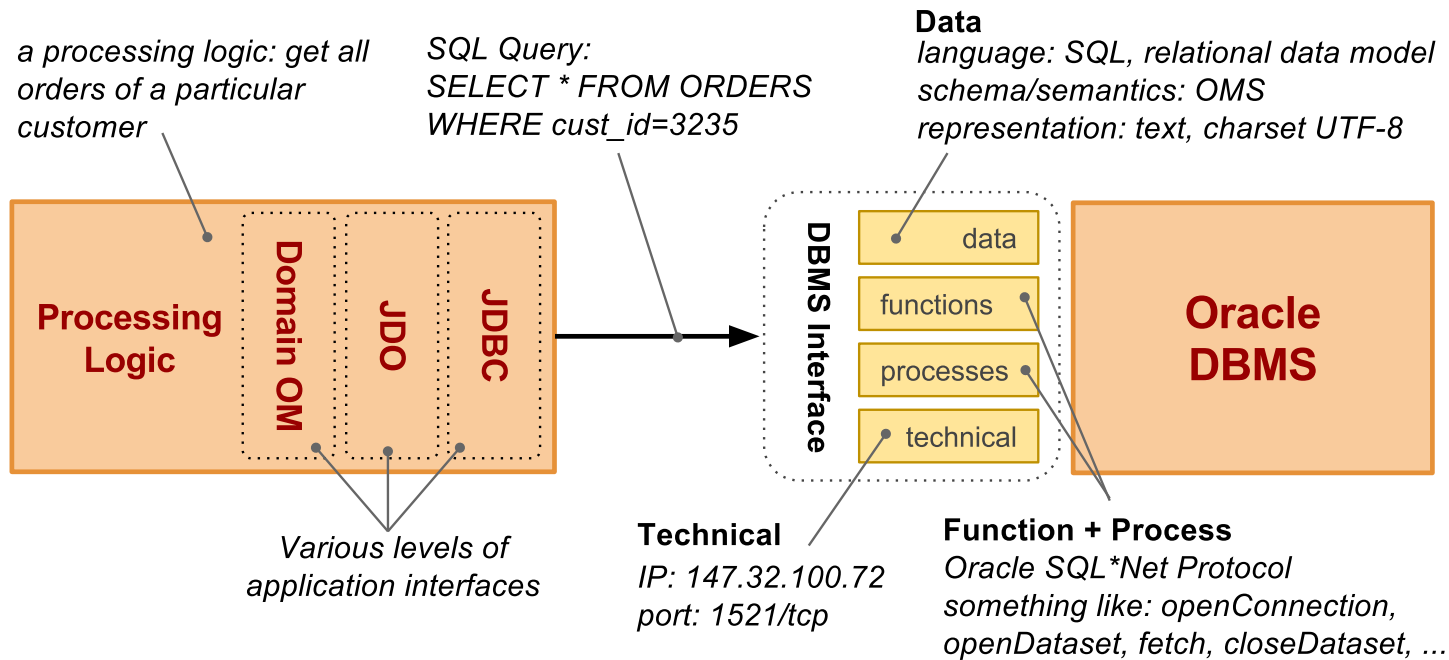
- Definition
 - *Agreement (contract) between two or more layers during communication*
- May be achieved by
 - *Through standards (accepted or enforced),*
 - *Through a social agreement during design*
 - *A dominant position of a technology on the market*
- Interface includes subsets of domain architectures
 - *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



- **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



- 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

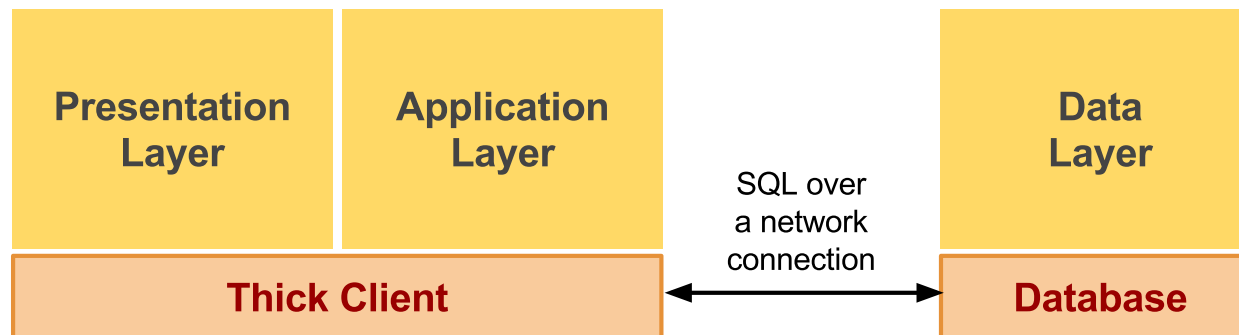
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Monolithic Architecture



