Middleware Architectures 1

Lecture 2: Service Oriented Architecture

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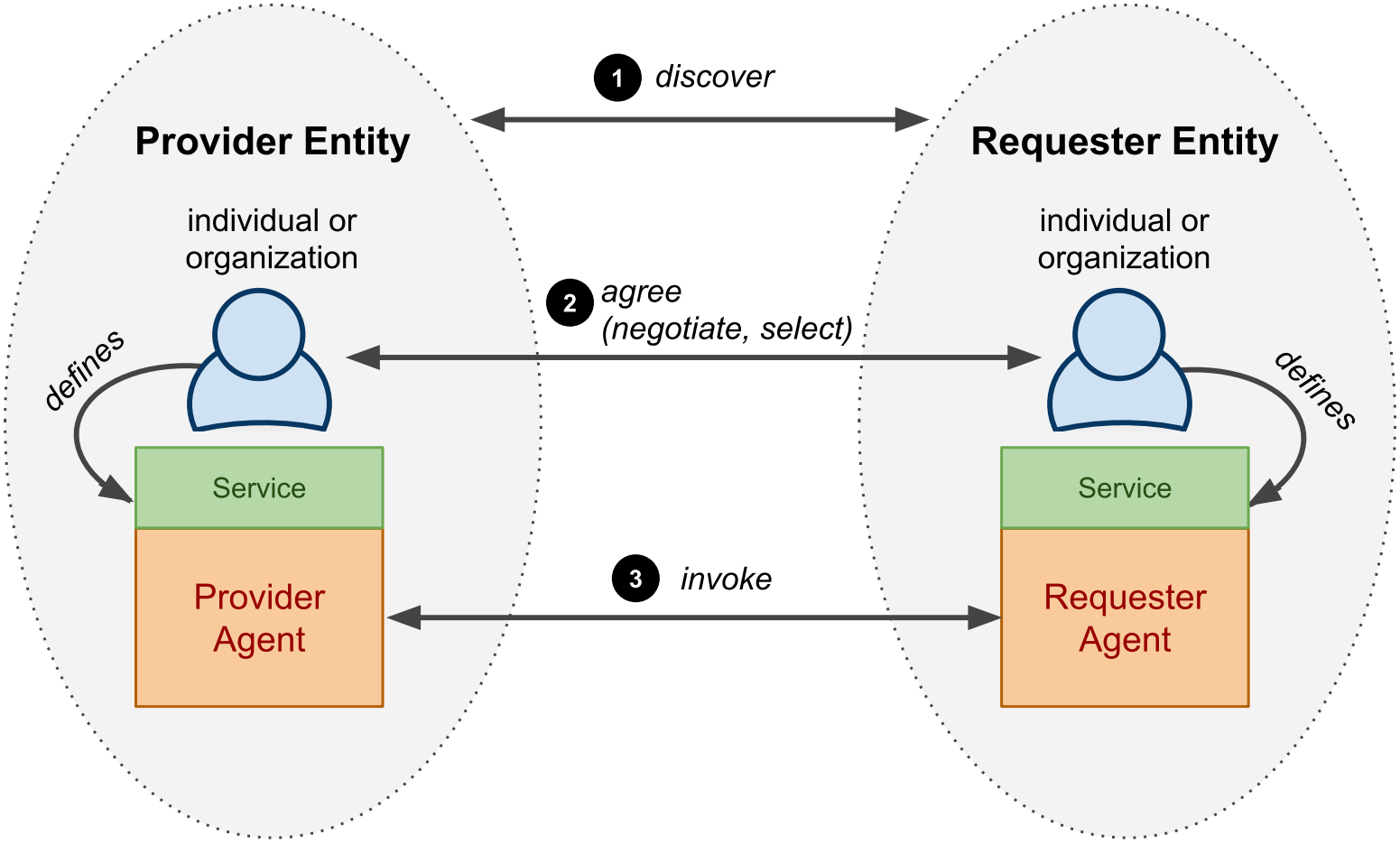
Overview

- Service Definition
- Integrating Applications
- Enterprise Service Bus
- Microservices Architecture

Basic Entities

- Agent
  - *software or hardware that sends/receives messages*
  - *concrete implementation of a service*
- Service interface
  - *abstract set of functionality and behavior*
  - *two different agents may realize the same service*
- Provider
  - *owner (person or organization) that provides an agent realizing a service*
  - *also called a service provider*
- Requester
  - *a person or organization that wishes to make use of a provider's service*
  - *uses a requester's agent to exchange messages with provider's agent*

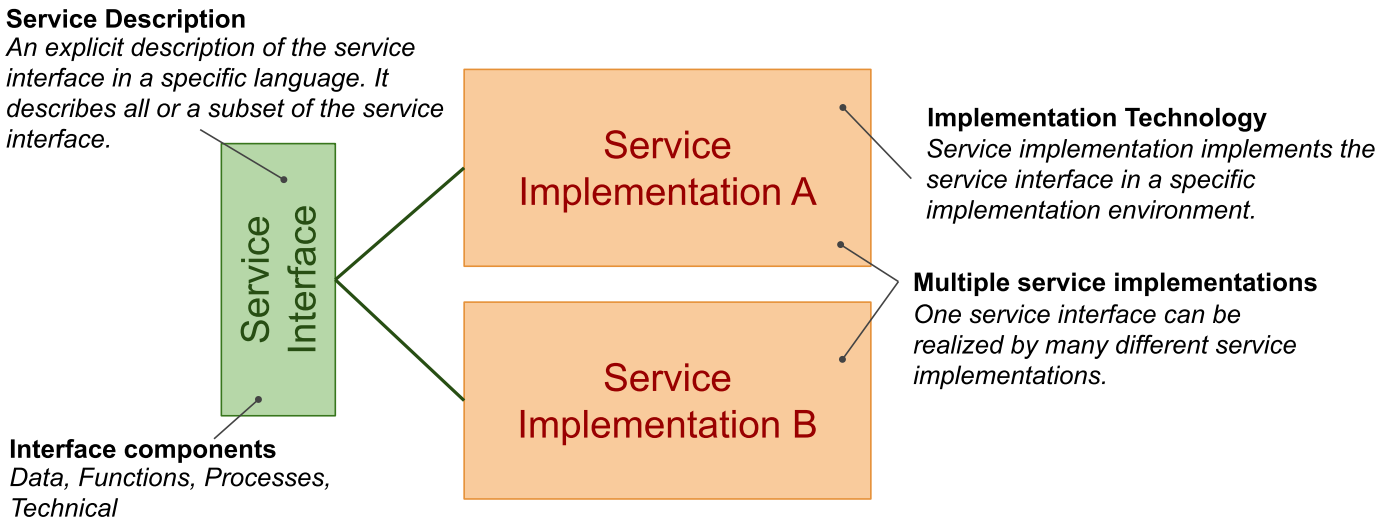
Interaction of Entities



Service

- Difficult to agree on one definition
- Business definition
  - *A service realizes an effect that brings a business value to a service consumer*
    → *for example, to pay for and deliver a book*
- Conceptual definition
  - *service characteristics*
    → *encapsulation, reusability, loose coupling, contracting, abstraction, discoverability, composability*
- Logical definition
  - *service interface, description and implementation*
  - *message-oriented and resource-oriented*
- Architectural definition
  - *business service (also application service)*
    → *external, exposed functionality of an application*
  - *infrastructure service*
    → *internal/technical, supports processing of requests*

