Middleware Architectures 1

Lecture 1: Information System Architectures

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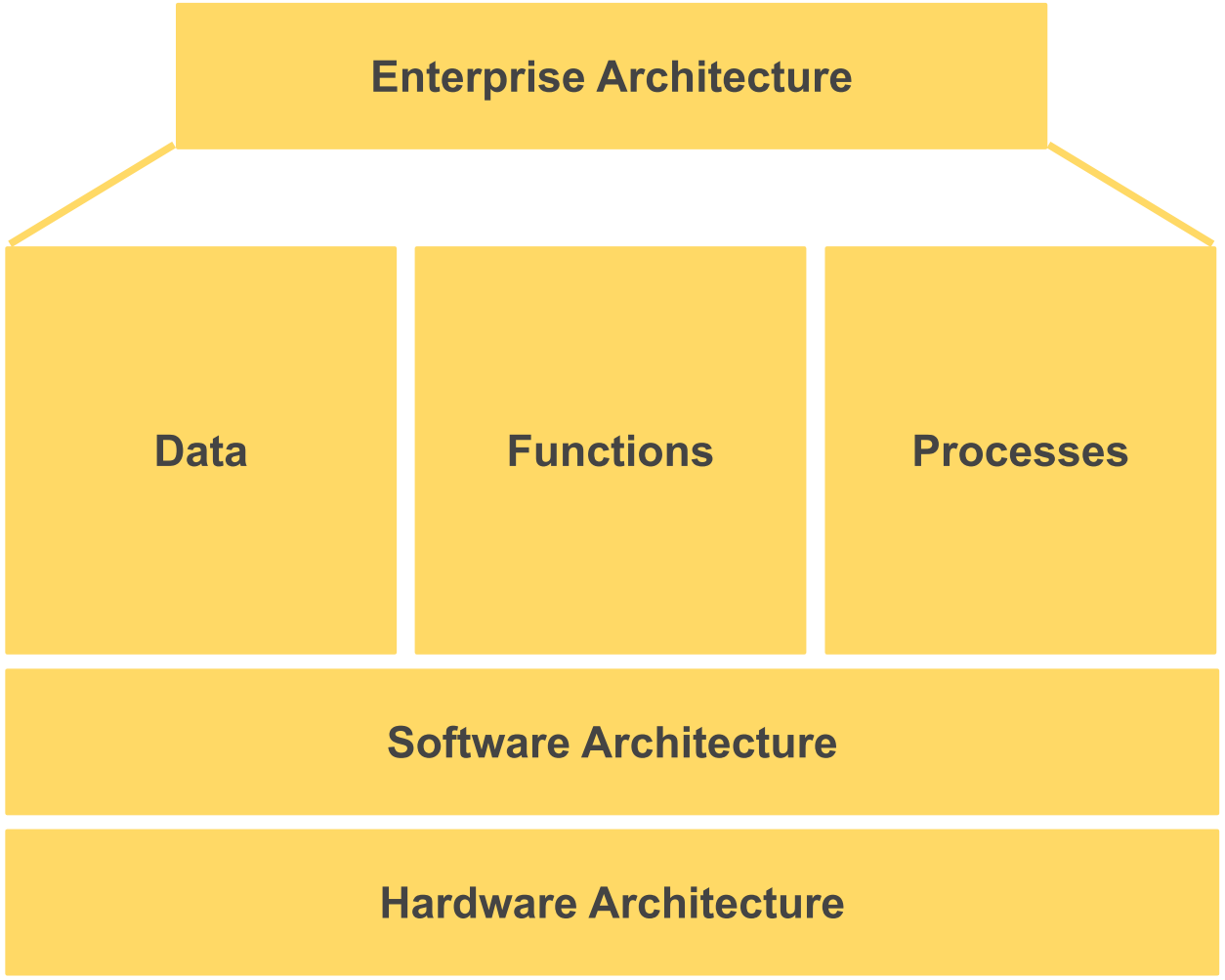
Overview

