

Middleware and Web Services

Lecture 8: Enterprise Service Bus

doc. Ing. Tomáš Vitvar, Ph.D.

tomas@vitvar.com • @TomasVitvar • <http://vitvar.com>



Czech Technical University in Prague

Faculty of Information Technologies • Software and Web Engineering • <http://vitvar.com/courses/mdw>



Modified: Sun Dec 10 2017, 22:26:12
Humla v0.3

Overview

- 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*
 - *Resequencing of messages*
 - *Session pooling*
 - *Service orchestrations – BPMN, BPEL*
 - *Message enrichment*

ESB Vendors

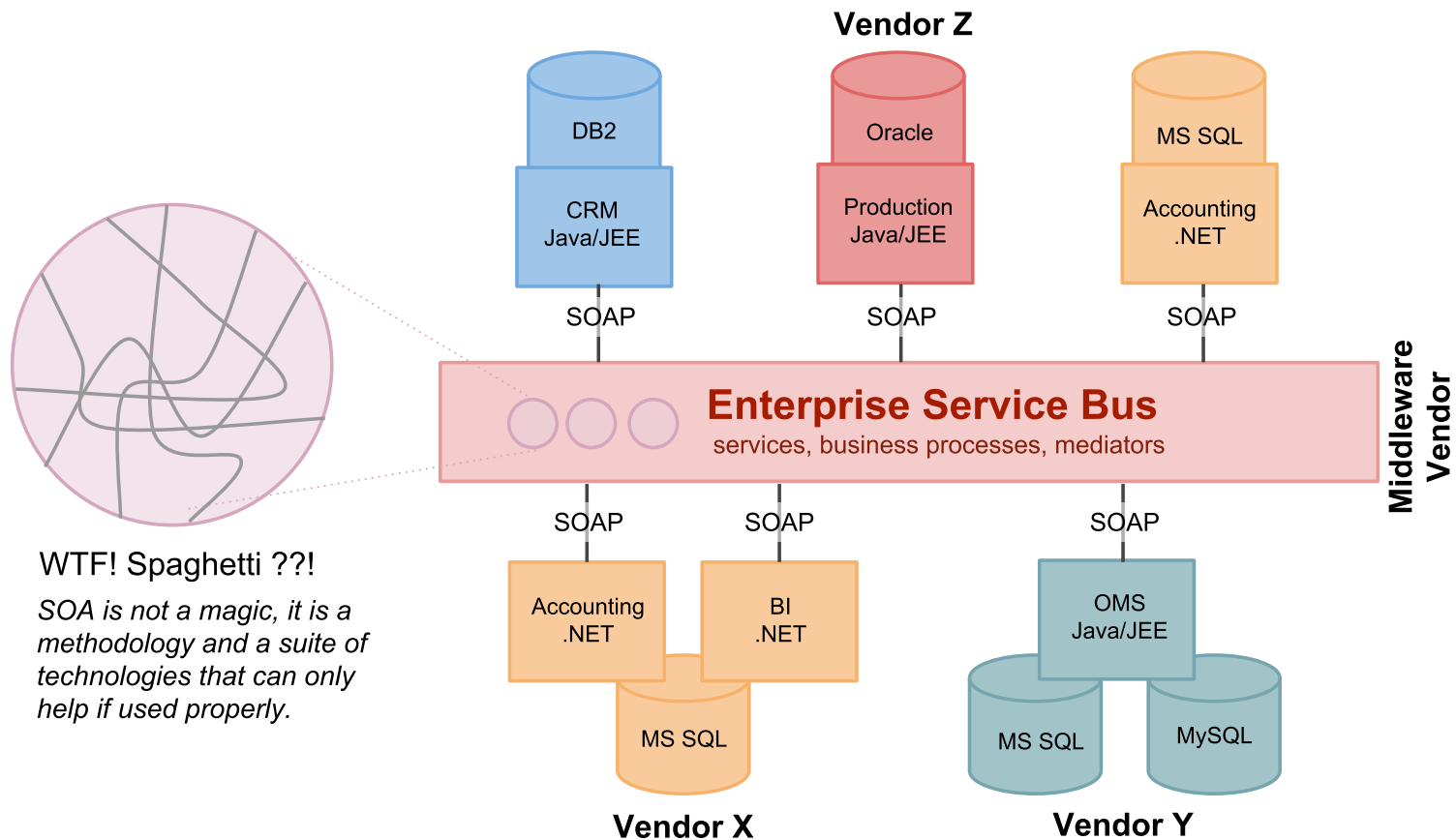
- Oracle
 - *Oracle Service Bus (OSB)*
 - *Oracle SOA Suite*
 - *Oracle Enterprise Gateway (OEG)*
- IBM
 - *IBM WebSphere*
- SAP
 - *SAP NetWeaver*
- Microsoft
 - *.NET Framework*
 - *BizTalk server*
- Opensource
 - *JBoss*
 - *Apache ServiceMix*
 - *WSMX – Semantic Web Service Execution Environment*

Overview

- **Architecture**
 - *Service Component Architecture*
 - *Metadata Repository*
 - *Service Types*
- **Integration Patterns**