Interface, Description and Implementation



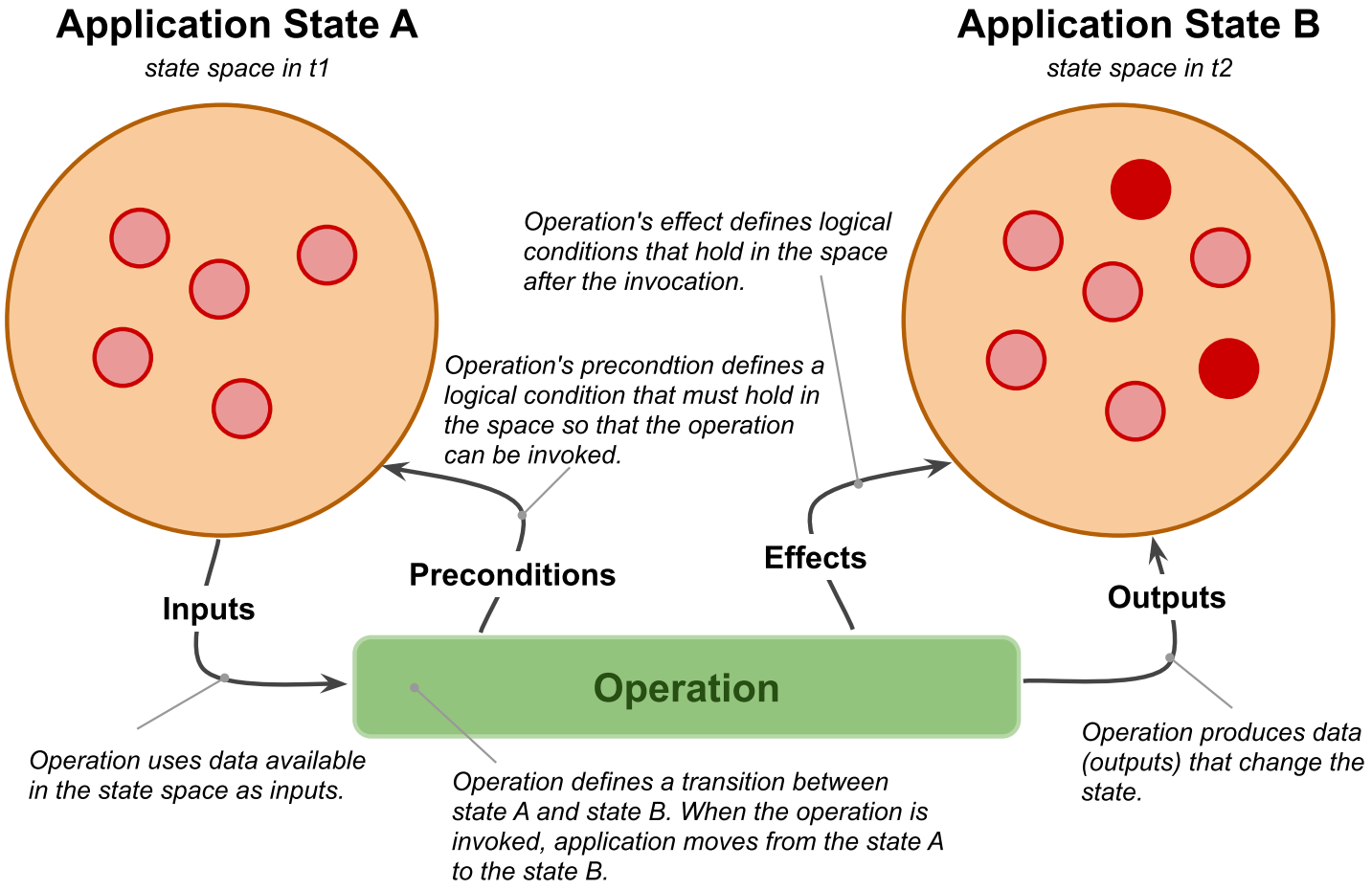
- Terminology clarification
  - *service ~ service interface + service implementation*
  - *WSDL service ~ service description in WSDL language*
  - *SOAP service ~ a service interface is possible to access through SOAP protocol; there is a WSDL description usually available too.*
  - *REST/RESTful service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

Service Interface

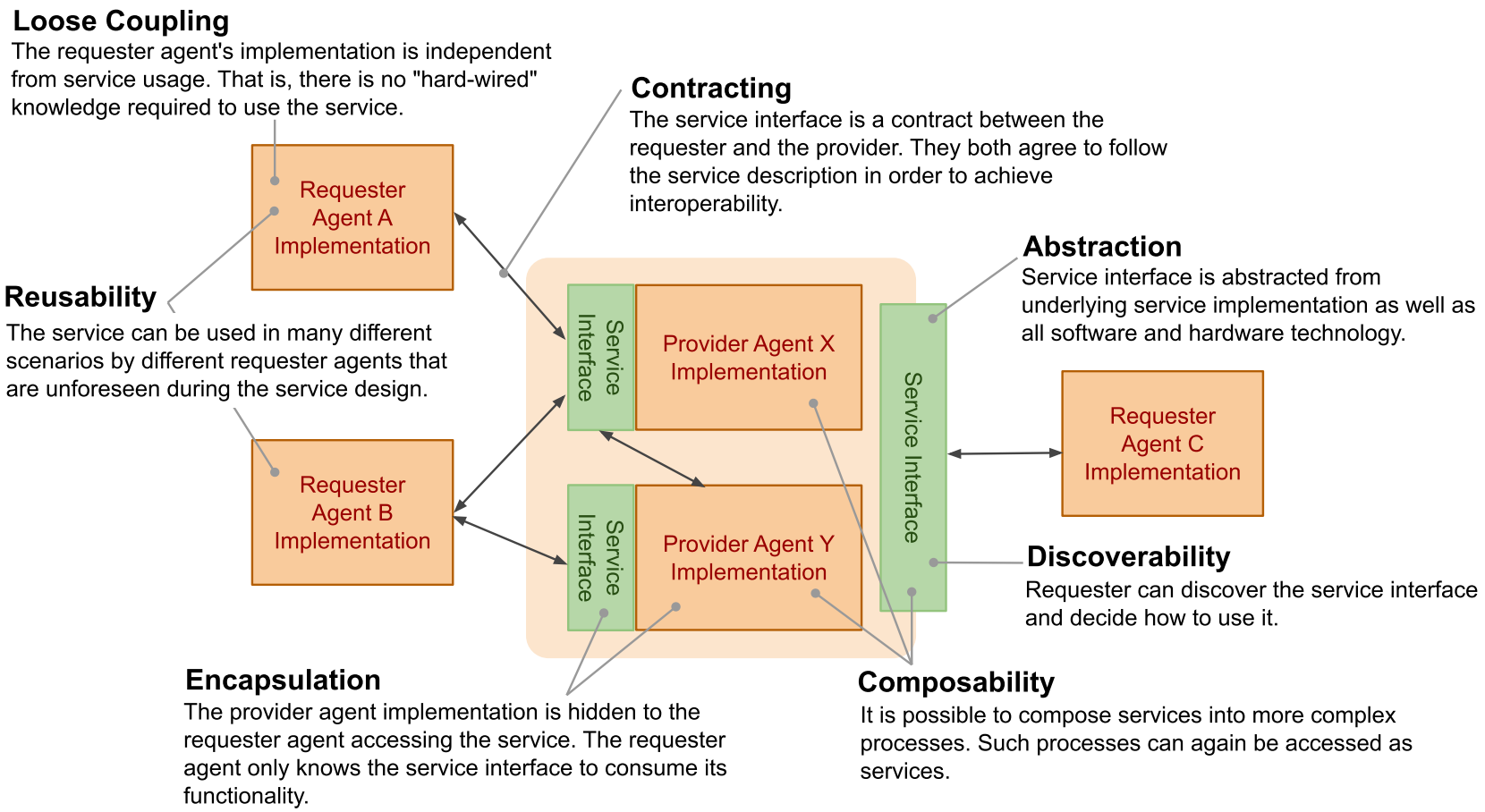
- Service interface components
  - *Data*
    - → *Data model definition used by the service*
    - → *for example, input and output messages, representation of resources*
  - *Functions*
    - → *operations and input and output data used by operations*
  - *Process*
    - → *public process: how to consume 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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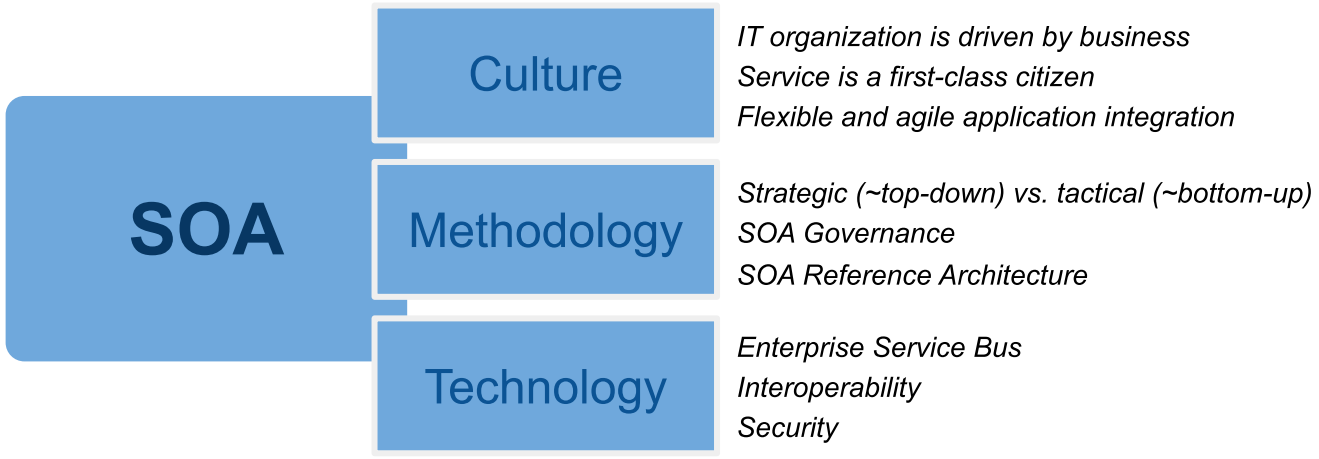
Integration and Interoperability

