Middleware and Web Services

Lecture 10: Service Orchestration

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Overview

- Business Processes in SOA
 - Process Execution Models
 - Key Mapping
- Business Process Management Notation

• Service Orchestration

- How a functionality of a service is realized by interactions with other services.
- Business process is one possible form of a service orchestration that uses a business process language to describe the orchestration.

Business Process

- A set of activities and transitions between activities performed by one or more persons or systems..
- A process usually spans multiple departments/divisions and applications

Business Process Management

- Management of business processes that involves:
 - → *Methodology to design processes*
 - → Tools to design, execute, monitor processes

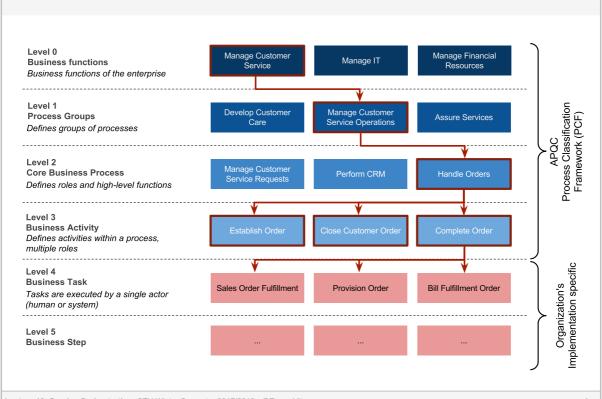
Business process standardization

- APOC American Productivity & Quality Center
- TMForum eTOM Enhanced Telekom Operations Map (Business Process Framework)

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Process Classification Framework: Recall

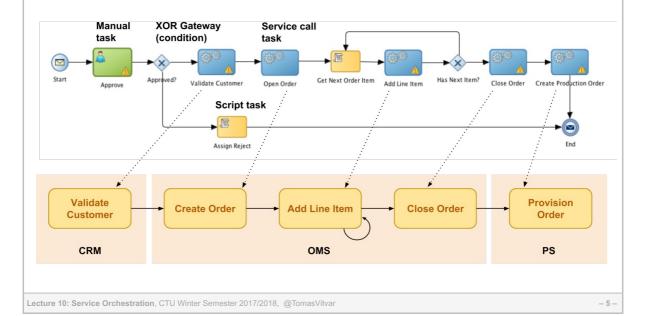


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Level 5 Business Process

Level 5 Details

- The lowest level of a process classification framework
- Level 5 business process involves technical parts that run in ESB



Languages

- Business Process Management Notation (BPMN)
 - Easy to understand
 - Originally only a language for people to model processes
 - Now also possible to describe execution ready processes
 - → Seamless transition from a business view to a technical view
- Business Process Execution Language (BPEL)
 - Only execution language for ESB, not suitable for modeling higher levels of business processes
 - Architects need to translate from BPMN (or other language) to BPEL
 - → Part of technical SOA design

- Business Processes in SOA
 - Process Execution Models
 - Key Mapping
- Business Process Management Notation

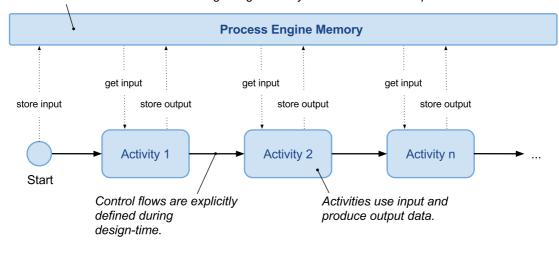
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Static Process Execution

• Explicitly defined process using control flows

Process engine memory stores data that correspond to data schemas. Data schemas are determined during design-time by used activities in the process.

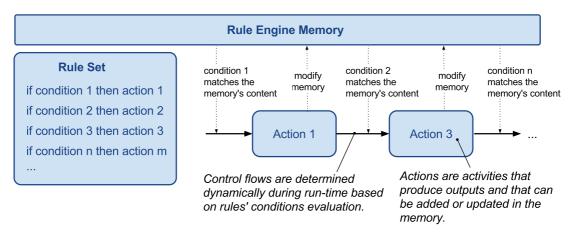


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Dynamic Process Execution

• Implicitly defined process using rules



- Forward-chaining algorithm (inference)
 - 1. A user defines a goal described as a state (memory content)
 - 2. Rule engine finds a rule which condition matches content in the memory
 - 3. Rule's action is executed; the result may add or modify data in the memory
 - 4. When the memory content matches the goal, execution stops otherwise go to 2

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Dynamic Process Execution Example

