Middleware Architectures 1

Lecture 2: Service Architectures

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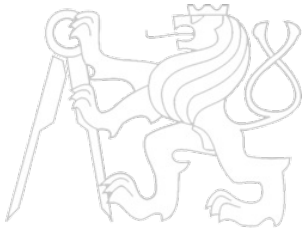

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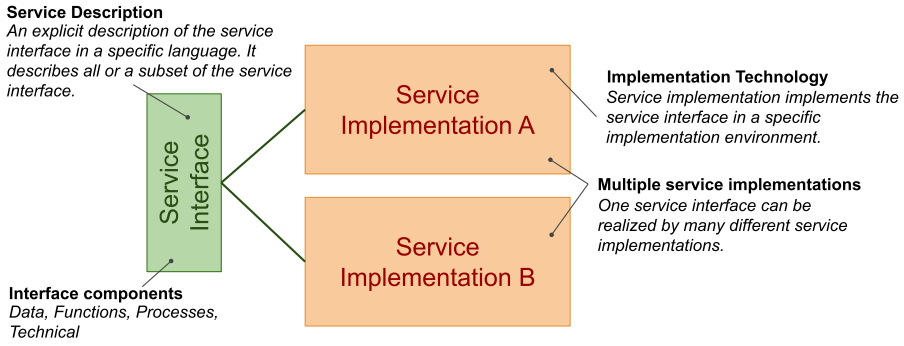
Overview

- Service Definition
- Integrating Applications
- Integration Patterns

Service Views

- Business view
  - *A service realizes an effect that brings a business value to a service consumer*
    → for example, to pay for and deliver a book
- Conceptual view
  - *encapsulation, reusability, loose coupling, contracting, abstraction, discoverability, composability*
- Logical view
  - *service interface, description and implementation*
  - *message-oriented and resource-oriented*
- Software architecture view
  - *business service (also application service)*
    → external, exposed functionality of an application
  - *middleware service*
    → internal/technical, supports processing of requests
- Technology architecture view
  - *REST/RESTful, GraphQL*
  - *XML-RPC/SOAP, RMI, gRPC*
  - *WebSocket, WebRTC, SSE*

Interface, Description and Implementation



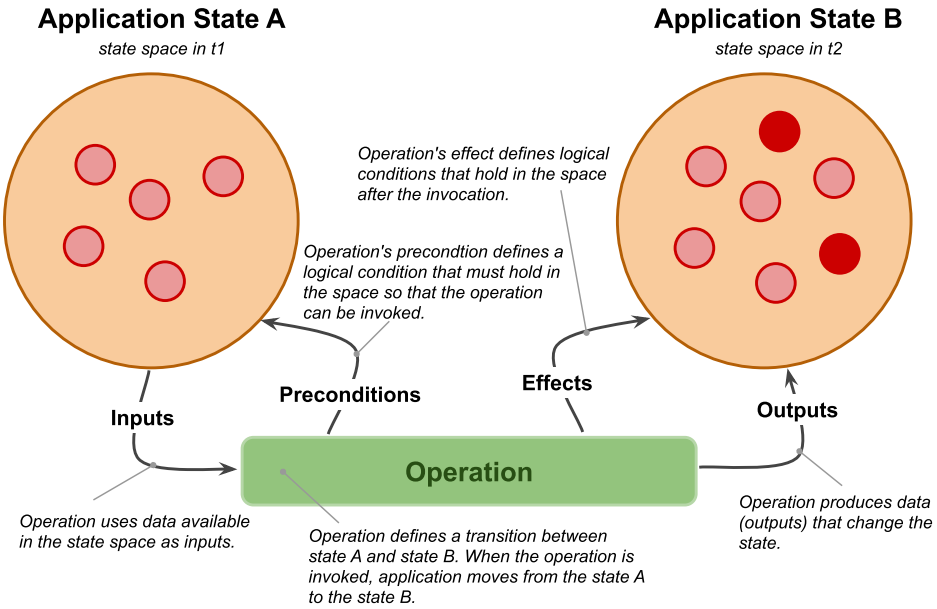
- Terminology clarification
  - *service ~ service interface + service implementation*
  - *WSDL service ~ service description in WSDL language*
  - *SOAP service ~ a service interface is possible to access through SOAP protocol; there is a WSDL description usually available too.*
  - *REST/RESTful service ~ service interface that conforms to REST architectural style and HTTP protocol*
  - *Microservice ~ a set of services that realize an app's capability*

