# **Middleware Architectures 1**

### **Lecture 2: Service Oriented Architecture**

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### **Overview**

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

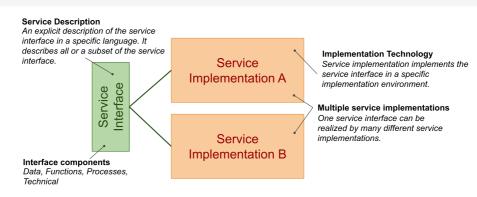
#### **Service**

- Difficult to agree on one definition
- Business definition 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 definition view
  - service characteristics
    - → encapsulation, reusability, loose coupling, contracting, abstraction, discoverability, composability
- Logical definition 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

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# 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

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### **Service Interface**

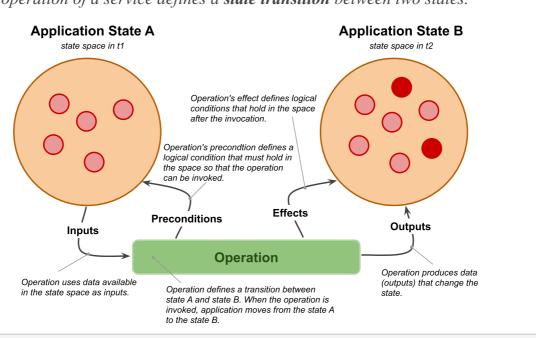
- Service interface components
  - Data
    - → Data model definition used by the service
    - → for example, input and output messages, representation of resources
  - Functions
    - → operations and input and output data used by operations
  - Process
    - $\rightarrow$  public process: how to consume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

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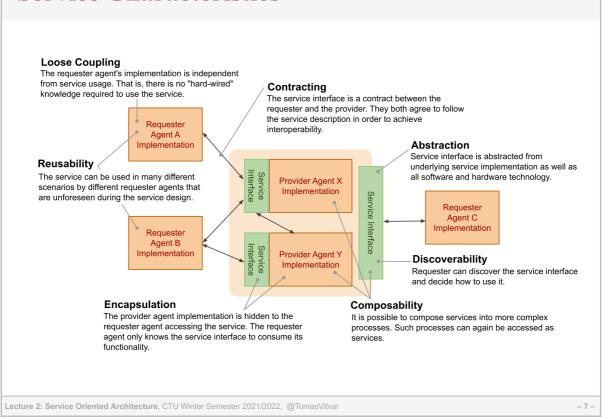
### **Public Process**

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



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### **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

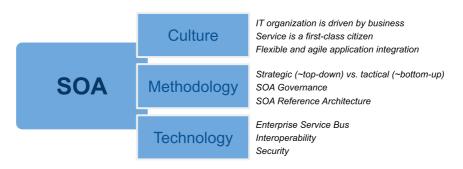
### Interoperability

- Ability of two or more applications to understand each other
- Interoperability levels
  - → Data syntax/structure and semantics
  - → Functions/Processes syntax and semantics
  - $\rightarrow$  Technical aspects protocols, network addresses, etc.

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### **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

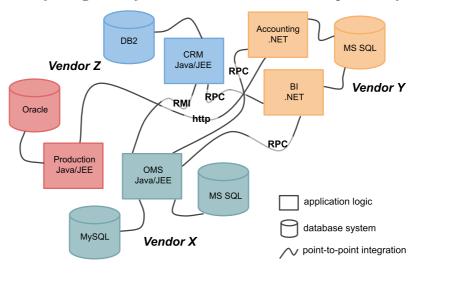
- Out-of-the-box applications and integration solutions among them

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## **One-to-One Service Integration**

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

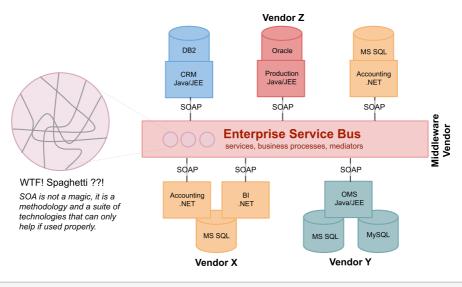


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# **Many-to-Many Service Integration**

- 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.