- Architecture Overview
- Software Architecture

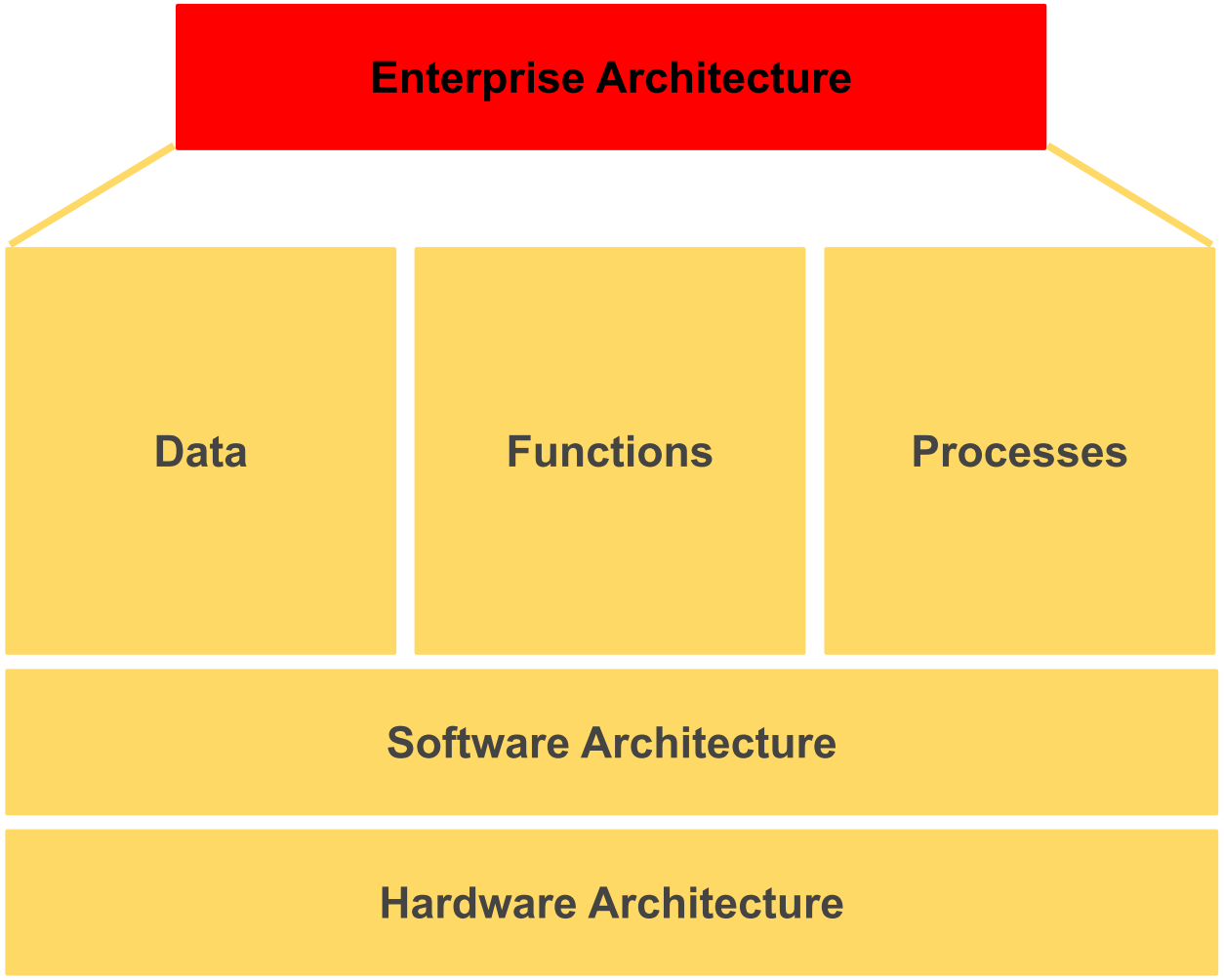
Global Architecture

- 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
Data
Functions
Processes
Software Architecture
Hardware Architecture

