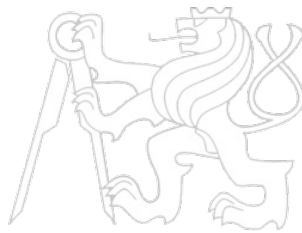


Middleware and Web Services

Lecture 10: Enterprise Service Bus

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Modified: Mon Jan 05 2015, 12:53:57
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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

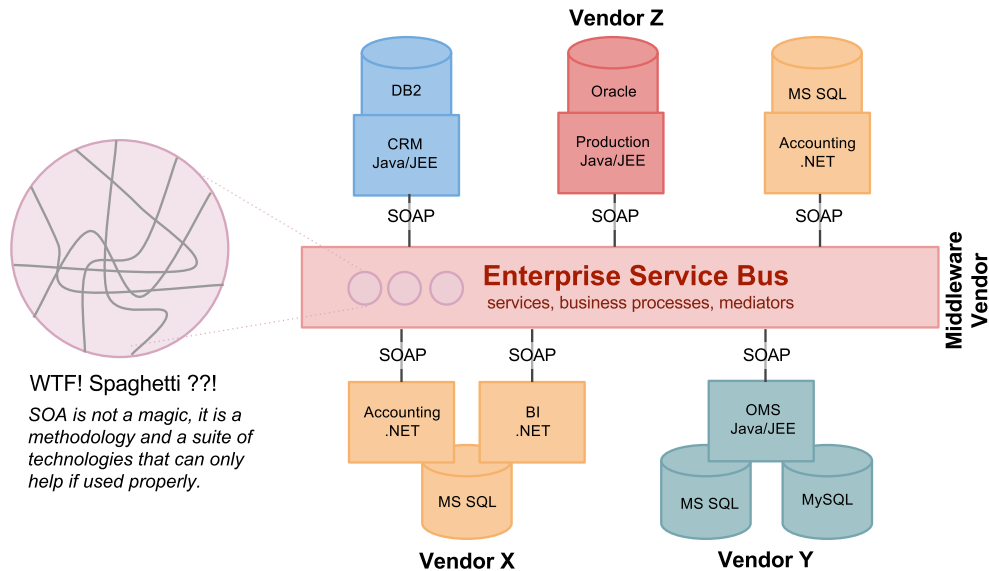
- Oracle
 - *Oracle Service Bus (OSB)*
 - *Oracle SOA Suite*
 - *Oracle Enterprise Gateway (OEG)*
- IBM
 - *IBM WebSphere*
- SAP
 - *SAP NetWeaver*
- Microsoft
 - *.NET Framework*
 - *BizTalk server*
- Opensource
 - *JBoss*
 - *Apache ServiceMix*
 - *WSMX – Semantic Web Service Execution Environment*

Overview

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

Enterprise Service Bus

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



Overview

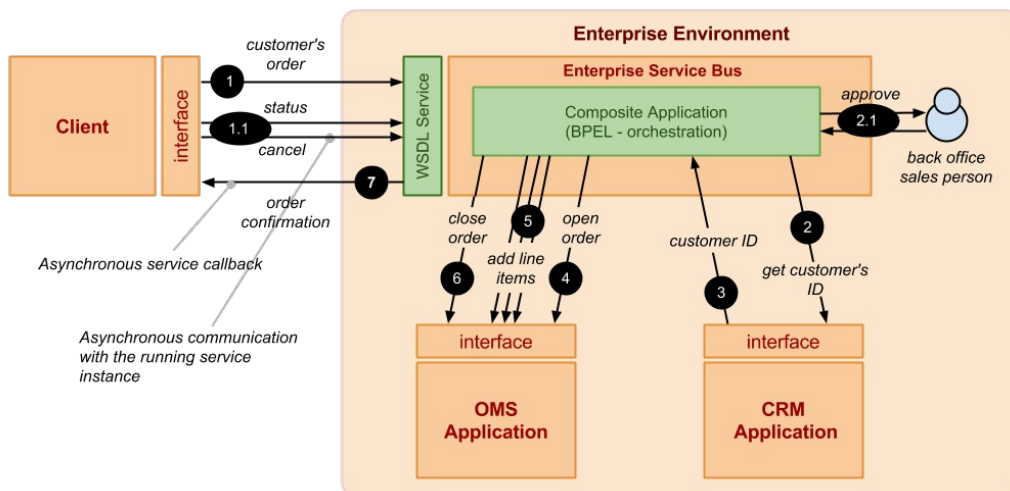
- Architecture
 - *Service Component Architecture*
 - *Metadata Repository*
 - *Service Types*
- Integration Patterns

Service Component Architecture

- Industry standard
 - SCA defines an architecture and a technology for composing applications following SOA principles
 - Many adopters: Apache Tuscany, Service Conduit, Oracle SOA Suite 11g
- 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.