Enterprise Service Bus

- Integration organized
 - *Enterprise Service Bus, to be used wisely*



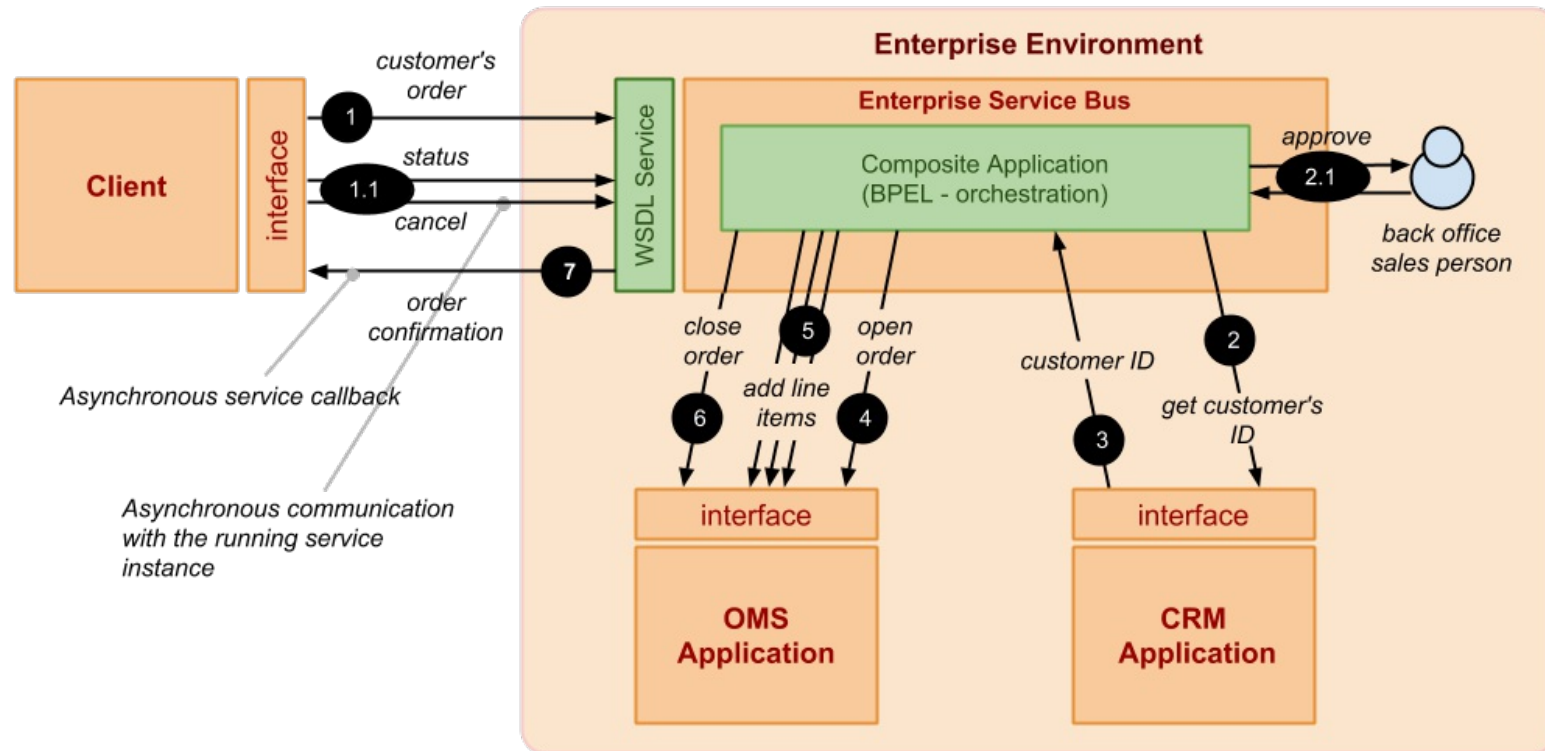
Overview

- Architecture
 - *Service Component Architecture*
 - *Metadata Repository*
 - *Service Types*
- Integration Patterns