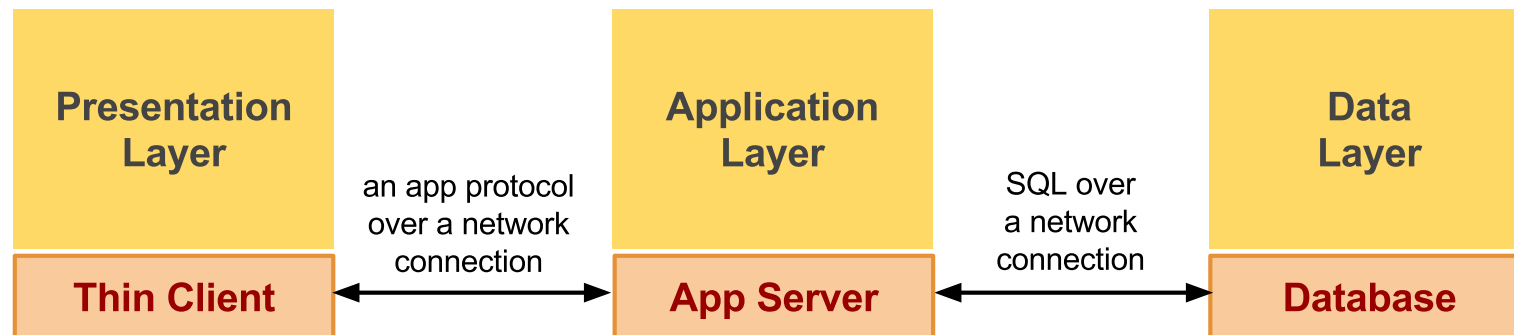
- All layers on a single machine
 - *usually non-portable apps; specific OS*
 - *first types of computer systems, typical for 90-ties*
 - *single-user only; standalone apps, minimal integration*
 - *technologies: third-gen programming languages, local storage systems*
- Drawbacks
 - *hard to maintain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

Two-tier Client/Server Architecture



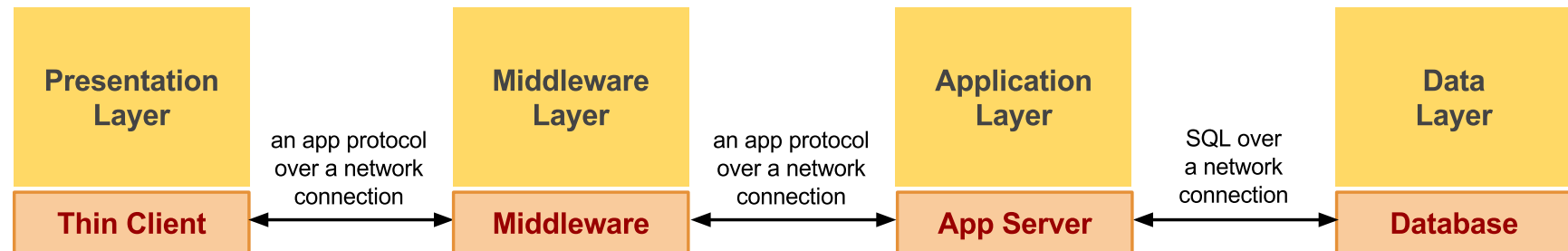
- Presentation and app layers separated with data
 - *Thick client – desktop application, OS-dependent*
 - *Data on a separate server (DBMS)*
 - *Multi-user system, all sharing a database*
 - *Storage system of high performance, transactions support*
 - *SQL technology; native OS desktop application*
- 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 (see [Lecture 0](#))*
 - *Limited, single app server scalability*

Multi-tier Client/Server Architecture



- 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, ...*