- Rule Set
 - A: if a customer is a premium customer, give them 10% discount
 - if customer.type=='premium' then order.discount=0.1
 - − B: if a customer is a gold customer, give them 5% discount
 - if customer.type=='gold' then order.discount=0.05
 - C: if customer spends 1,000 or more, make them a premium customer
 - if customer.revenue>1000 then customer.type='premium'
 - Note: actions are memory modifications but can be results of service calls
- Execution
 - Option 1

```
MEM: customer.type=='gold', customer.revenue==1500
```

Rules C A

MEM: customer.type=='premium', customer.revenue==1500,

order.discount==0.1

- Option 2

MEM: customer.type=='gold', customer.revenue==200

Rules: B

MEM: customer.type=='gold', customer.revenue==200, order.discount==0.05

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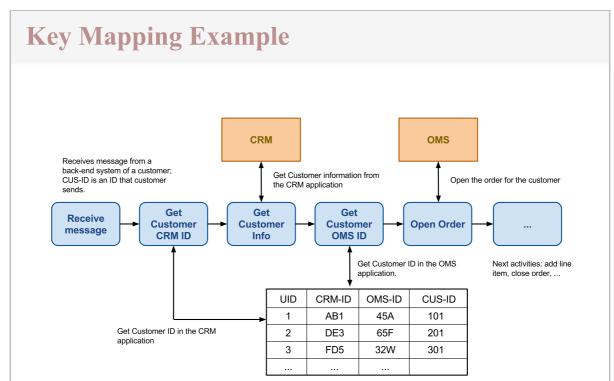
Overview

- 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: Business Entity CUSTOMER

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Overview

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BPMN Constructs – Activities and Gateways

• Activities (Tasks)













- Service Task synchronous service invocation
- Send and receive task asynchronous service invocation
- User task human step, managed by workflow engine
- Manual task human step, not managed by workflow engine
- Script task automatic activity, assigning variables, modify variables' values
- Call activity to call a another process (modularisation, process chaining)

Gateways







- Exclusive OR (XOR)
- Inclusive OR (OR)
- Parallel fork and join (AND)
- Complex gateway

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BPMN Constructs – Catch Events

Catch Events

- They start a process or continue a process from a sub-process when event occurs.















- Catch Event Types

- → Start Message starts a process by a new message
- → Start Timer starts a proceess by a timer
- → Start Signal starts a process by a new event
- → Catch Error catches error during execution of an activity (boundary event)
- → Catch Timer a timeout when during execution of an activity (boundary event)
- → Catch Signal catches a signal during execution of an activity (boundary event)

BPMN Constructs – Throw Events

• Throw Events

- They end a process or a sub-process



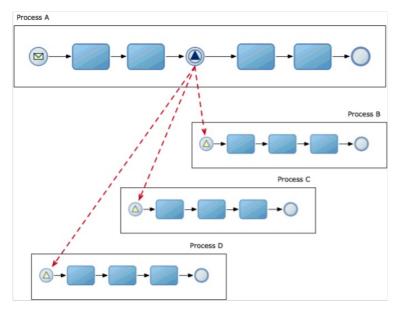
- Throw Event Types
 - → End Message ends a process by sending a message back to client
 - \rightarrow End Terminate ends a process silently
 - → End Signal ends a process by signalling an event
 - → End Error ends a process by throwing an error (fault)
 - → Throw Message throws a message during process execution
 - → Throw Signal throws an event during process execution

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Throw and Catch Events

- Broadcasting a signal
 - Process A throws a signal, processes B, C, and D catch the signal and start

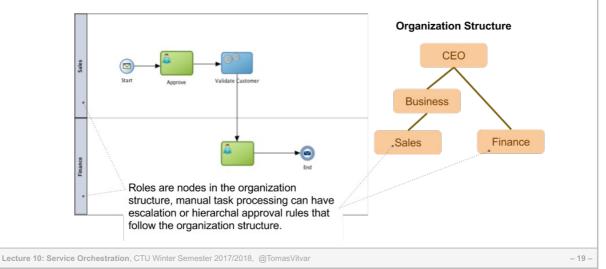


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Swim Lanes

- Swim Lanes
 - Group of activities in a process
 - Each swim lane is associated with a role; a user in the role performs activities
 - A special role "Automated" or "System" defines automated activities or activites performed by the system, not humans.
- Example



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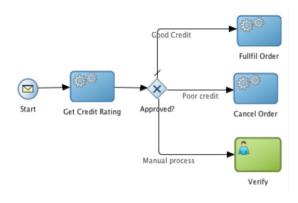
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Exclusive OR

Definition

- XOR defines multiple alternative paths
- One and only one path can result from an evaluation of conditions on each branch
- There must be a **default path**
 - → Path that will be used when no conditions on other paths will evaluate to true