Service Component Architecture

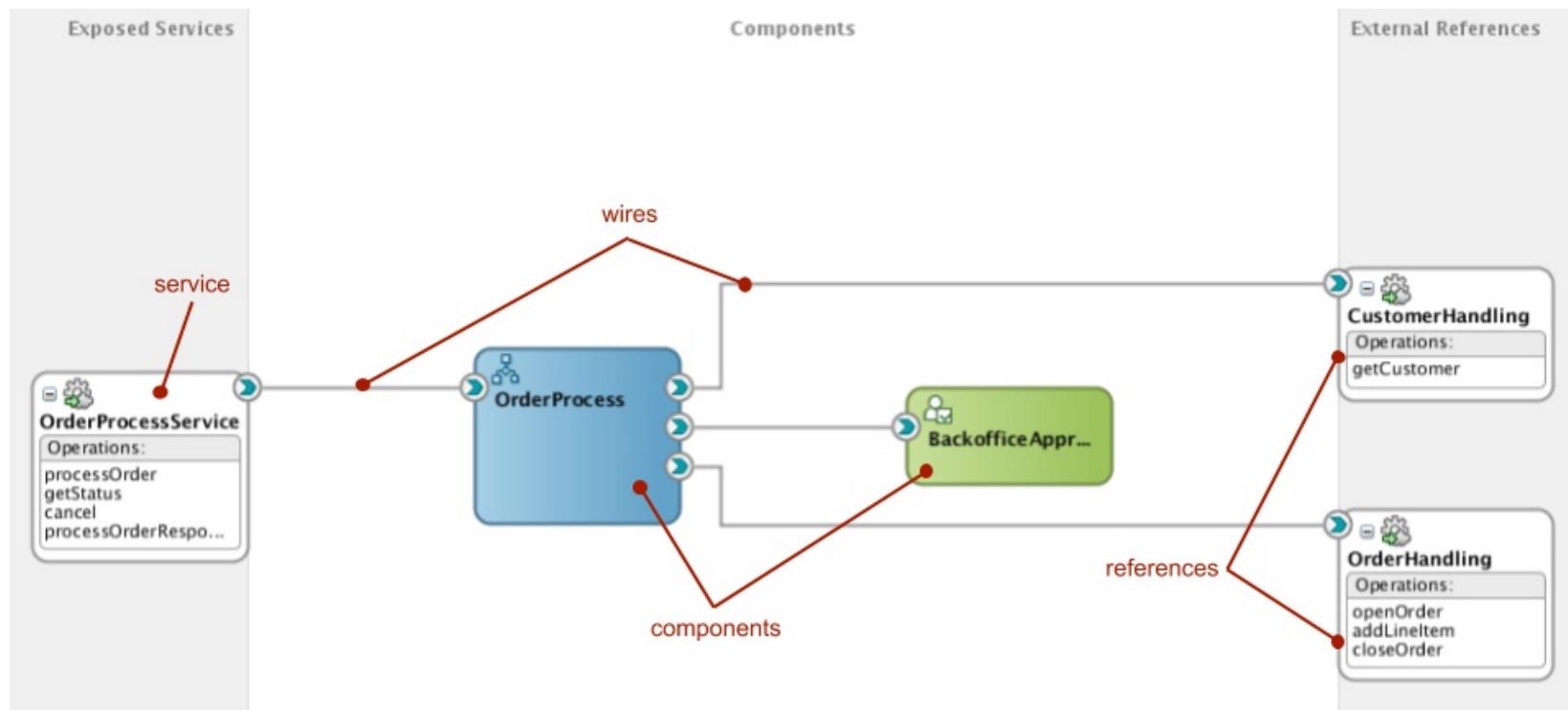
- Industry standard
 - *SCA defines an architecture and a technology for composing applications following SOA principles*
- SCA Application
 - Composite**
collection of components, services, references
 - Component**
application building block that provides certain functionality; it can be implemented by various technologies (BPEL, Java, etc.)
 - Services**
exposed services by the application
 - References**
references to external services that the application uses
 - Wires**
links between components, services and references.

Simplified Order Process



Order Process – SCA Application

- SCA Application Composite
 - Service implements Order Process WSDL interface (*processOrder*, *getStatus*, *cancel*, *processOrderResponse* callback)
 - A screenshot from JDeveloper IDE:



Composite.xml

- Main configuration file of the composite application
 - *previous slide shows its graphical representation*

- **service** – exposes the composite as a service

{ns-path}='mimdw.fit.cvut.cz/mdw_examples/ProcessOrder'

```
1  <service name="OrderProcessService" ui:wSDLLocation="OrderProcess.wsdl">
2    <interface.wSDL
3      interface="http://{ns-path}/OrderProcess#wsdl.interface(OrderProcess)"
4      callbackInterface="http://{ns-path}/OrderProcess#wsdl.interface(OrderProcessCallback)"
5    <binding.ws
6      port="http://{ns-path}/OrderProcess#wsdl.endpoint(OrderProcessService/OrderProcess_)
7      <property name="weblogic.wsee.wsat.transaction.flowOption"
8        type="xs:string" many="false">NEVER</property>
9    </binding.ws>
10   <callback>
11     <binding.ws
12       port="http://{ns-path}/OrderProcess#wsdl.endpoint(OrderProcessService/OrderProcessC
13     </callback>
14   </service>
```

- **component** – implements the composite in a specific technology

```
1  <component name="OrderProcess" version="2.0">
2    <implementation.bpel src="OrderProcess.bpel"/>
3    <property name="bpel.config.oneWayDeliveryPolicy" type="xs:string"
4      many="false">async.persist</property>
5  </component>
```

Composite.xml (cont.)

- **reference** – provides an access to an external service

`{ns-path}='mimdw.fit.cvut.cz/mdw_examples/APP_CRM_GetCustomer'`

```
1  <reference name="CustomerHandling"
2      ui:wsdlLocation="http://sb.vitvar.com/soa-infra/services/mdw-examples/APP_CRM_GetCust
3  <interface.wsdl
4      interface="http://{ns-path}/GetCustomer#wsdl.interface(GetCustomer)"/>
5  <binding.ws
6      port="http://{ns-path}/GetCustomer#wsdl.endpoint(getcustomer_client_ep/GetCustomer_
7      location="http://sb.vitvar.com/soa-infra/services/mdw-examples/APP_CRM_GetCustomer/
8      soapVersion="1.1">
9      <property name="weblogic.wsee.wsat.transaction.flowOption"
10         type="xs:string" many="false">WSDLDriven</property>
11  </binding.ws>
12 </reference>
```

Order Process SCA Application Instance

Overview

- Architecture
 - *Service Component Architecture*
 - *Metadata Repository*
 - *Service Types*
- Integration Patterns