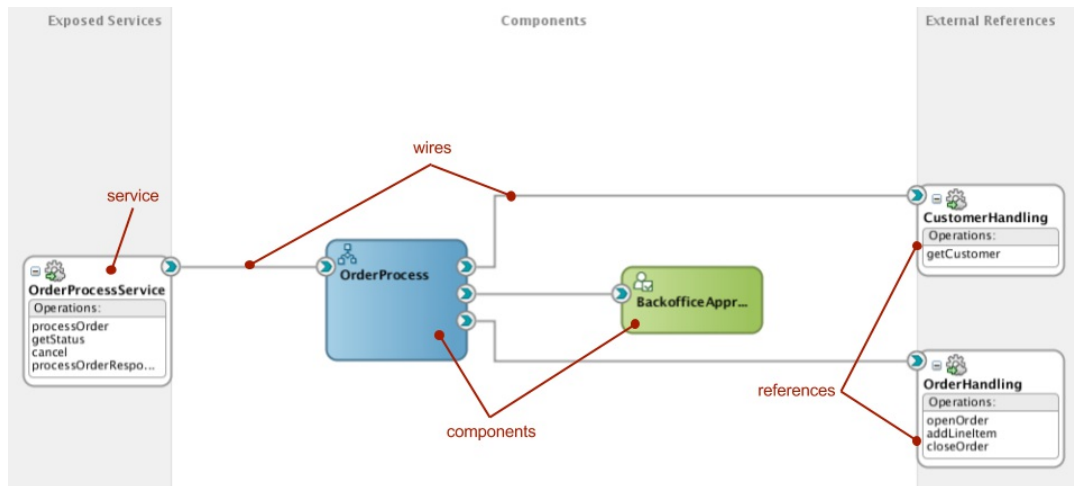
Simplified Order Process

- Example from Lecture 9



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/OrderProcess
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_GetCus
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:*

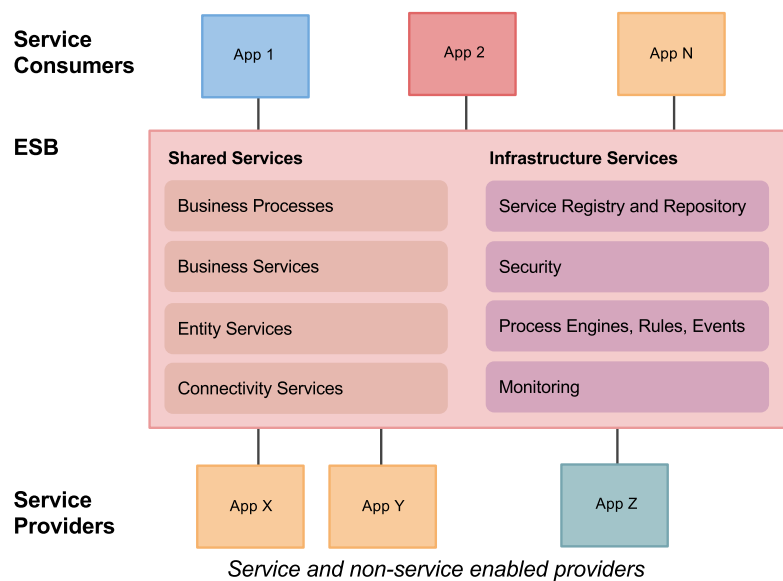
```
1  ...
2  <wsdl:types>
3    <schema
4      xmlns="http://www.w3.org/2001/XMLSchema">
5      <import namespace="http://mimdw.fit.cvut.cz/mdw-examples/cdm/order"
6      schemaLocation="oramds:/apps/MDWMetaData/order.xsd"/>
```

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* [🔗](#)
 - *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
 - Close order