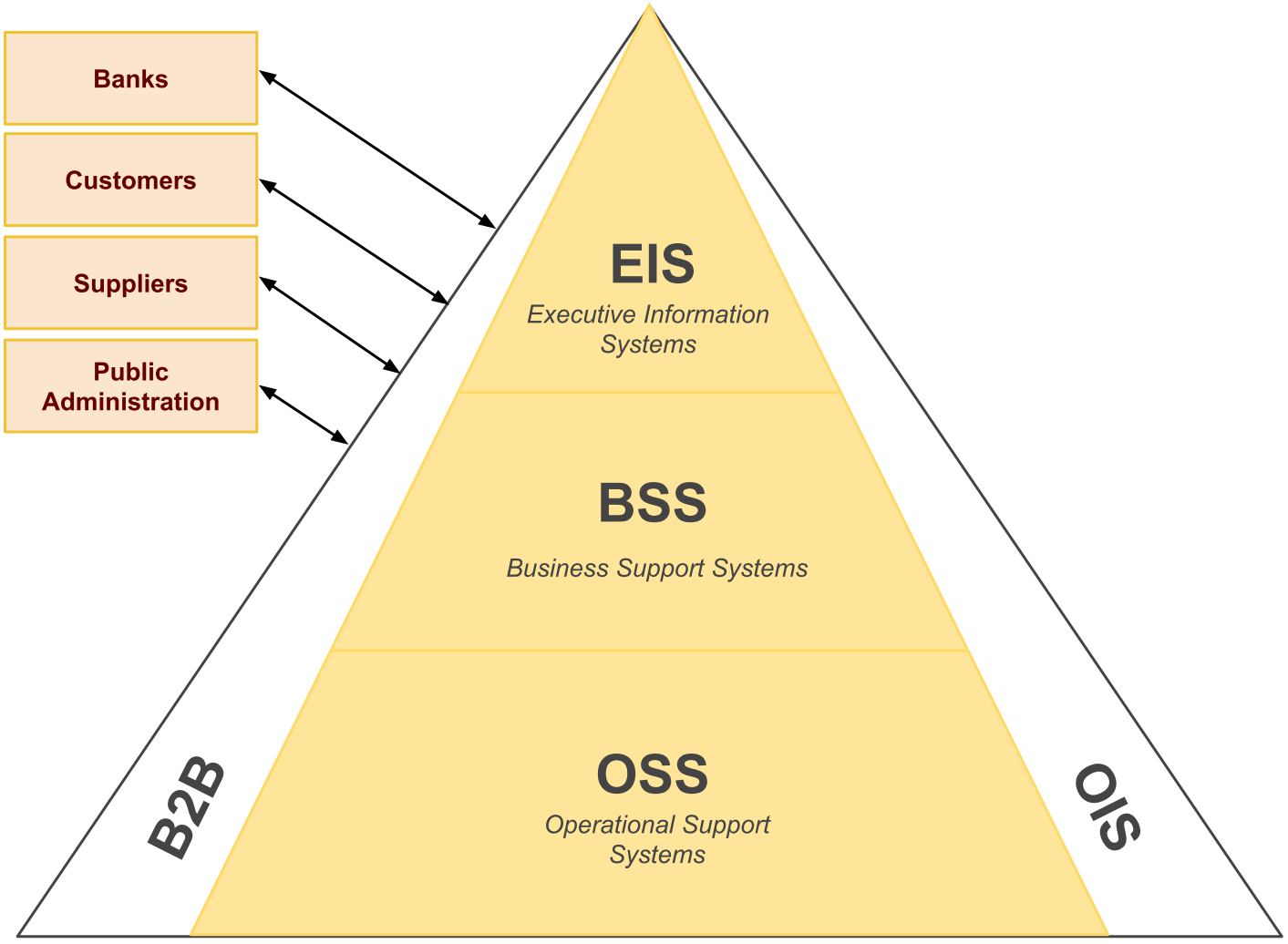
Enterprise Architecture



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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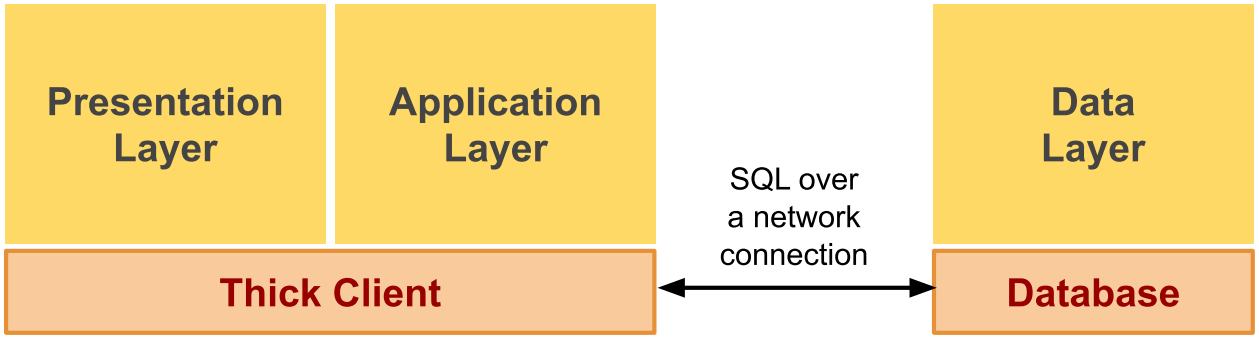
Monolithic Architecture