Service Interface

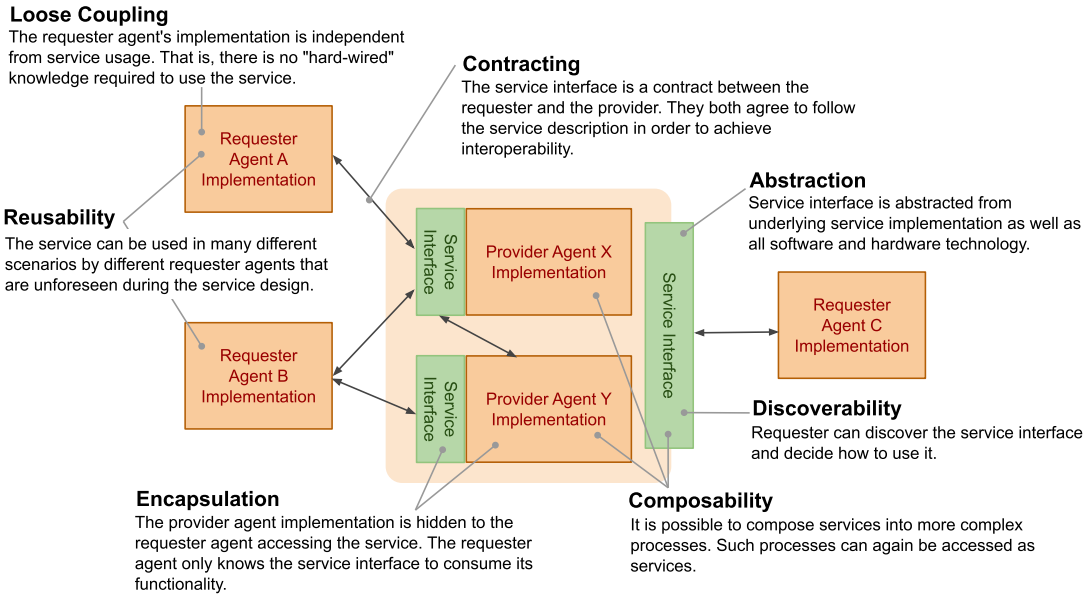
- Service interface components
  - *Data*
    - → *Data model definition used by the service*
    - → *for example, input and output messages, representation of resources*
  - *Functions*
    - → *operations and input and output data used by operations*
  - *Process*
    - → *public process: how to consume the service's functionality*
  - *Technical*
    - → *security, usage aspects (SLA-Service Level Agreement)*
    - → *other technical details such as IP addresses, ports, protocols, etc.*

Public Process

- A state diagram
  - *operation of a service defines a **state transition** between two states.*



Service Characteristics



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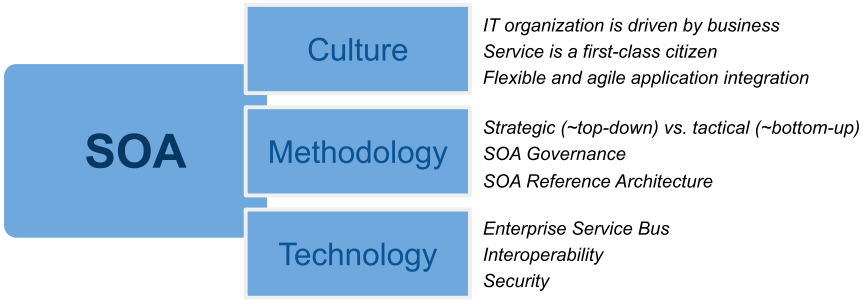
Integration and Interoperability

- Integration
  - *A process of connecting applications so that they can exchange and share capabilities, that is — information and functionalities.*
  - *Includes methodological approaches as well as technologies*
- Interoperability
  - *Ability of two or more applications to understand each other*
  - *Interoperability levels*
    - → *Data – syntax/structure and semantics*
    - → *Functions/Processes – syntax and semantics*
    - → *Technical aspects – protocols, network addresses, etc.*

