

# Middleware and Web Services

## Lecture 9: Service Orchestration

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## Overview

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

# Overview

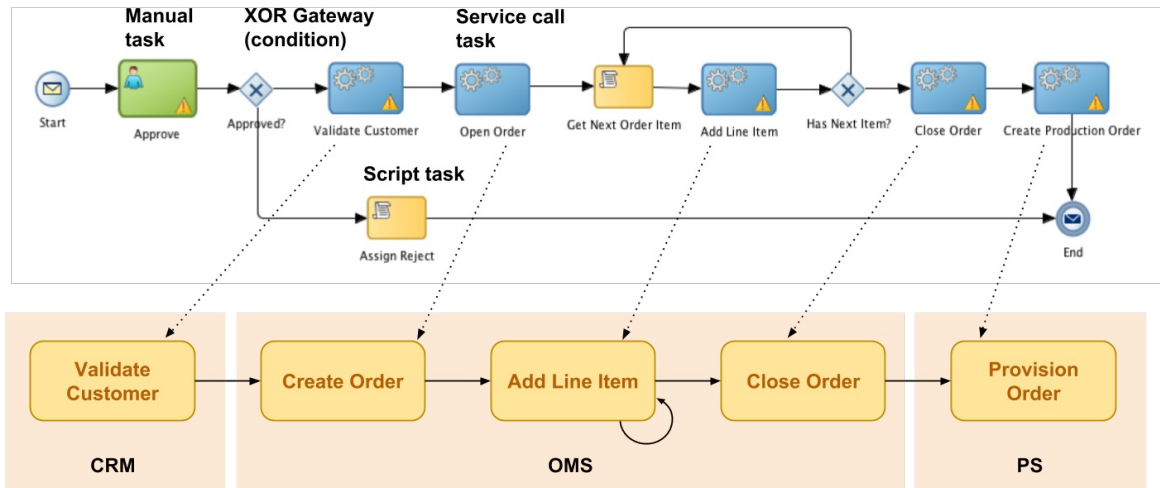
- **Service Orchestration**
  - *How a functionality of a service is realized by interactions with other services.*
  - *Business process is one possible form of a service orchestration that uses a business process language to describe the orchestration.*
- **Business Process**
  - *A set of activities 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**
  - *APQC – American Productivity & Quality Center*
  - *TMForum – eTOM – Enhanced Telekom Operations Map (Business Process Framework)*

## Process Classification Framework: Recall



## 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

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  - *Process Execution Models*
  - *Key Mapping*
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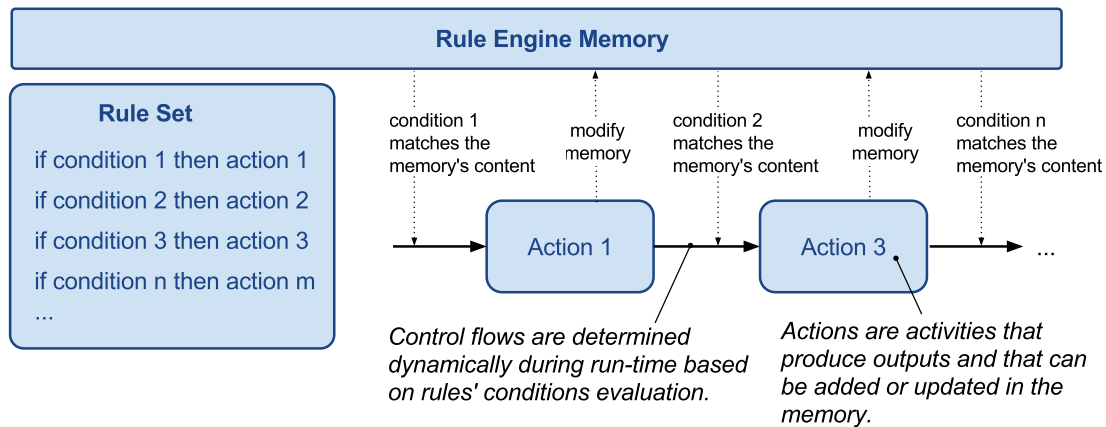
## Static Process Execution