- 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.*

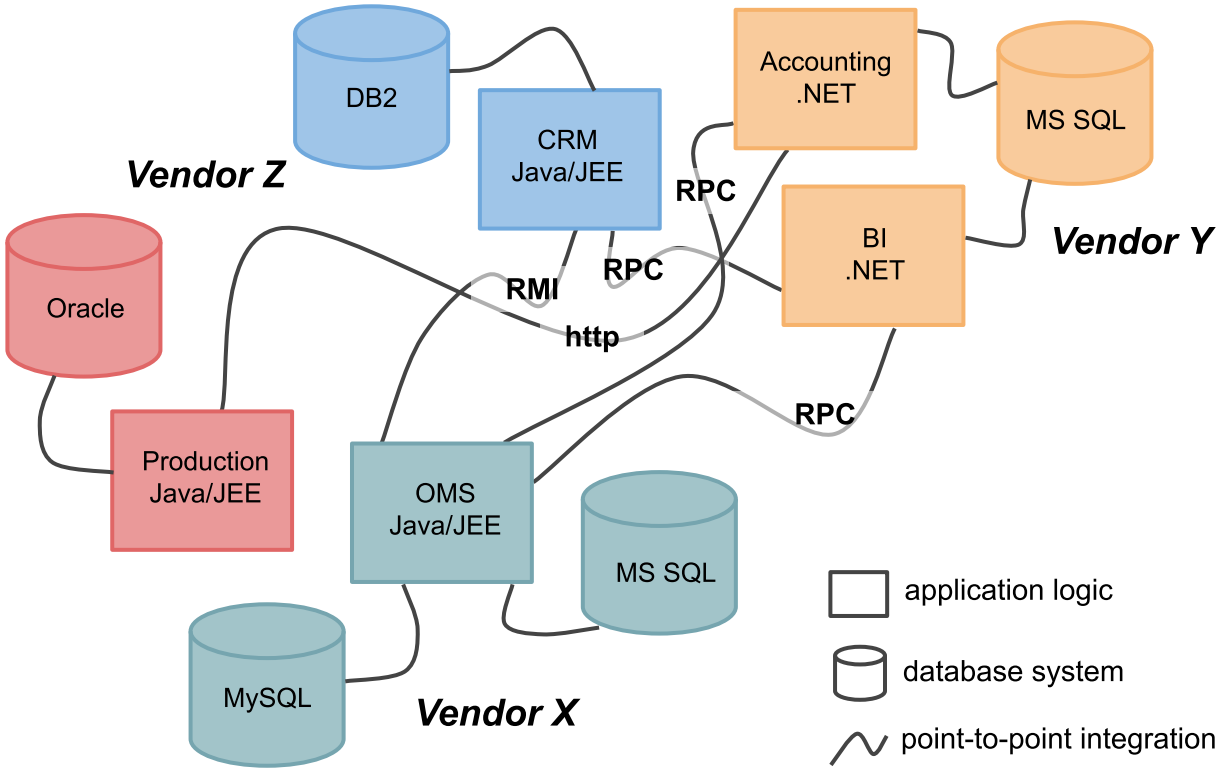
Service Oriented Architecture



- 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*

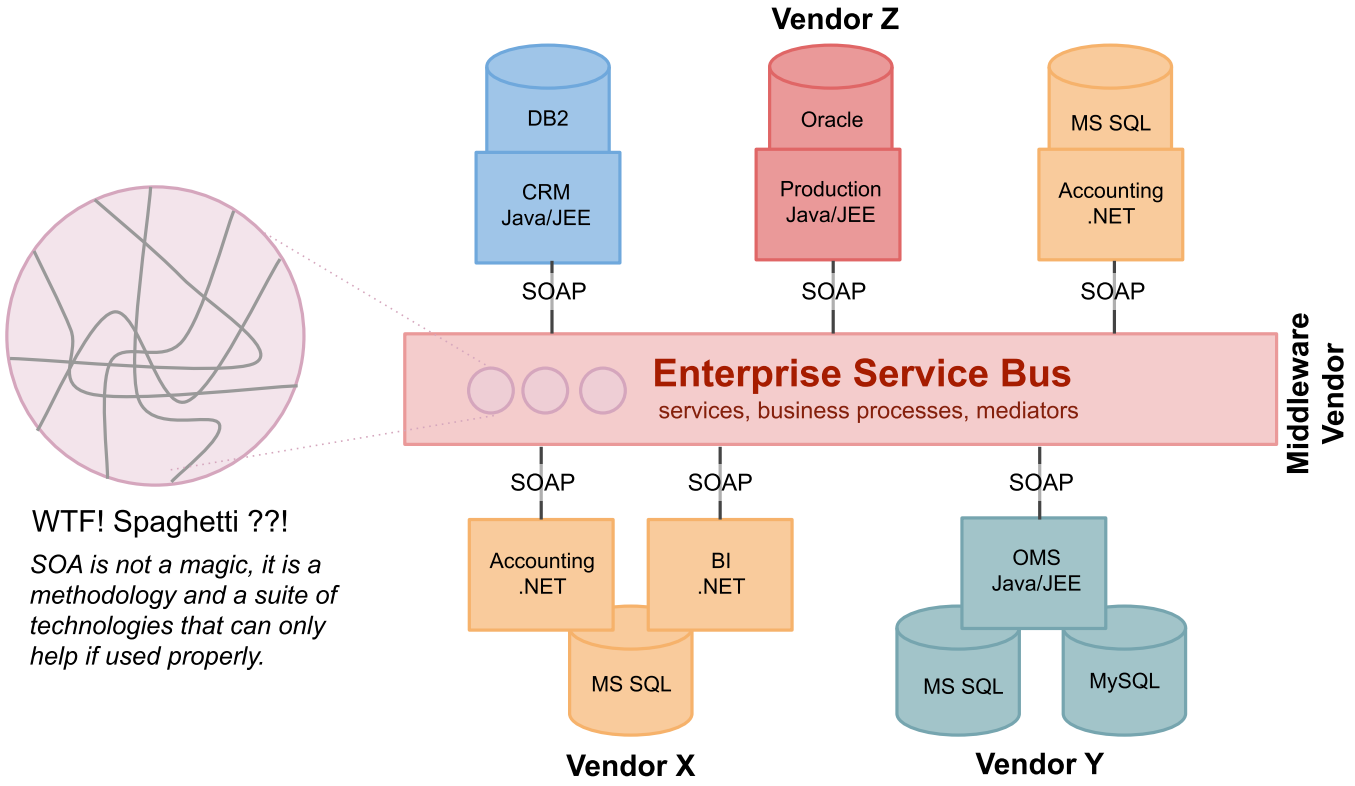
One-to-One Service Integration

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



Many-to-Many Service Integration

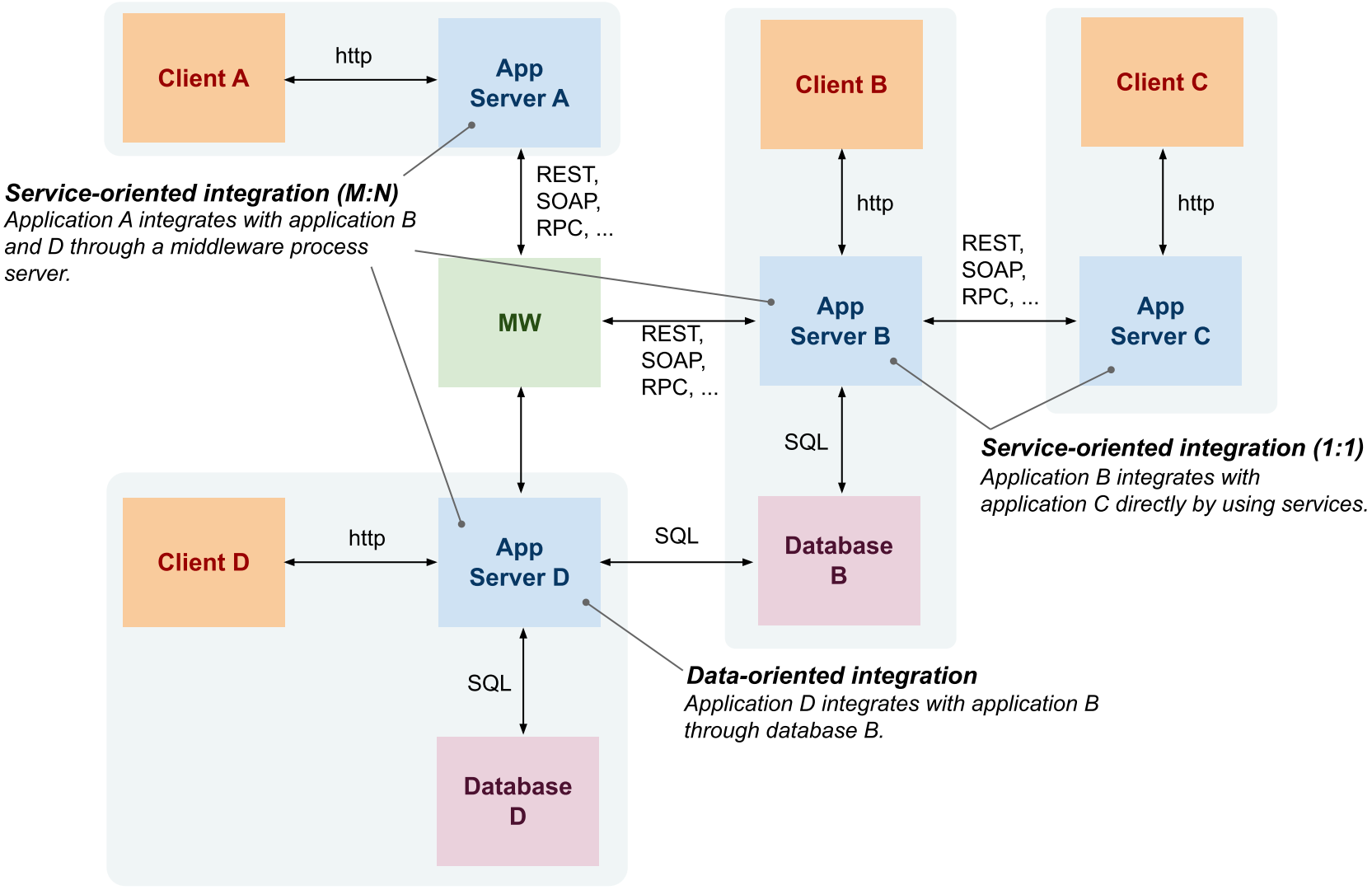