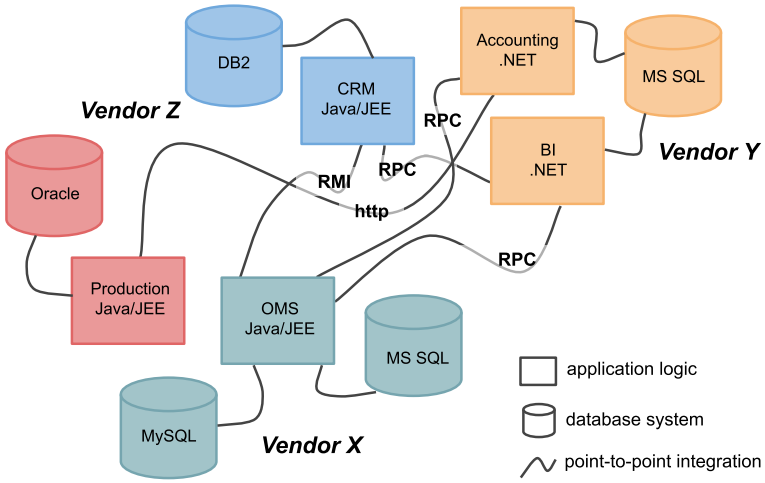
Service Oriented Architecture



- SOA supports two core business strategies
  - *Growing top-line revenue*
    - → *Enterprise reacts quickly to requirements from the market*
    - → *Business processes can be reconfigured rather than reimplemented*
  - *Improving bottom-line profit*
    - → *Saving development costs by resuing existing services*
- Pre-integrated solutions
  - *Out-of-the-box applications and integration solutions among them*

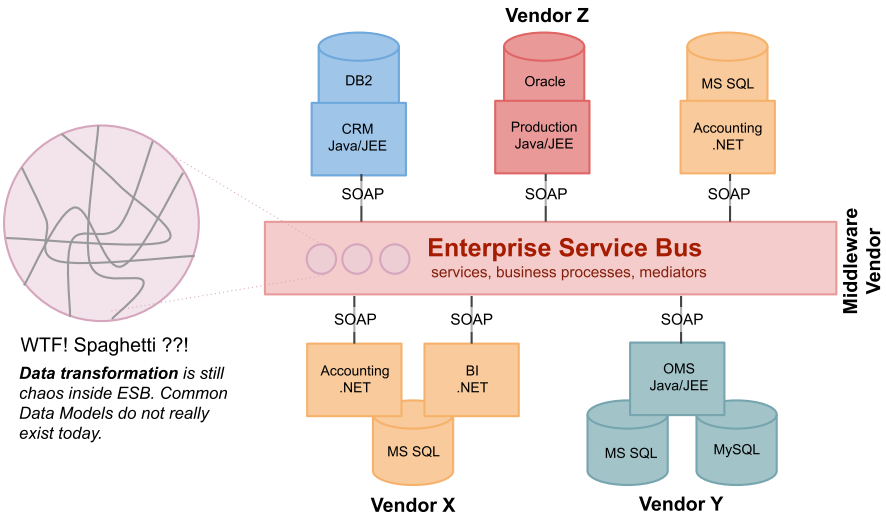
One-to-One Service Integration

- Direct integration of applications
  - *Multiple protocols problem, multiple vendor problem*
  - *Replication of integration functionalities such as interoperability solutions*