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#### **Integration Approaches Overview** http App Client A Client B Client C Server A REST, Service-oriented integration (M:N) SOAP, http http Application A integrates with application B RPC, ... and D through a middleware process REST SOAP RPC, App App Server B Server C SOAP, RPC, .. SQL Service-oriented integration (1:1) Application B integrates with application C directly by using services. SQL Database App Client D Server D Data-oriented integration SQL Application D integrates with application B through database B. **Database**

# **Data-oriented Integration**

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### 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

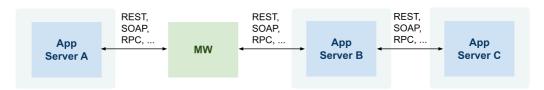
#### Problems

- 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

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# **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
    - $\rightarrow$  Data limited to input and output messages only
    - → Functions/processes limited to semantics of services
    - → Technical access mechanisms can vary

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# **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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### Overview

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# **Enterprise Service Bus**

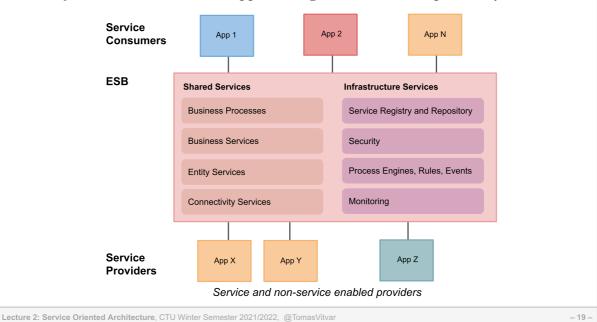
- ESB is a central intermediary in SOA
  - Types of services: shared and infrastructure
  - Types of processes: Technical and Business
- ESB Application
  - Application running on an application server
  - Exposes functionality via Web service interface
  - $Allows \ to \ communicate \ with \ various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

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# **Service Types**

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



### **Overview**

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  - Integration Patterns
- Microservices Architecture

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### **Integration Patterns**

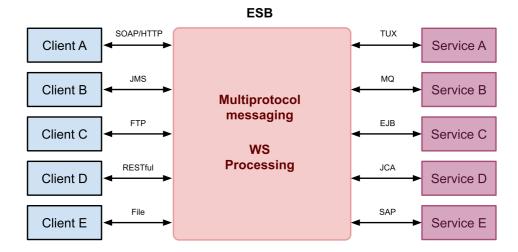
- Applied in implementation of business services and processes
  - Usually a combination of more patterns
- Technical patterns
  - Deals with technical aspects of service communication
  - Message broker technical-level interoperability
  - Location transparency
  - Session pooling
- Business patterns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

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# **Message Broker**

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

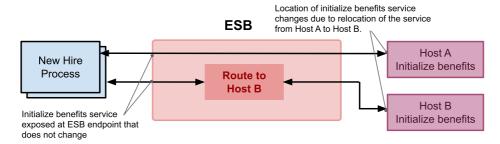


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## **Location Transparency**

### 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



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# **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



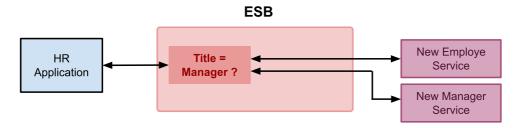
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# **Dynamic Routing**

# • Dynamic routing

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



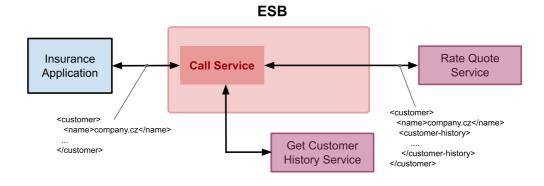
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# **Message Enrichment**

### • Message enrichmenet

- Enriches a message before invoking back-end application service.



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### **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
    - $\rightarrow$  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

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# **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
```

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### **Key Mapping Example CRM OMS** Receives message from a back-end system of a customer; Get Customer information from CUS-ID is an ID that customer Open the order for the customer the CRM application sends

Get

Customer Customer **Open Order CRM ID** OMS ID Info Get Customer ID in the OMS application. UID CRM-ID OMS-ID CUS-ID AB1 101 Get Customer ID in the CRM 2 DE3 65F 201 FD5 32W 301

Key mapping: **Business Entity CUSTOMER** 

Get

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Get

Customer

Next activities: add line

item, close order, ..

### **Overview**

Receive

message

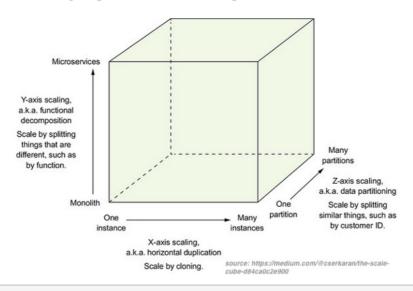
Service Definition

application

- **Integrating Applications**
- Enterprise Service Bus
- 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*



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### **Overview**

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

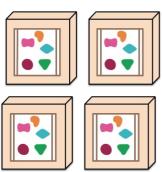
A monolithic application puts all its functionality into a single process...



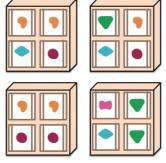
A microservices architecture puts each element of functionality into a separate service...



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



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



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# **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

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