

# Middleware Architectures 1

## Lecture 1: Information System Architectures

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## Overview

- **Architecture Overview**
- 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



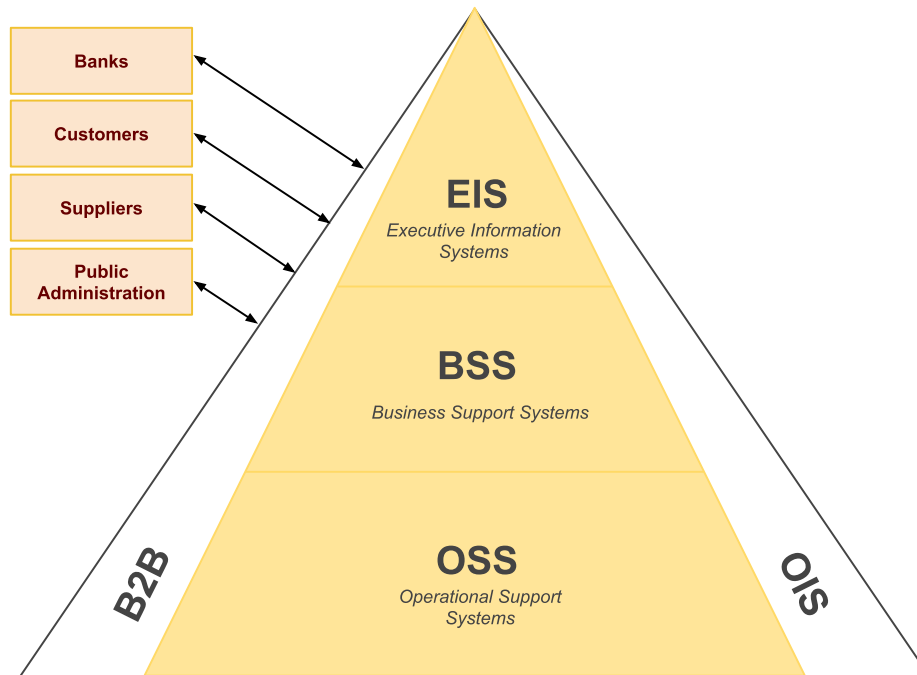
# Enterprise Architecture



## 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 in Enterprise Systems

- **Customer Organization**
  - **Primary need:** Business process automation and optimization
  - **Responsibilities:** Define business requirements, acceptance criteria, change management
  - **Key roles:** Enterprise architect, business analysts, end users, IT administrators
  - **Example:** Bank implementing new CRM system for customer management
- **Supplier Organization (System Integrator)**
  - **Primary need:** Deliver tailored solutions meeting customer requirements
  - **Responsibilities:** Solution design, customization, implementation, support
  - **Key roles:** Solution architects, technical architects, developers, project managers
  - **Example:** Accenture implementing SAP for manufacturing company
- **Vendor Organization (Technology Provider)**
  - **Primary need:** Develop market-driven products and platforms
  - **Responsibilities:** Product roadmap, R&D, platform maintenance, market analysis
  - **Key roles:** Product managers, platform architects, developers, DevOps engineers
  - **Example:** Microsoft developing Azure cloud services

# Architect Roles and Responsibilities

- **Enterprise Architect**
  - *Scope:* Organization-wide architecture strategy and governance
  - *Focus:* Business-IT alignment, application portfolio, data architecture
  - *Deliverables:* Enterprise architecture blueprints, technology roadmaps
  - *Standards:* TOGAF, industry-specific (eTOM for telecom)
- **Solution Architect**
  - *Scope:* End-to-end solution design for specific business problems
  - *Focus:* Requirements analysis, system integration, functional design
  - *Deliverables:* Solution design documents, integration patterns, data flows
  - *Skills:* Business analysis, system design, stakeholder management
- **Technical Architect**
  - *Scope:* Technology implementation and infrastructure design
  - *Focus:* Performance, scalability, security, technology selection
  - *Deliverables:* Technical specifications, deployment guides, performance benchmarks
  - *Skills:* Deep technical expertise, cloud platforms, DevOps practices

# Modern Technical Architect Roles

- **Cloud Architect**
  - *Cloud-native solutions, migration strategies, multi-cloud designs*
  - *AWS, Azure, GCP certifications and expertise*
- **Security Architect**
  - *Zero-trust architecture, compliance frameworks (GDPR, SOX)*
  - *Identity management, encryption, threat modeling*
- **Data Architect**
  - *Data lakes, data warehouses, real-time analytics*
  - *Data governance, privacy, master data management*
- **API Architect**
  - *API strategy, microservices design, API governance*
  - *REST, GraphQL, event-driven architectures*
- **DevOps Architect**
  - *CI/CD pipelines, infrastructure as code, monitoring*
  - *Kubernetes, containerization, observability platforms*