Many-to-Many Service Integration

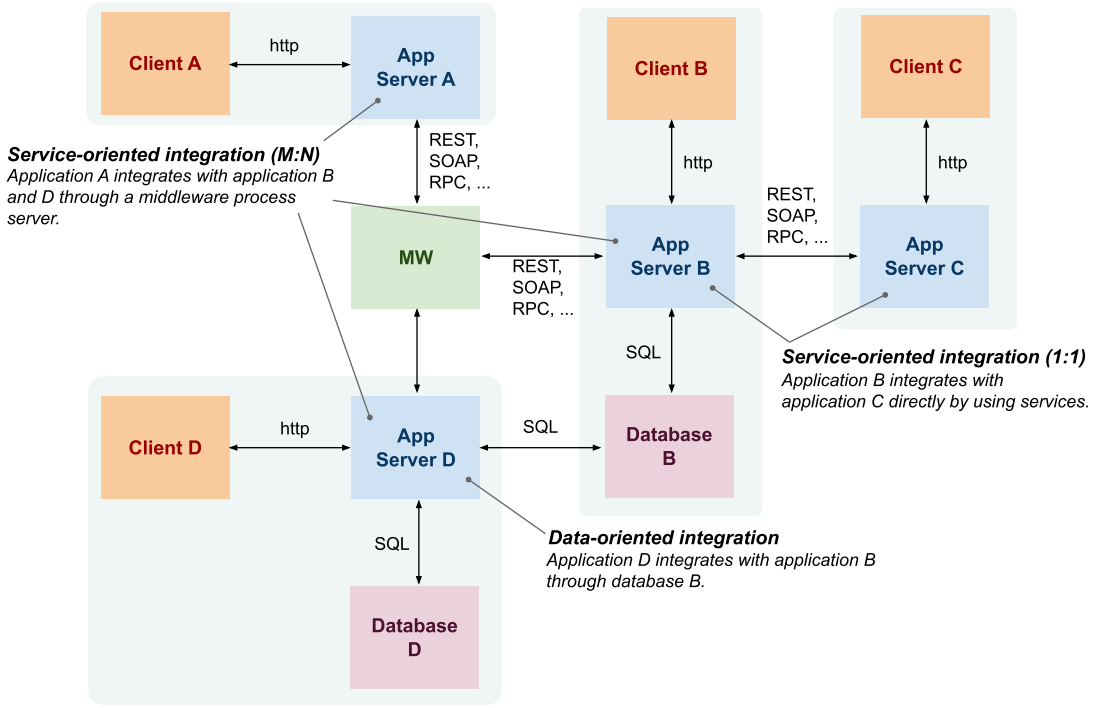
- Enterprise Service Bus – central integration technology
  - *Realizes so called Service Oriented Architecture (SOA)*
  - *Contains various integration components such as process server, mediators, messaging middleware, identity management, etc.*



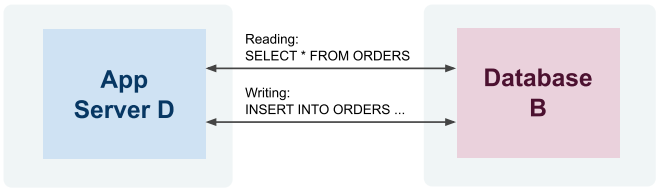
WTF! Spaghetti ??!

***Data transformation** is still chaos inside ESB. Common Data Models do not really exist today.*

Integration Approaches Overview

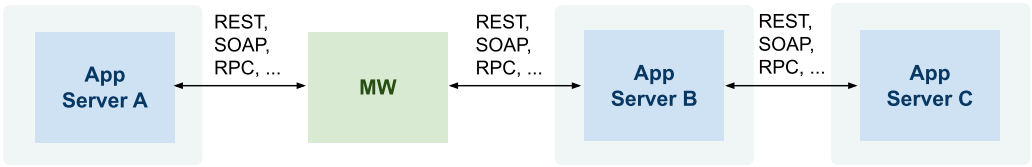


Data-oriented Integration



- Third-party database access
  - *Application D accesses a database of application B directly by using SQL and a knowledge of database B structure and constraints*
  - *In the past: monolithic and two-tier client/server architectures*
  - *Today: ETL (Extract, Transform, Load) technologies*
- Problems
  - *App D must understand complex structures and constraints*
    - *→ Data – very complex, includes structure and integrity constraints*
    - *→ Functions/processes – hidden in integrity constraints*
    - *→ Technical – access mechanisms can vary*

Service-oriented Integration



- Integration at the application layer
  - *Application exposes services that other applications consume*
  - *Services hide implementation details but only define interfaces for integration*
- Problems
  - *Can become unmanageable if not properly designed*
  - *Interoperability*
    - → *Data – limited to input and output messages only*
    - → *Functions/processes – limited to semantics of services*
    - → *Technical – access mechanisms can vary*