Metadata Repository

- Central Store
 - *Central store for common artefacts used by applications*
- Artefacts
 - *Abstract WSDLs – common interface for integration between clients and ESB and among applications running in ESB*
 - *XML Schemas – common information models used in WSDLs*
 - *Common Data Model (CDM)*
- Oracle SOA Suite 11g
 - *MDS – Metadata Store; can be in the DB or on file system*
 - *Common artefacts as above + deployed composites*
 - *Artefacts can be referenced/access by **oramds** protocol:*

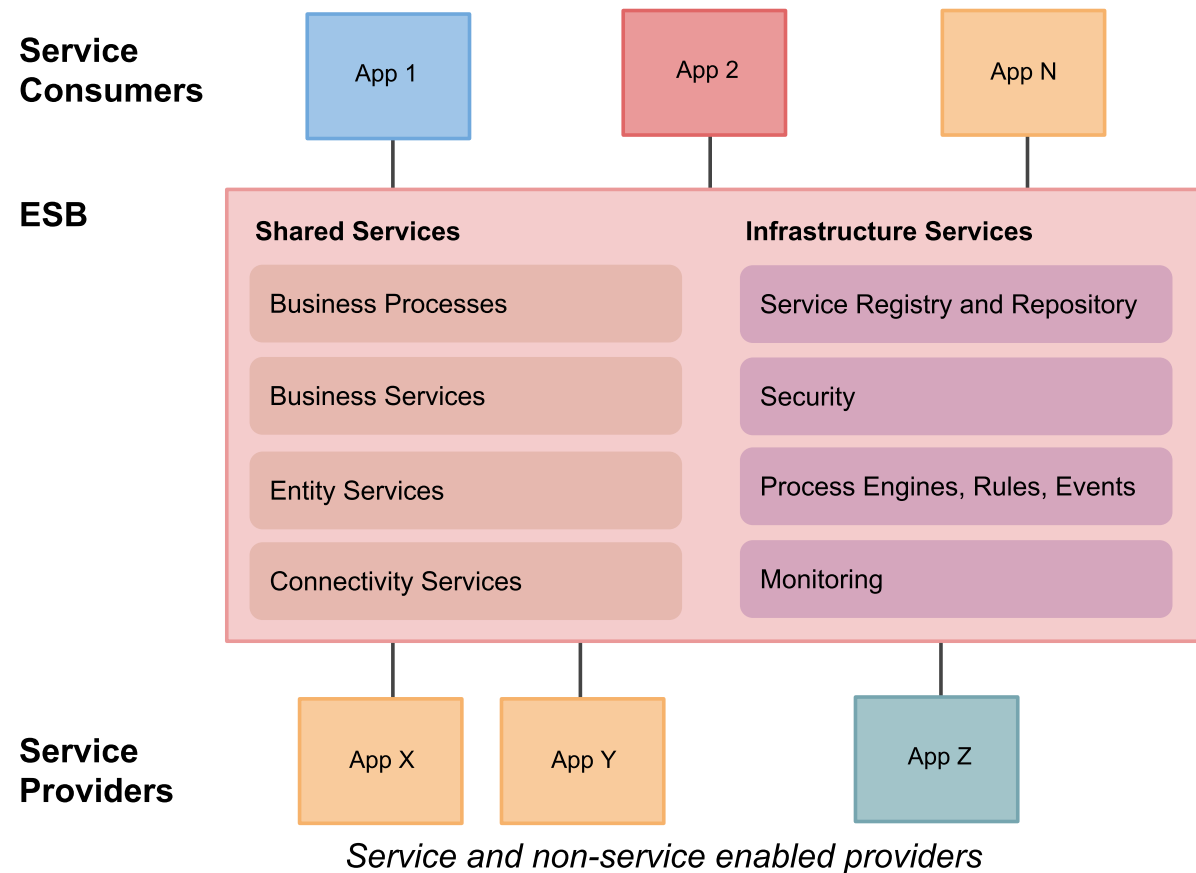
```
1  ...
2  <wsdl:types>
3      <schema
4          xmlns="http://www.w3.org/2001/XMLSchema">
5          <import namespace="http://mimdw.fit.cvut.cz/mdw-examples/cdm/order"
6          schemaLocation="oramds:/apps/MDWMetaData/order.xsd"/>
```

Overview

- Architecture
 - *Service Component Architecture*
 - *Metadata Repository*
 - *Service Types*
- Integration Patterns

Service Types

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



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: OSB Proxy service, JCA adapters*

JCA Adapters

- JCA – Java EE Connector Architecture
 - *Standard Java interface to connect to back-end systems*
 - *Standardized in JSR 112* [!\[\]\(467d80e979964f7f8c752fb22248b5b7_img.jpg\)](#)
 - *Main JCA Adapters*
 - *JCA DB Adapter – access to DB objects*
 - *JCA JMS Adapter – JMS queues*
 - *JCA AQ Adapter – Oracle AQ (in a database)*
 - *JCA MQ Adapter – IBM MQ*
 - *JCA FTP Adapter – FTP access*
 - *JCA File Adapter – File system access*
- Major Features (Contracts)
 - *Connection pool*
 - *cache of connections to a back-end system (DB, etc.)*
 - *Transaction management*
 - *JCA adapters can participate in a distributed transaction*

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*

```
1  <customer>
2    <name>Company.cz</name>
3    <invoice-address>
4      ...
5    </invoice-address>
6    <main-address>
7      ...
8    </main-address>
9  </customer>
```