- Enterprise Service Bus – central integration technology
  - *Realizes so called Service Oriented Architecture (SOA)*
  - *Contains various integration components such as process server, mediators, messaging middleware, identity management, etc.*



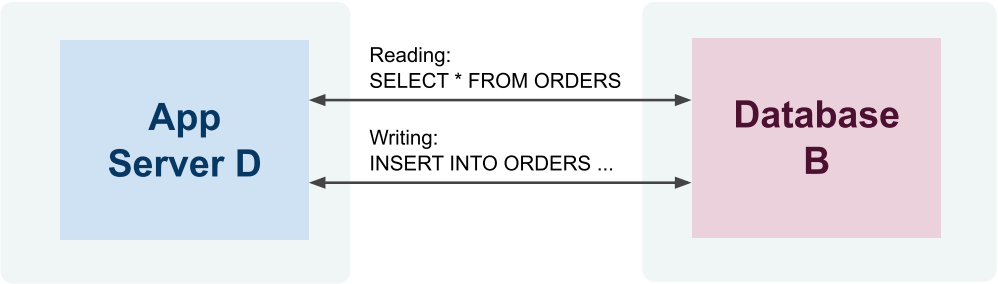
WTF! Spaghetti ??!

SOA is not a magic, it is a methodology and a suite of technologies that can only help if used properly.