Integration and Types of Data

- Real-time data – Web services
  - *Service-oriented integration*
  - *online, realtime communication between a client and a service*
  - *Usually small data and small amount of service invocation in a process*
- Bulk data – ETL
  - *Data-oriented integration*
  - *processing of large amount of data in batches*
  - *Sometimes required for reconciliation across apps*
    - → *when real-time integration fails and there is poor error handling*
- **SOA provides both Web service and ETL capabilities**

Enterprise Service Bus

- ESB is a central intermediary in SOA
  - *Types of services: shared and infrastructure*
  - *Types of processes: Technical and Business*
- ESB Application
  - *Application running on an application server*
  - *Exposes functionality via Web service interface*
  - *Allows to communicate with various messaging protocols*
- Middlware Integration Patterns
  - *Technical-level interoperability – message broker*
  - *Location transparency*
  - *Dynamic routing*
  - *Session pooling*
  - *Message enrichment*
  - *Data transformation*
  - *Key mapping*

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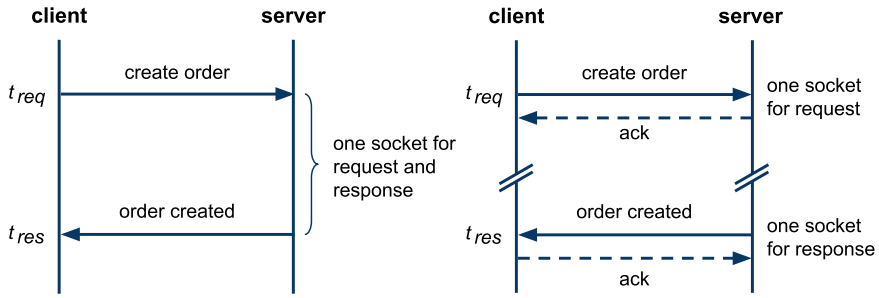
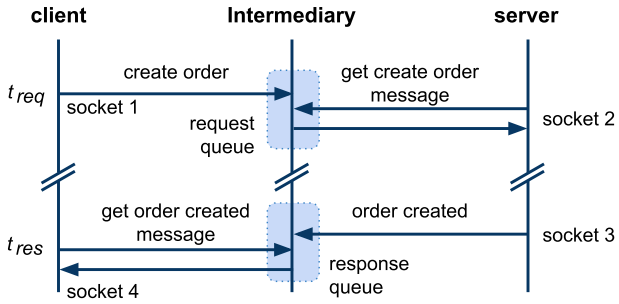
  - *Synchronous and Asynchronous Integration*
  - *Microservices Architecture*

Synchronous and Asynchronous Integration



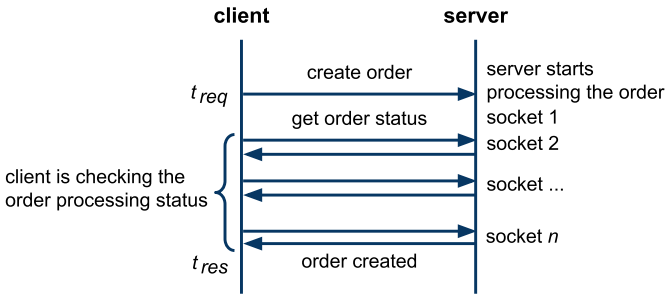
- Synchronous
  - *one socket, $|t_{req} - t_{res}|$ is small*
  - *easy to implement and deploy, only standard firewall config*
  - *only the server defines endpoint*
- Asynchronous
  - *request, response each has socket, client and server define endpoints*
  - *$|t_{req} - t_{res}|$ can be large (hours, even days)*
  - *harder to do across network elements (private/public networks issue)*

Asynchronous via Intermediary



- Intermediary
  - *A component that decouples a client-server communication*
  - *It increases reliability and performance*
    - *→ The server may not be available when a client sends a request*
    - *→ There can be multiple servers that can handle the request*
- Further Concepts
  - *Message Queues (MQ) – queue-based communication*
  - *Publish/Subscribe (P/S) – event-driven communication*