- *Operations: 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*
 - *OSB uses its own orchestration language which translates to XQuery*
- Example
 - *Order processing*
 - *Get customer information from the CRM system*
 - *Add line items to OMS*

Overview

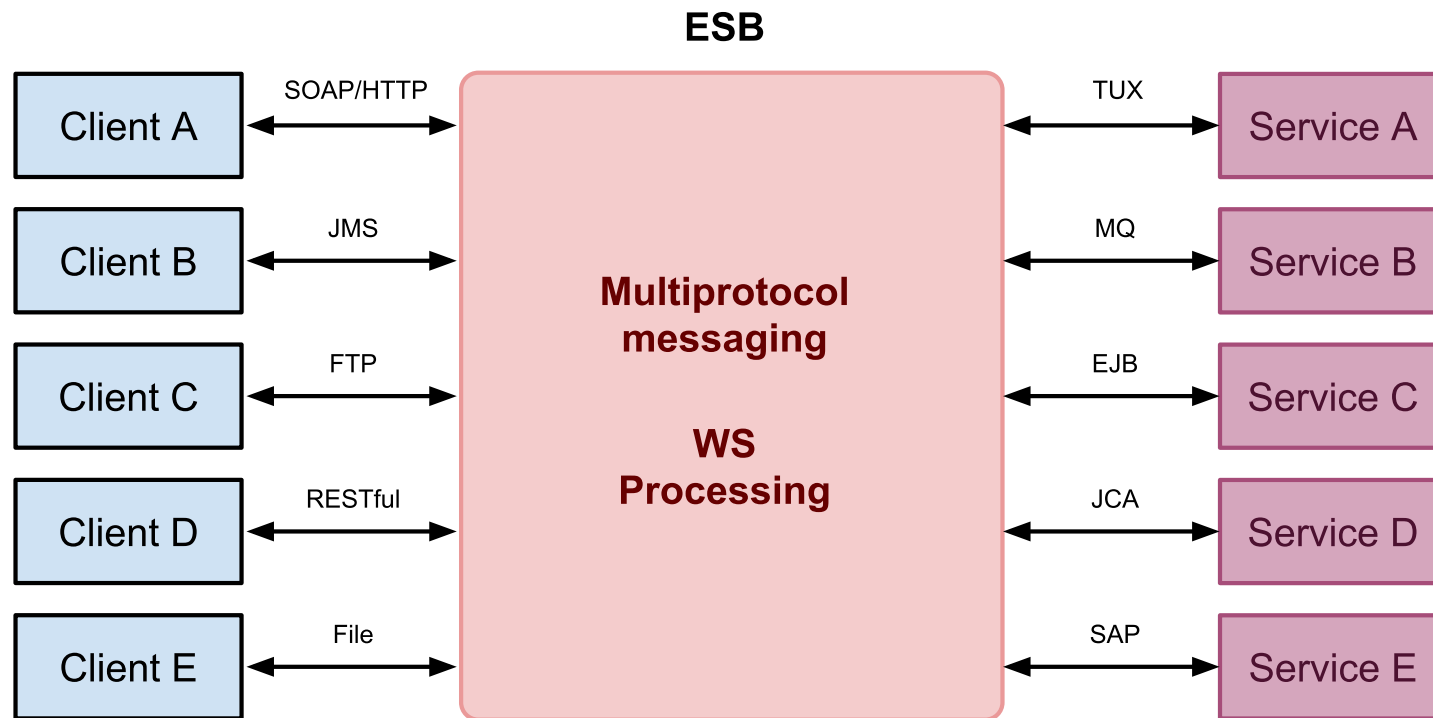
- Architecture
- Integration Patterns

Overview

- 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*
 - *Service orchestrations – BPMN, BPEL*
 - *Message enrichment*
 - *Resequencing of messages*