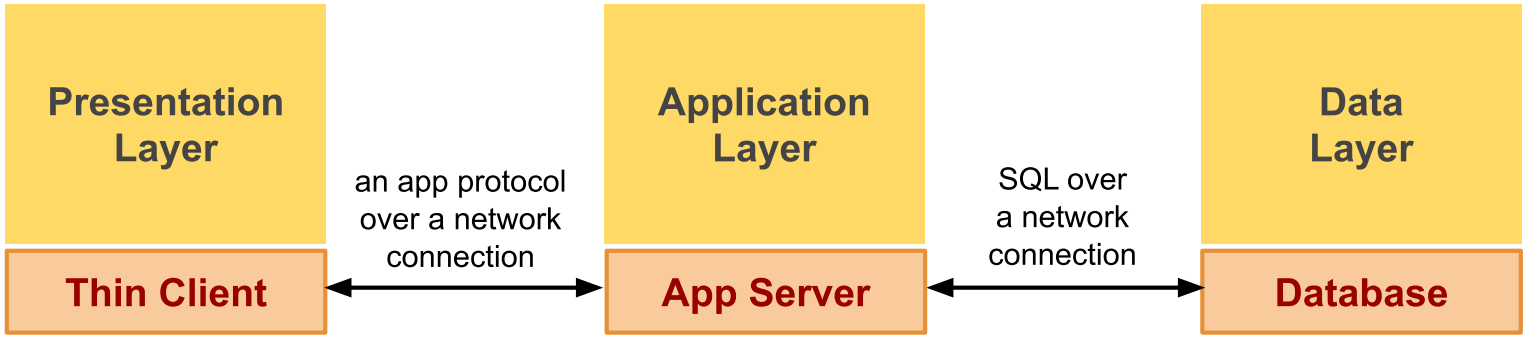
- All layers on a single machine
  - *usually non-portable apps; specific OS*
  - *first types of computer systems, typical for 90-ties*
  - *single-user only; standalone apps, minimal integration*
  - *technologies: third-gen programming languages, local storage systems*
- Drawbacks
  - *hard to maintain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

Two-tier Client/Server Architecture



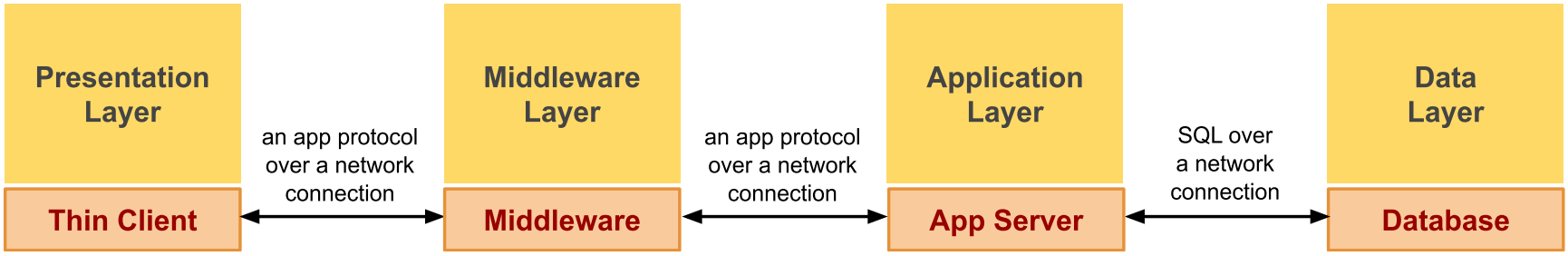
- Presentation and app layers separated with data
  - *Thick client – desktop application, OS-dependent*
  - *Data on a separate server (DBMS)*
  - *Multi-user system, all sharing a database*
  - *Storage system of high performance, transactions support*
  - *SQL technology; native OS desktop application*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

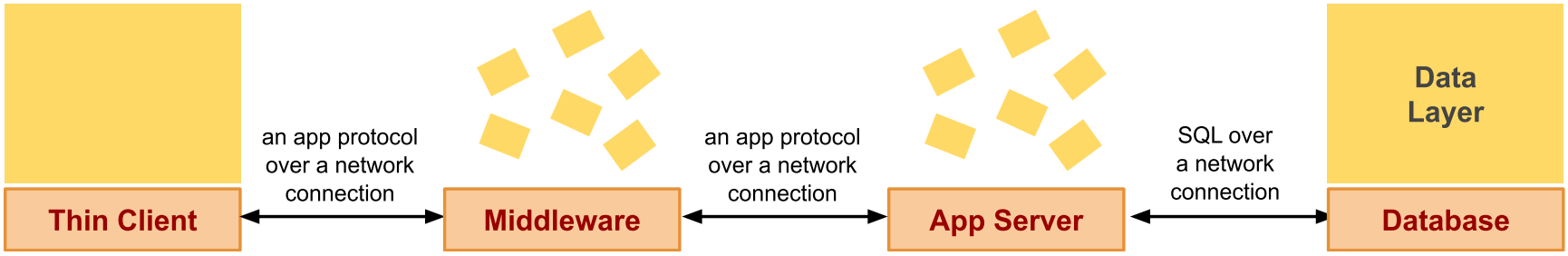


- Additional middleware layer
  - *provides value-added services for communications*
  - *individual servers or a compact solution (e.g., Enterprise Service Bus)*
- Drawbacks
  - *Monolithic apps are difficult to scale as a whole*
  - *Deployment overhead*
  - *A single technological environment for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