Integration Approaches Overview

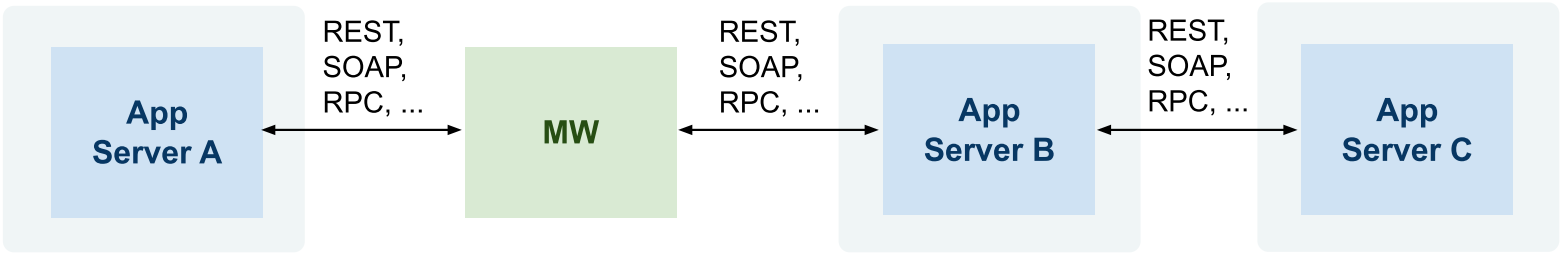


Data-oriented Integration



- 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**

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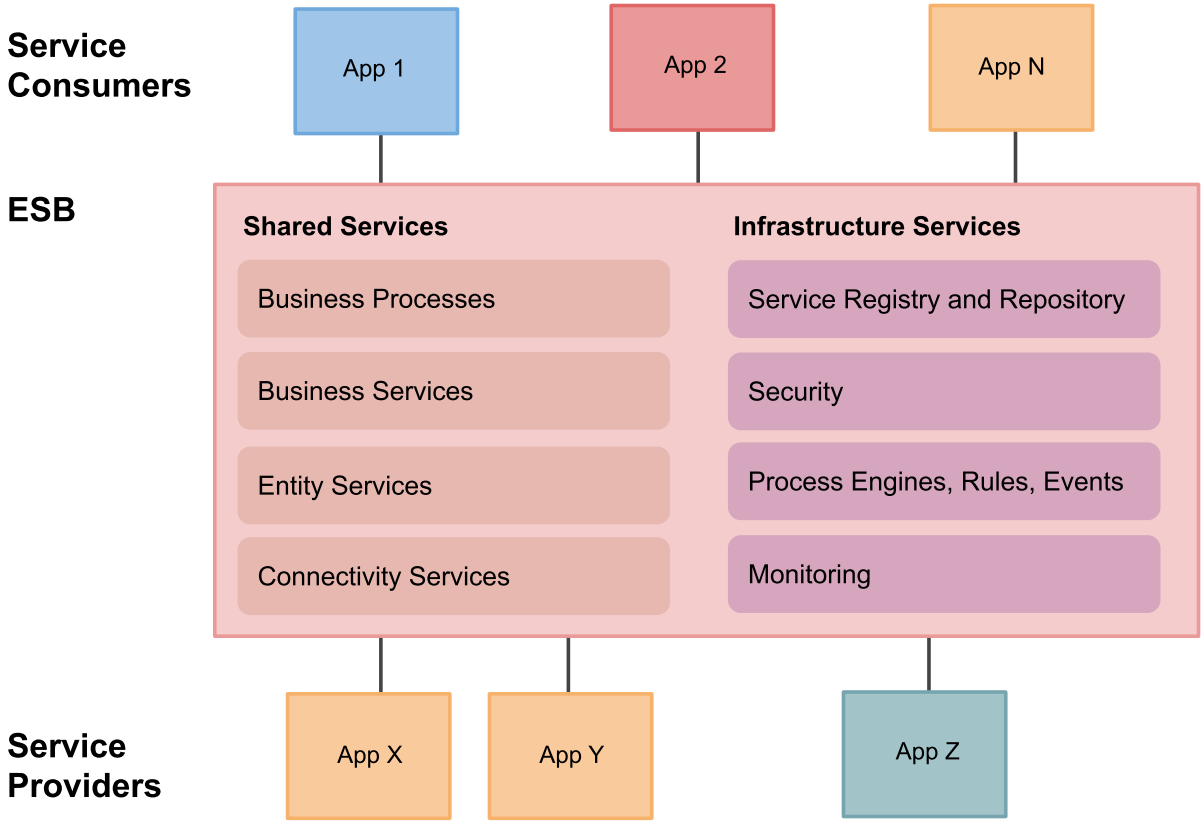
Enterprise Service Bus

- 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*
- Integration Patterns
  - *Technical-level interoperability – message broker*
  - *Location transparency*
  - *Dynamic routing*
  - *Data transformations – mediator*
  - *Session pooling*
  - *Message enrichment*

Service Types

- ESB services
  - *shared services – created for particular domain*
  - *infrastructure services – support integration and interoperability*



Service and non-service enabled providers

Connectivity Services

- Purpose
  - *Adapters for various back-end technologies*
  - *Connectivity to legacy applications*
  - *No business logic, Usually stateless, ESB internal*
- Example
  - *Database adapters*

    → *SQL statement:*

```
1  SELECT ID, NAME FROM CUSTOMERS C
2  WHERE  C.REVENUE > :revenue
```

    `Revenue` – *input parameter*

    `ID, NAME` – *structure of output message*

    → *Expose the SQL statement as a connectivity service*
  - *Example implementation: JCA adapters*

Entity Services

- Purpose
  - *Expose services on top of one or more entities in a database*
  - *Do not add any specific logic to entities' operations*
    - → *Provide CRUD operations only*
  - *May be used to facilitate a Common Data Model*
    - → *Business entities – entities of CDM*
    - → *Business objects – instances of business entities*
    - → *Business Entity Service – manipulations for business entities*
  - *No business logic, usually stateless, ESB internal*
- Example
  - *Two entities in a database:* `CUSTOMERS`, `ADDRESS` *(1:N)*
  - *Business entity* `CUSTOMER`

```
<customer>
  <name>Company.cz</name>
  <invoice-address>
    …
  </invoice-address>
  <main-address>
    …
  </main-address>
</customer>
```

  - *Operarions: read, write*

Business Services

- Purpose
  - *Business/integration logic, can be stateful or stateless*
  - *Atomic business activities*
    - *→ direct mapping to back-end application services*
  - *Can be "imported" in ESB to be used in a business process*
  - *Can be exposed by ESB and add values in terms of business/integration logic or technical processing*
- Example
  - *Data transformation*
    - *→ Back-end application service exposed in CDM language*
  - *Message enrichment*
    - *→ Adds information to content from other sources*
  - *Monitoring*
    - *→ Every invocation of the service logged*
    - *→ Monitoring of business metrics*
      - *→ Number of orders, total revenue per customer*

Business Processes

- Purpose
  - *Business/integration logic, usually stateful*
  - *Complex processes involving invocations of multiple business services at various back-end applications*
  - *Handles transformations from various data formats of back-end applications*
  - *Handles **key-mapping***
    - → *Business entities exist in multiple systems*
    - → *Each back-end application maintains its own ID for corresponding business objects*
  - *Usually implemented in a process language such as BPMN or BPEL*
- Example
  - *Order processing*
    - → *Get customer information from the CRM system*
    - → *Add line items to OMS*
    - → *Close order*