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

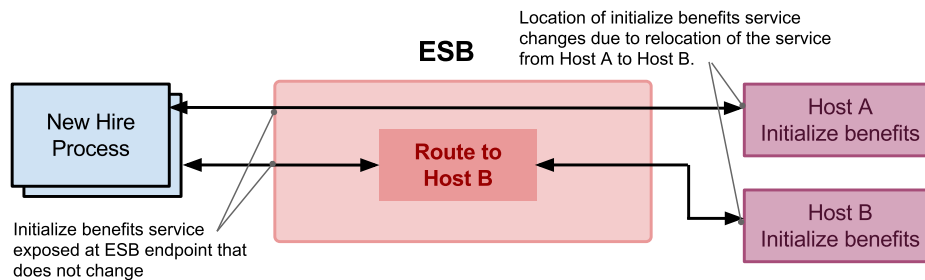
Message Broker

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



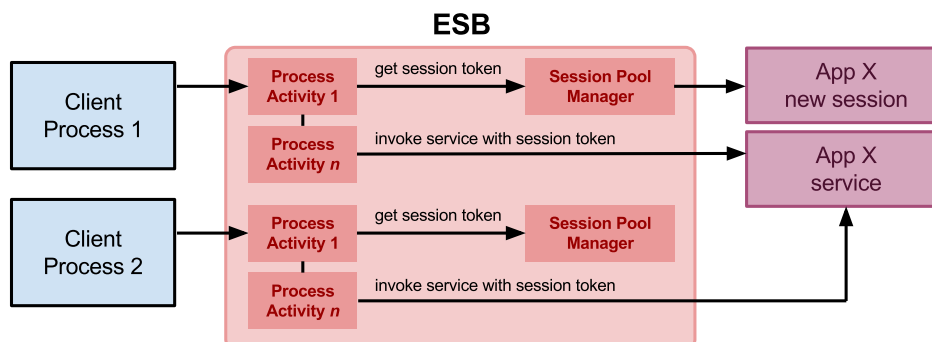
Location Transparency

- 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



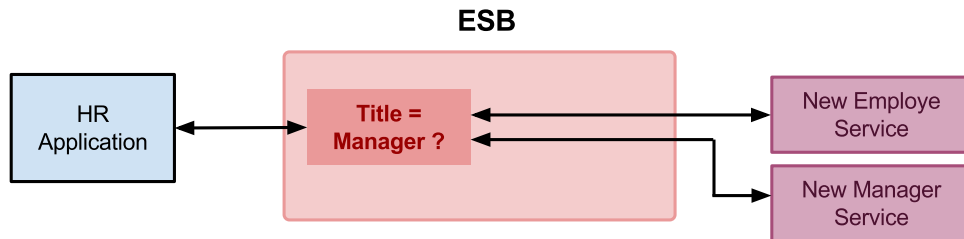
Session Pooling

- 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



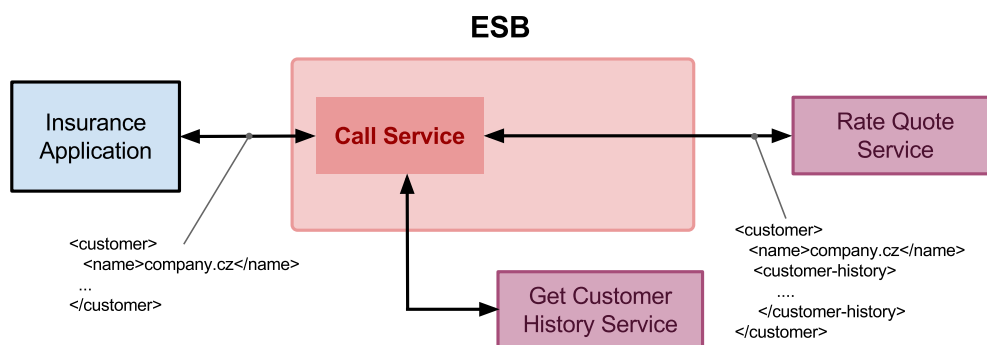
Dynamic Routing

- 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.*

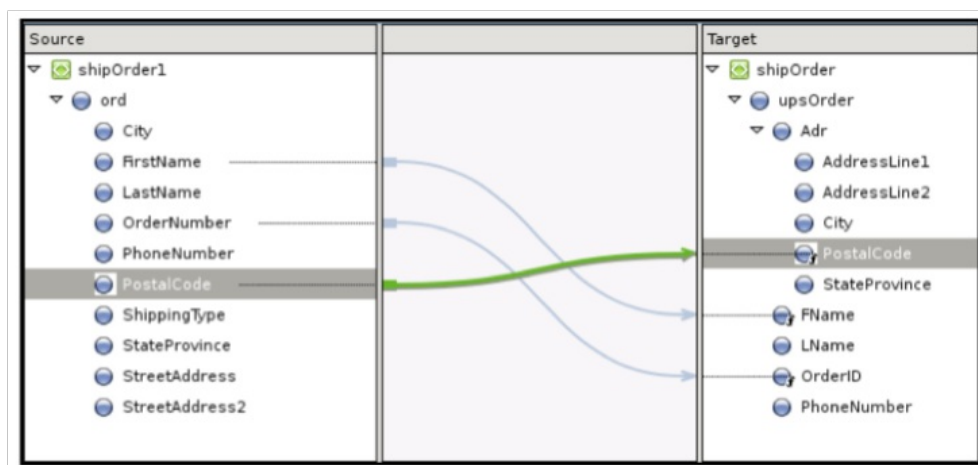


Data Transformation

- 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

Resequencer

- 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)