Example



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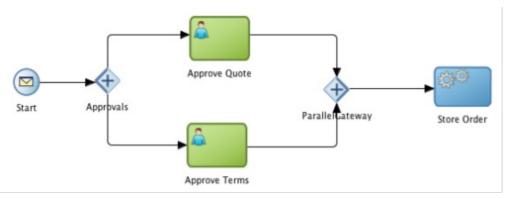
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Parallel Fork and Join

Definition

- AND Gateway defines multiple paths
- All paths are processed
- All paths must be either joined by AND Gateway or each path may end with a separated end events

Example



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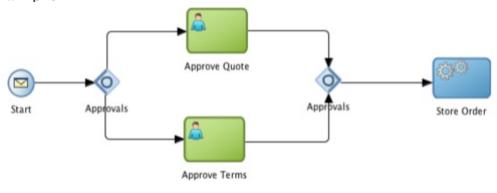
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Inclusive OR

Definition

- OR Gateway defines multiple paths
- One or more paths are processed in parallel
 - → There can be more than one possible outcomes
- There can be a default path
- All paths must be either joined by OR Gateway or each path may end with a separated end events

Example



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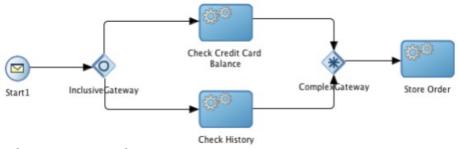
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Complex Gateway

Definition

- Evaluates conditions to decide when the process should continue
- Used only when merging process flows (OR is used for splitting)

• Example



- Complex gatway condition
 - 1 | credit-card/balance/text() > 1000 OR customer/history/num-purchases/text()
 - → Only one condition needs to be satisfied for the process to continue
 - \rightarrow Other parallel flows are canceled

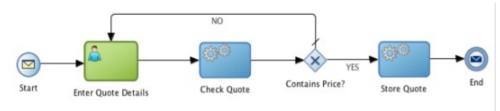
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Loops

Definition

- Loops can be created with XOR Gateways by connecting a flow to a previous step
- XOR checks for conditions
 - \rightarrow logical expression or counters

Example



- Example condition on "YES" path
 - 1 | quote/price/text() > 0

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Error Handling

Definition

- Mechanism to handle errors during process executions
- Throwing errors
 - \rightarrow On evaluation of conditions
 - \rightarrow A result of external service calls
- Catching Errors
 - → Take actions to resolve errors, continue process execution
 - → Throw errors as a result of process execution

Implementation

- Use boundary catch error events to catch errors on activities or sub-processes
- Implement paths in process flows that resolve errors

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Conversation: Recall

- Definition
 - A group of client-service interactions that logically and technically belong together, e.g. submitOrder, getOrderStatus, cancelOrder
 - There is typically one conversation per process but can be more
- Implementation
 - Single conversation corresponds to a single WSDL interface definition (portType in WSDL 1.1)
 - Two conversations will have own interface definition each
 - → hence you can define separated binding for each
 - To relate interactions in a single conversation, you should have:
 - → a main process, that is a main operation/event that triggers the process and creates a conversation, e.g. submitOrder
 - → a **sub-process** to the main process, e.g. checkStatus
 - WS-Addressing defines MessageID element that is a conversation ID
 - See details in lecture 8

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Correlation

Definition

- Correlation associates a client interaction with a running process instance by using correlation keys and data in an input message.
- A process may have one or more correlations defined

Correlation keys and properties

- Correlations are defined by so called correlation keys
- A key may have one or more properties
 - → Each property value is defined by xpath on a message structure

Example

- A correlation with two properties
 - $\rightarrow Key$: order_correlation
 - → *Property 1:* customer_id
 - → Property 2: order_id

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Correlation Example

- Correlation key for Order message
 - Order message

```
<s:Envelope xmlns:s="http://schemas.xmlsoap.org/soap/envelope/">
        <s:Body>
          <ns2:Order>
5
6
7
8
9
10
11
12
13
                  <ns2:OrderId>566</ns2:OrderId>
                  <ns2:CustomerId>4354</ns2:CustomerId>
                  <ns2:Address>Thakourova 6</ns2:Address>
                  <ns2:Phone>+42024537765</ns2:Phone>
                  <ns2:LineItems>
                      <ns2:item>
                         <ns2:name>HP ProBook 4540s</ns2:name>
                         <ns2:price>900</ns2:price>
                      </ns2:item>
                  </ns2:LineItems>
               </ns2:Order>
           </ns1:submitOrder>
       </s:Body>
    </s:Envelope>
```

- Correlation key order correlation, xpath definition

```
customer_id property: /ns1:submitOrder/ns2:Order/ns2:CustomerId
order_id property: /ns1:submitOrder/ns2:Order/ns2:OrderId
```

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