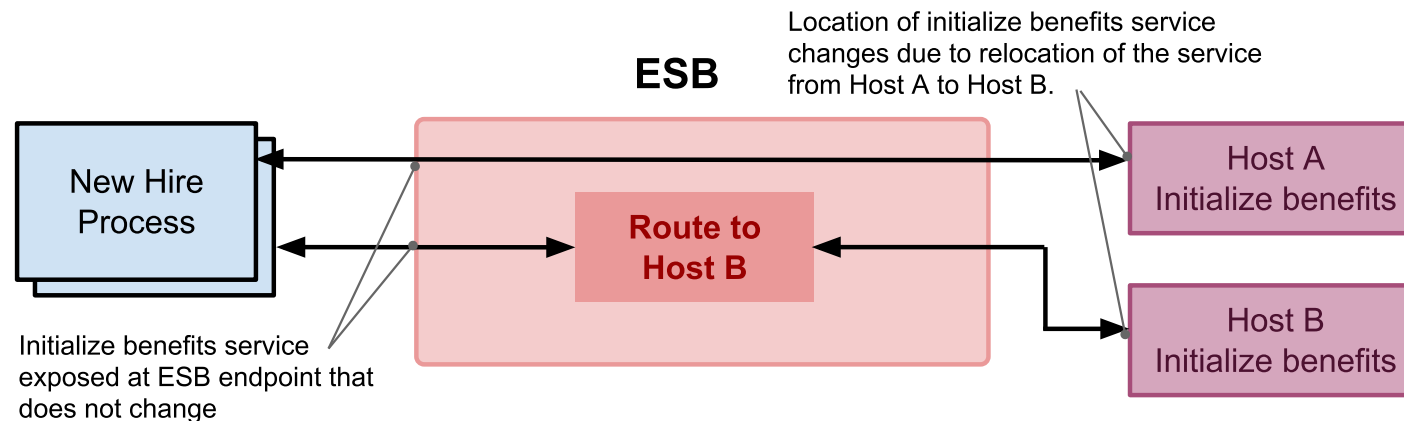
Message Broker

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



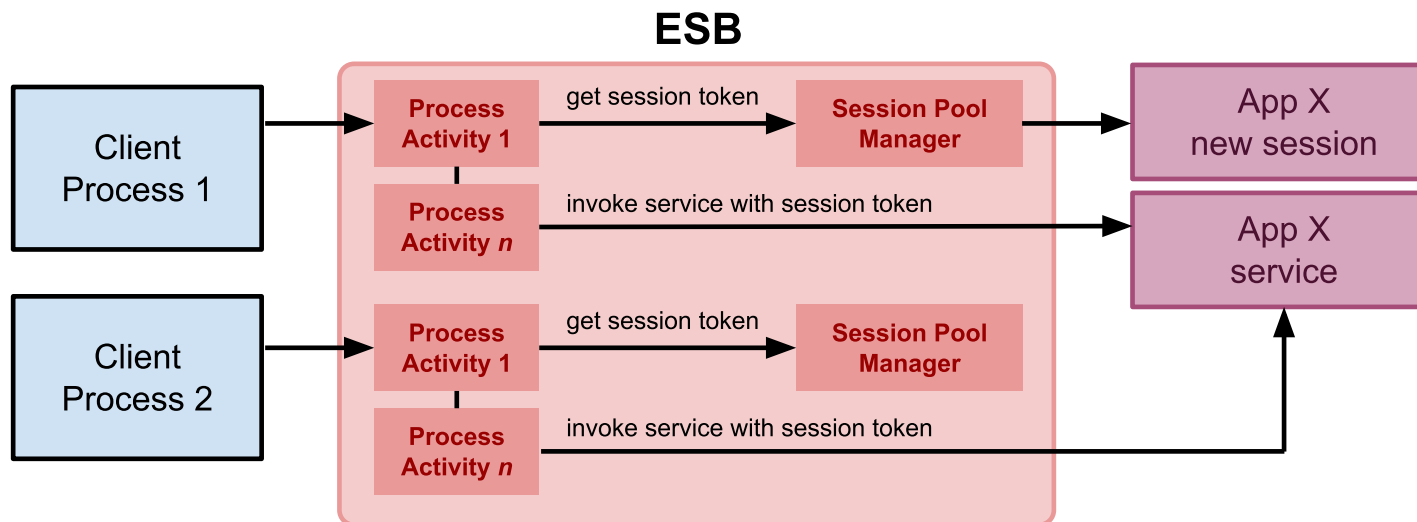
Location Transparency

- 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*



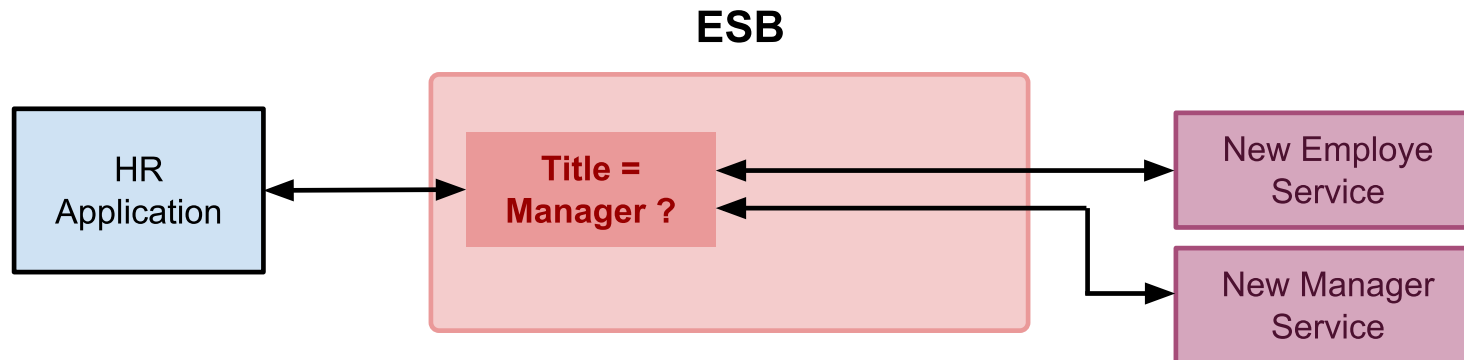
Session Pooling

- 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*



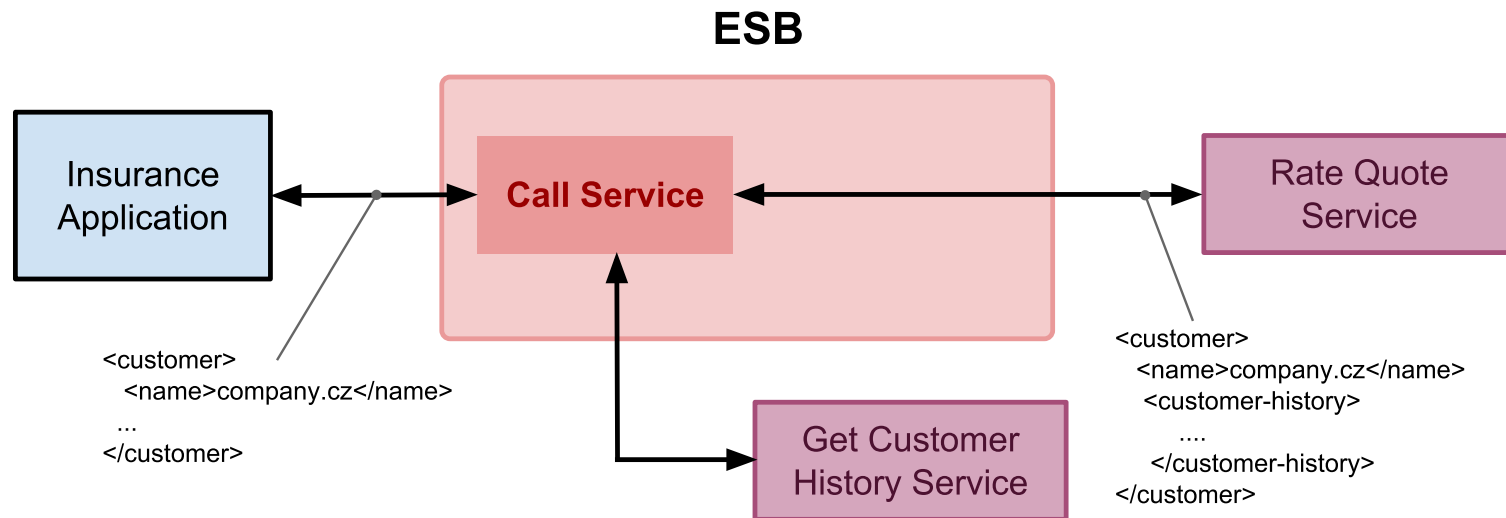
Dynamic Routing

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