Overview

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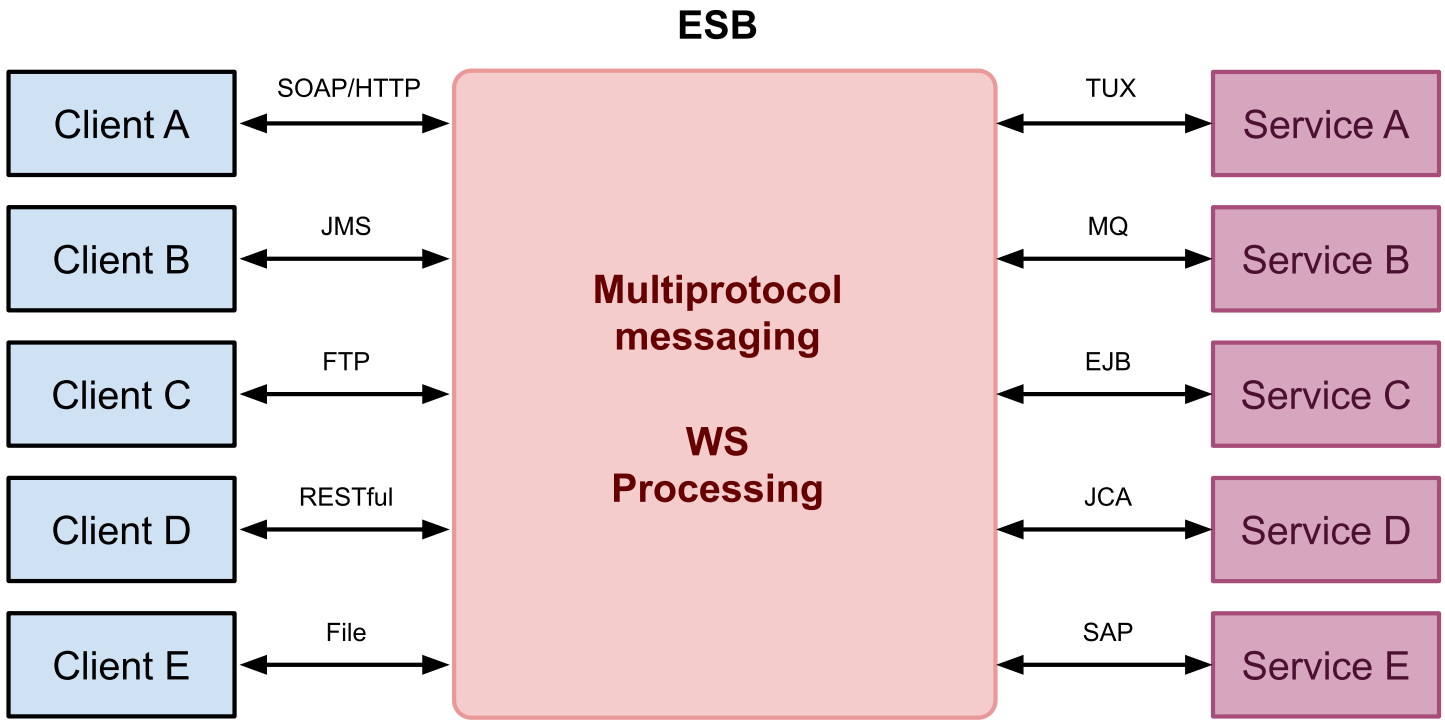
- Enterprise Service Bus
  - *Integration Patterns*
- Microservices Architecture

Integration Patterns

- Applied in implementation of business services and processes
  - *Usually a combination of more patterns*
- Technical patterns
  - *Deals with technical aspects of service communication*
  - *Message broker – technical-level interoperability*
  - *Location transparency*
  - *Session pooling*
- Business patterns
  - *Deals with business aspects (message content) of service communication*
  - *Dynamic routing*
  - *Data transformations – mediator*
  - *Message enrichment*

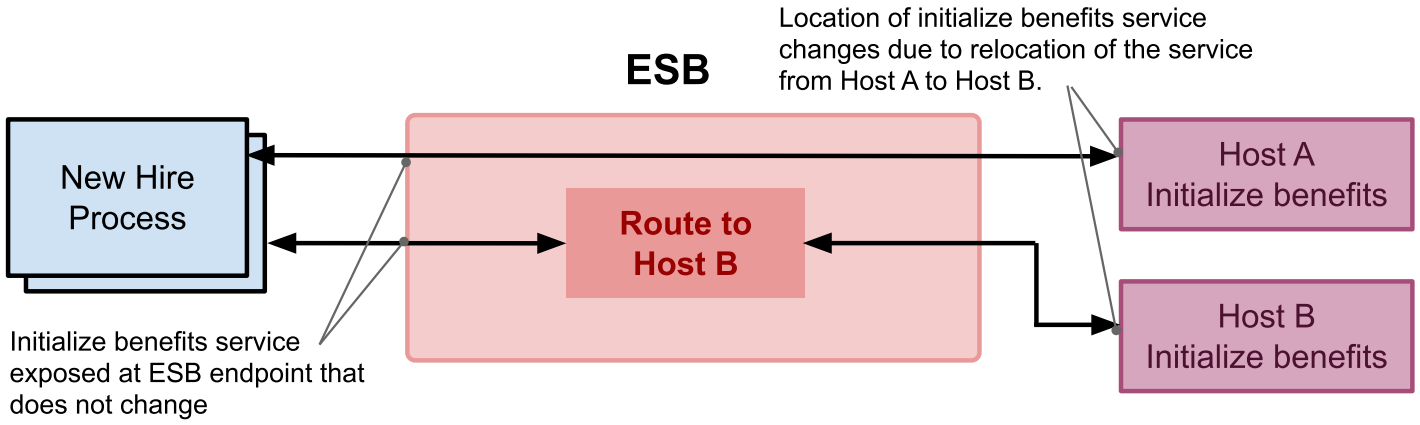
Message Broker

- Message broker
  - *ESB can mix and match transports both standard and proprietary*



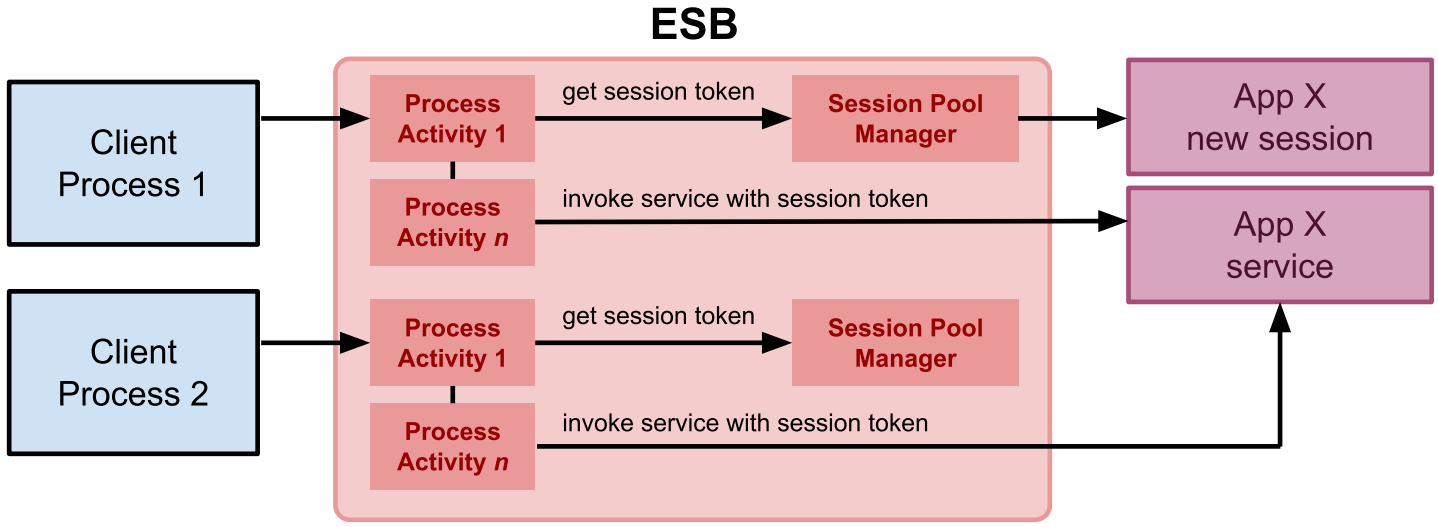
Location Transparency

- Location transparency
  - *ESB can hide changes in location of services*
  - *Such changes will not affect clients*
  - *Can also be used for load balancing for multiple service instances*