## Overview

- Architecture Overview
- 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.*

## Interface Example: REST API

- **Data** interface: JSON format
- **Function** interface: HTTP methods
  - *GET /customers/{id}* - retrieve customer
  - *POST /customers* - create customer
  - *PUT /customers/{id}* - update customer
- **Process** interface: state transitions
- **Technical** interface: HTTPS, port 443, authentication

## Overview

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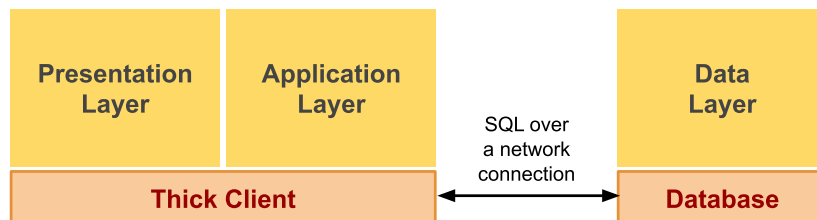


## Monolithic Architecture



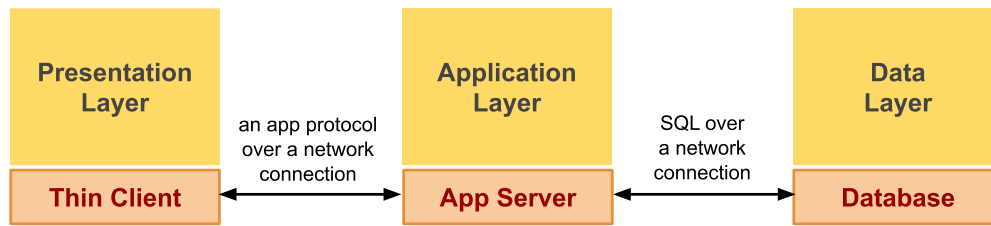
- All layers on a single machine
  - usually non-portable apps; specific OS
  - first types of computer systems, typical for 90-ties
  - single-user only; standalone apps, minimal integration
  - technologies: third-gen programming languages, local storage systems
- Drawbacks
  - hard to maintain (updates,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

## Two-tier Client/Server Architecture



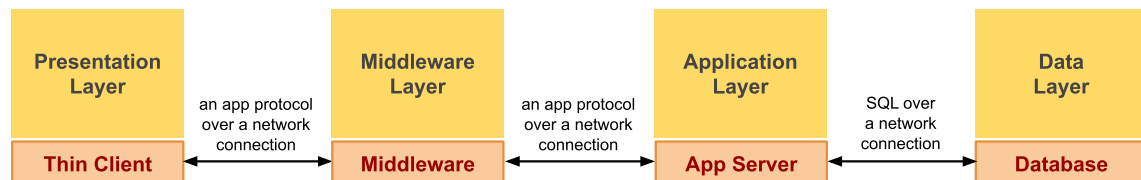
- Presentation and app layers separated with data
  - Thick client – desktop application, OS-dependent
  - Data on a separate server (DBMS)
  - Multi-user system, all sharing a database
  - Storage system of high performance, transactions support
  - SQL technology; native OS desktop application
- Drawbacks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

## Multi-tier Client/Server Architecture



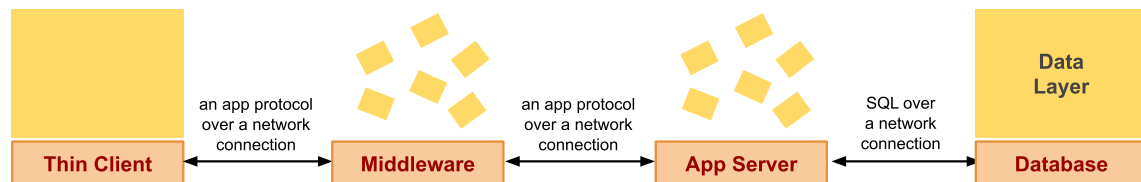
- Additional middleware layer
  - *provides value-added services for communications*
  - *individual servers or a compact solution (e.g., Enterprise Service Bus)*
- Drawbacks
  - *Monolithic apps are difficult to scale as a whole*
  - *Deployment overhead*
  - *A single technological environment for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