Message Enrichment

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

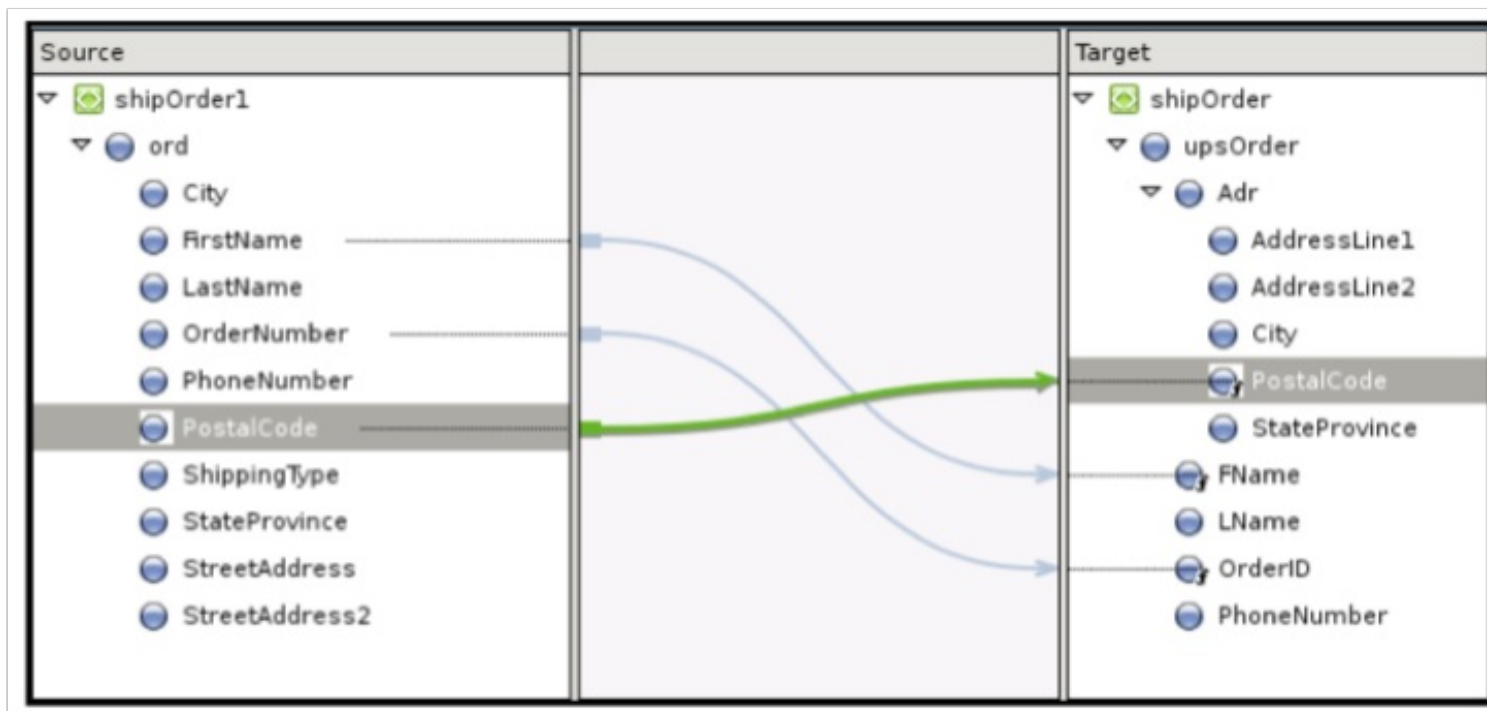


Data Transformation

- 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*

Definitions of Data Mapping Example

- Source and target schemas
 - *Source: Order – flat data structure*
 - *Target: UPS order with address as a sub-entity*
 - *Differences in names of entities*
 - *Conversion function applied to postal code*