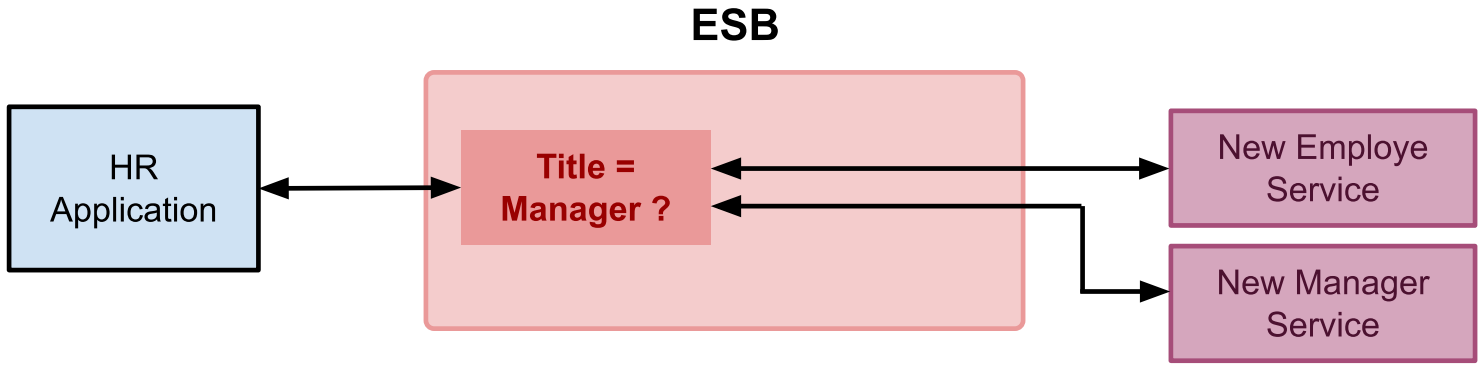
Session Pooling

- Session Pooling
  - *ESB can maintain a pool of connections (session tokens) to a back-end app when creating a new connection is expensive*
  - *A single session token can be reused by multiple instances of business processes*



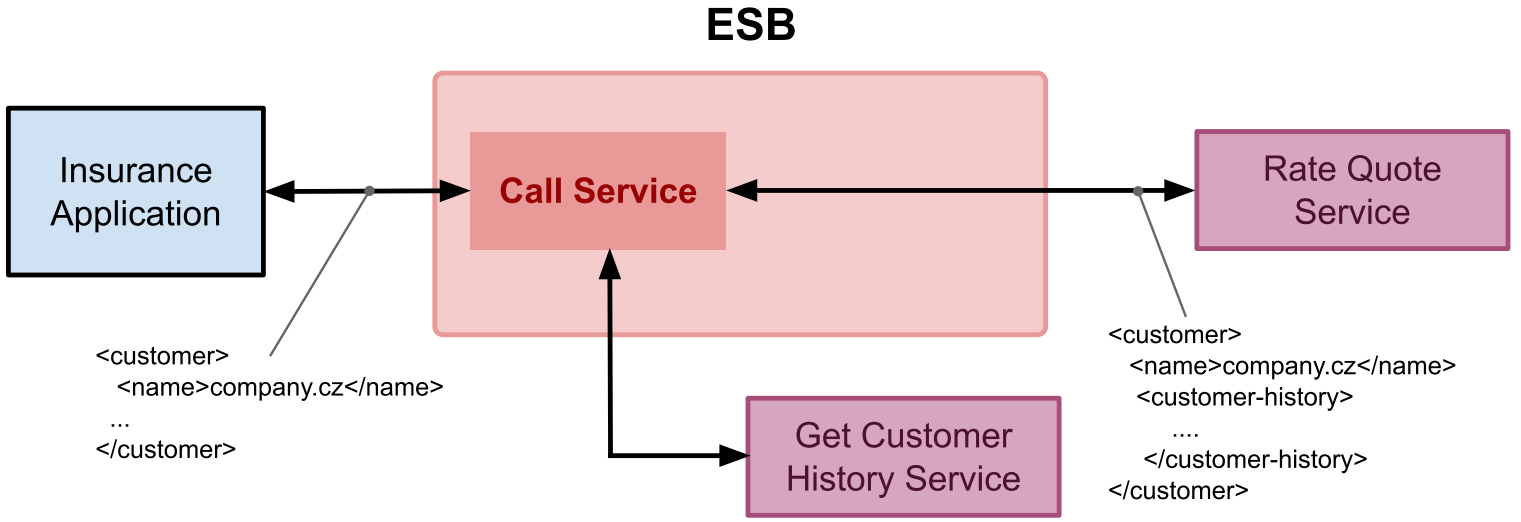
Dynamic Routing

- Dynamic routing
  - *ESB exposes a service that routes to various back-end services based on message contents.*



Message Enrichment

- Message enrichmenet
  - *Enriches a message before invoking back-end application service.*



Data Transformation

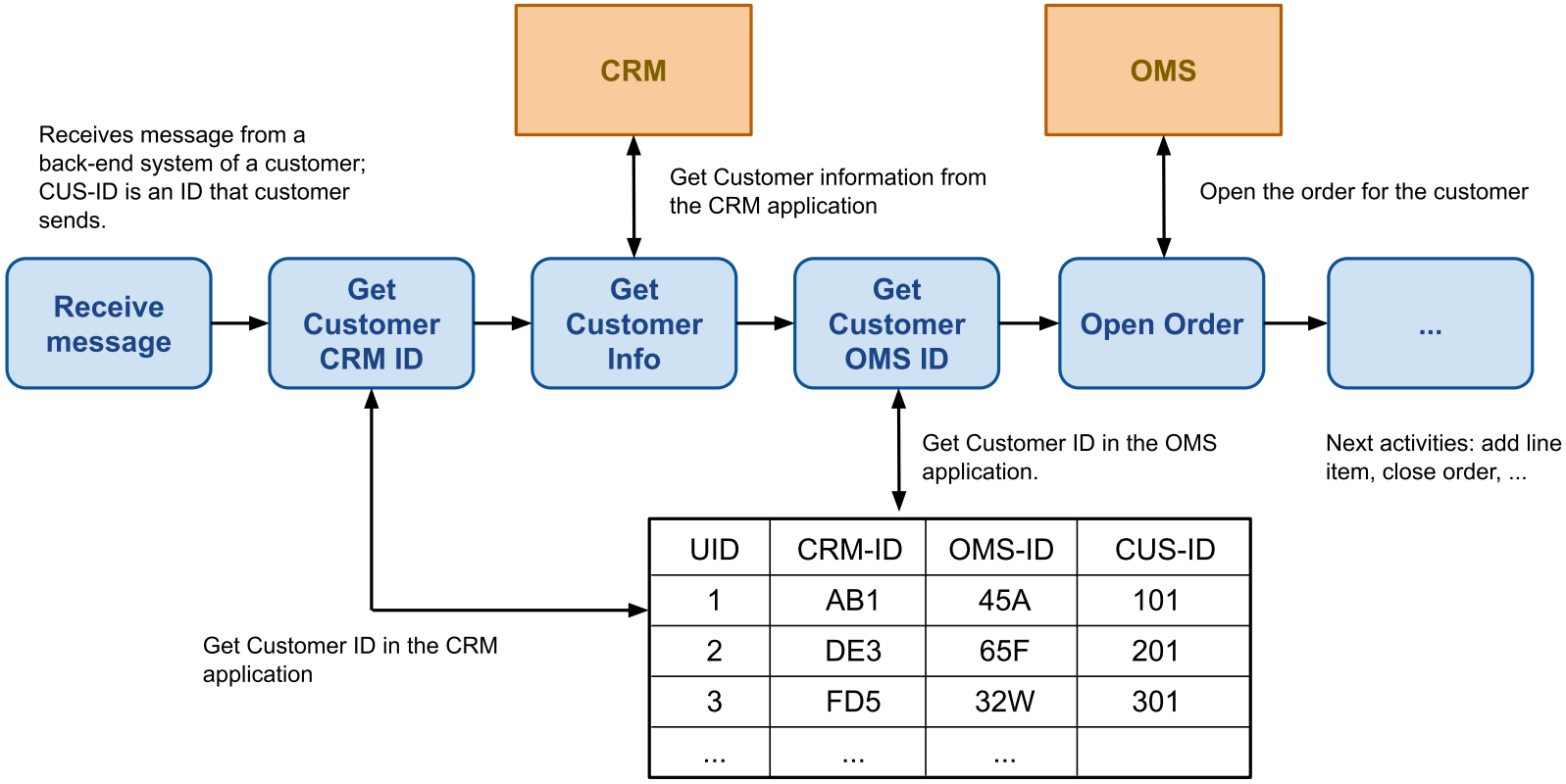
- Data transformation phases:
  - *Definition of mapping and execution of mappings*
- Definition of mappings (design-time)
  - *A mapping associates one data structure to another data structure and defines a conversion between them.*
  - *Mapping languages*
    → graphical for design that translates to XSLT, XQuery
    → Sometimes implemented in 3rd gen. languages (e.g., Java)
- Execution of mappings (runtime)
  - *application of mappings to instance data*
- CDM terminology
  - *Application Business Message – back-end app format*
  - *Enterprise Business Message – CDM format*