Asynchronous via Polling



- Polling – only clients open sockets
  - *A client performs multiple request-response interactions*
    - → *The first interaction initiates a process on the server*
    - → *Subsequent interactions check for the processing status*
    - → *The last interaction retrieves the processing result*
- Properties of environments
  - *A server cannot open a socket with the client (network restrictions)*
  - *Typically on the Web (a client runs in a browser)*

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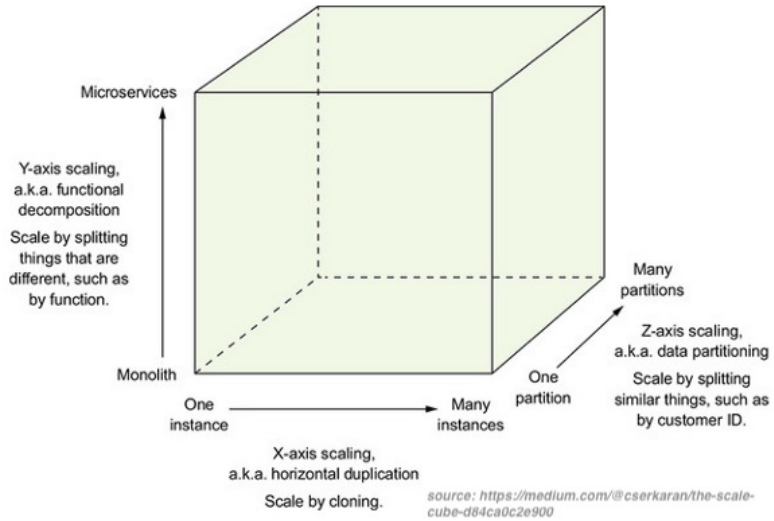
  - *Microservices Architecture*

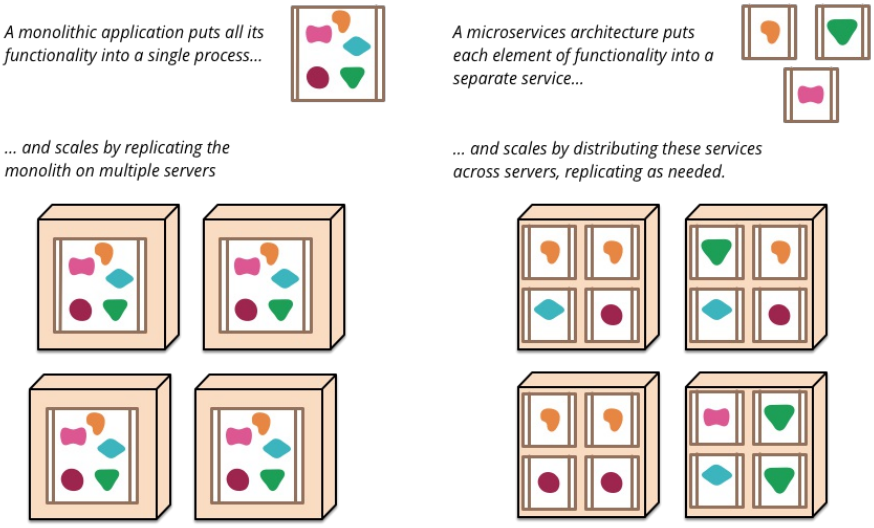
The Scale Cube

- Three-dimensional scalability model
  - *X-Axis scaling requests across multiple instances*
  - ***Y-Axis scaling decomposes an application into micro-services***
  - *Z-Axis scaling requests across "data partitioned" instances*



Overview

- Emerging software architecture
  - *monolithic vs. decoupled applications*
  - *applications as independenly deployable services*



Major Characteristics

- Loosely coupled
  – *Integrated using well-defined interfaces*
- Technology-agnostic protocols
  – *HTTP, they use REST architecture*
- Independently deployable and easy to replace
  – *A change in small part requires to redeploy only that part*
- Organized around capabilities
  – *such as accounting, billing, recommendation, etc.*
- Impplemented using different technologies
  – *polyglot – programming languages, databases*
- Owned by a small team