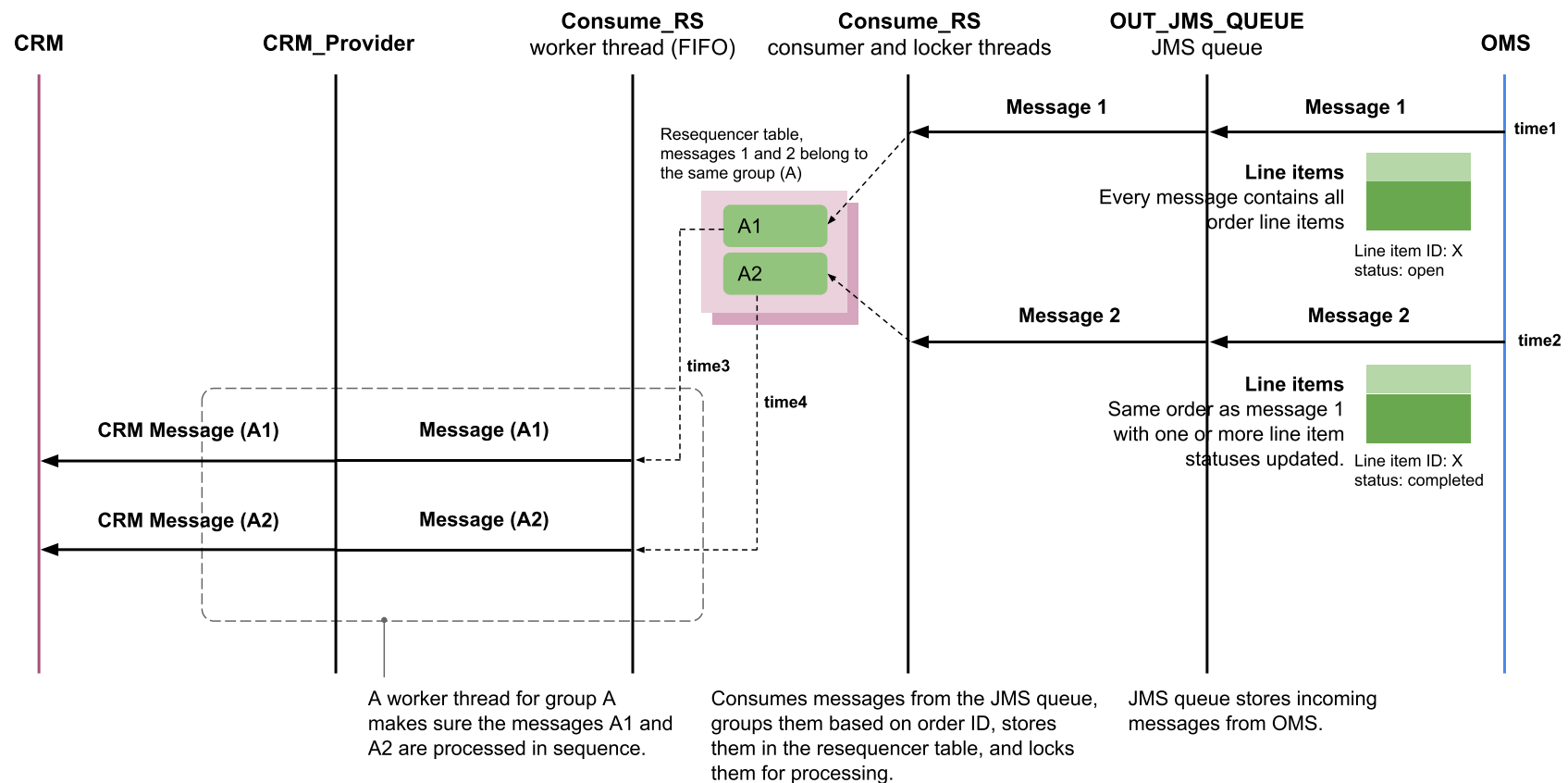


Service Orchestration

- Orchestration of multiple business services
 - *Includes transformation, message enrichment, service callouts, etc.*
 - *A step in orchestration is an activity*
- Patterns
 - *Sequential processing of activities*
 - *Parallel processing of activities with synchronization points*
 - *Decision branches, iterations*
- Technologies
 - *Graphical languages*
 - *Standard representations: BPEL, BPMN*
 - *Proprietary, for example OSB uses graphical language that translates to XQuery*
- Good design
 - *Orchestration facilitates communication in CDM*
 - *Orchestration handles key-mapping*

Message Sequencing

- Resequencer in update sales order
 - Every order line item needs to update its status several times (e.g. open, completed)
 - Resequencer makes sure that the update status messages arrive to CRM in the same order as they were created in OMS system (FIFO resequencer)



Message Aggregation