Key Mapping

- What is key mapping
  - *Key = identifier of en entity in a back-end application*
  - *Key Mapping = a mapping of an ID of an entity in one system to an ID of the same entity in another system.*
  - *Key mapping is realized using universal IDs (UID)*
- Example
  - *A customer MOON exists in CRM and OMS systems*
  - *In CRM system, MOON has an* `CRM-ID=AB1`
  - *In OMS system, MOON has an* `CRM-ID=45A`
  - *Key mappig allows to map the* `CRM-ID AB1` *to the* `OMS-ID 45A`
  - *Key mapping is a table*

    `CRM-ID → UID → OMS-ID`

Key Mapping Example



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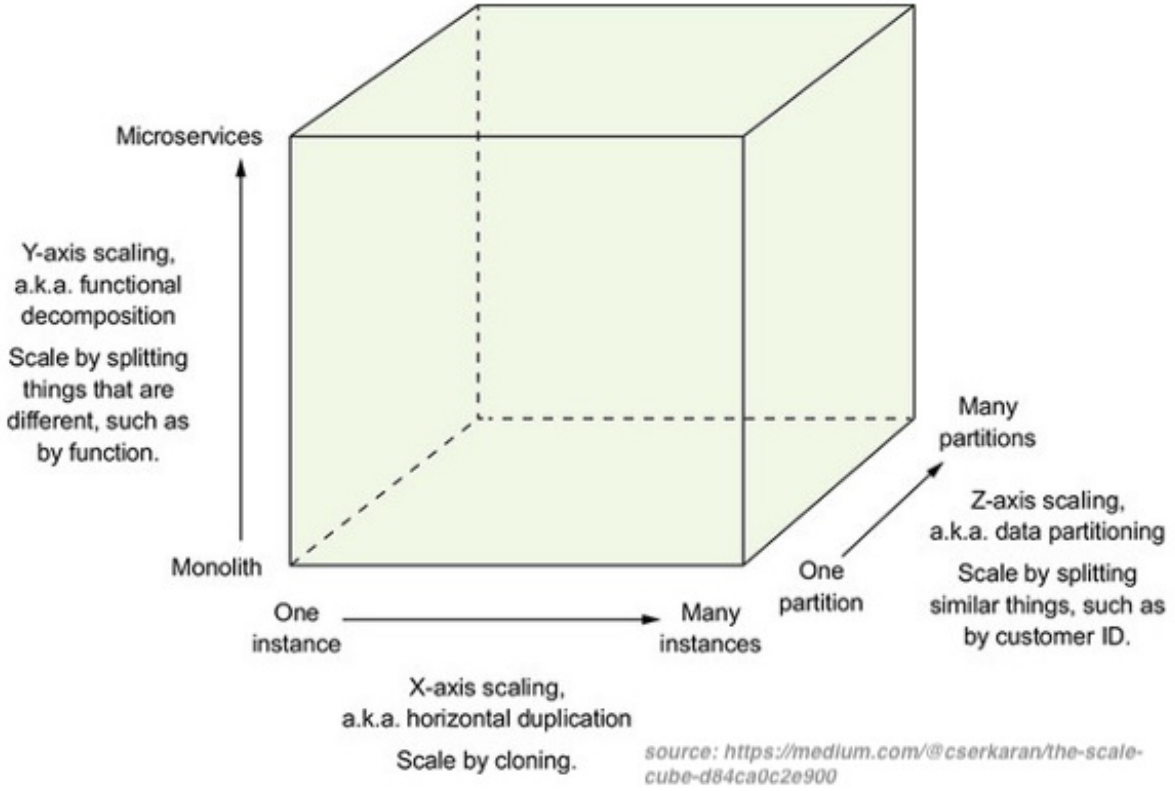
The Scale Cube

- 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*

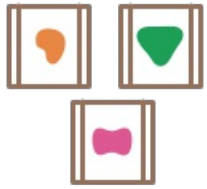


Overview

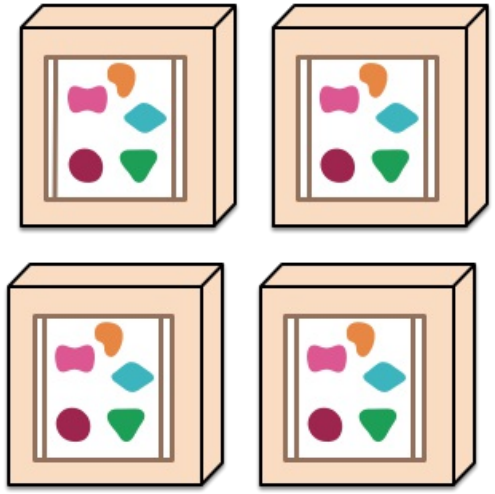
- Emerging software architecture
  - *monolithic vs. decoupled applications*
  - *applications as independenly deployable services*

A monolithic application puts all its functionality into a single process...

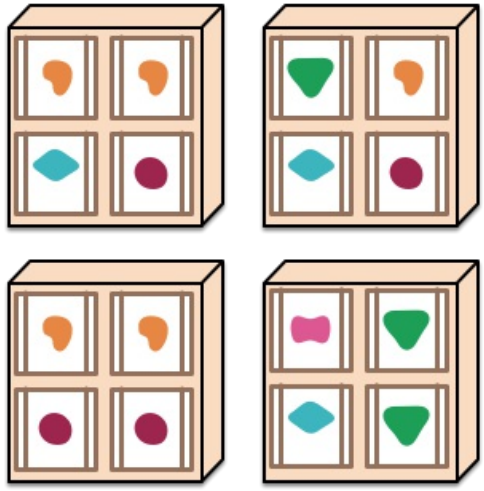
A microservices architecture puts each element of functionality into a separate service...



... and scales by replicating the monolith on multiple servers



... and scales by distributing these services across servers, replicating as needed.



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