- Explicitly defined process using control flows



# 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

# 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`

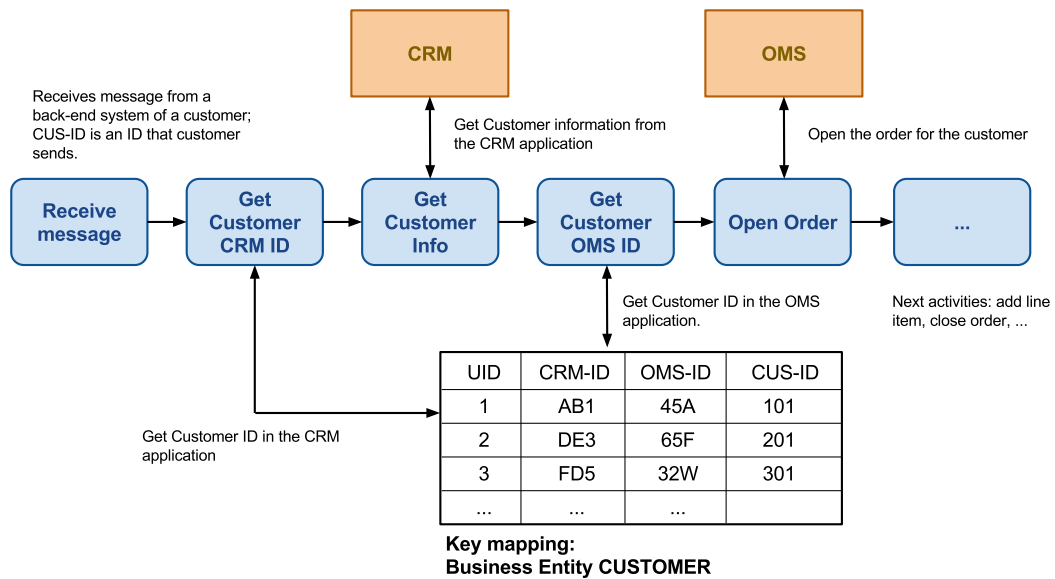
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## Overview

- What is key mapping
  - *Key = identifier of an 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 mapping 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



## Overview

- Business Processes in SOA
- Business Process Management Notation
  - Patterns
  - Conversation and Correlation

## 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

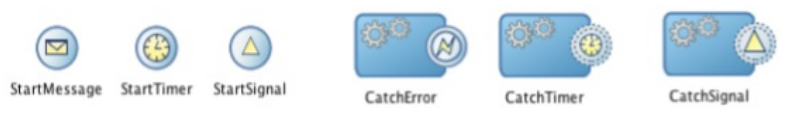


- Exclusive OR (XOR)
- Inclusive OR (OR)
- Parallel fork and join (AND)
- Complex gateway

## 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



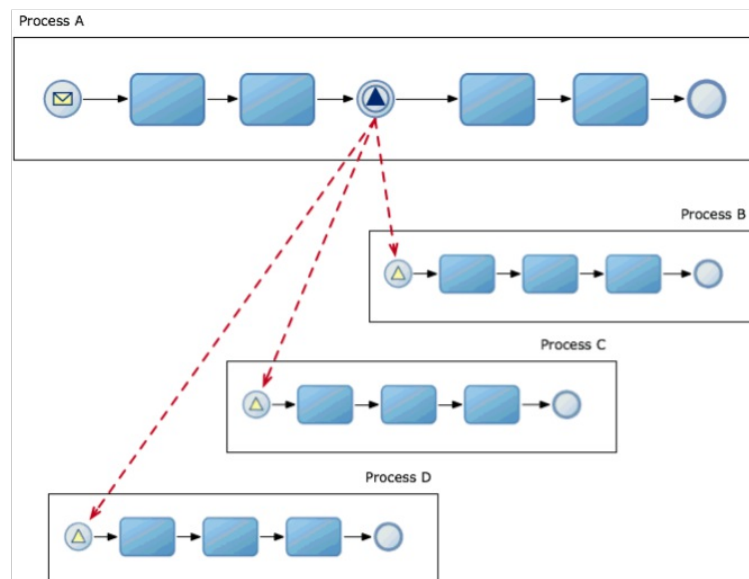
- Throw Event Types

- End Message – ends a process by sending a message back to client
    - 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

## Throw and Catch Events

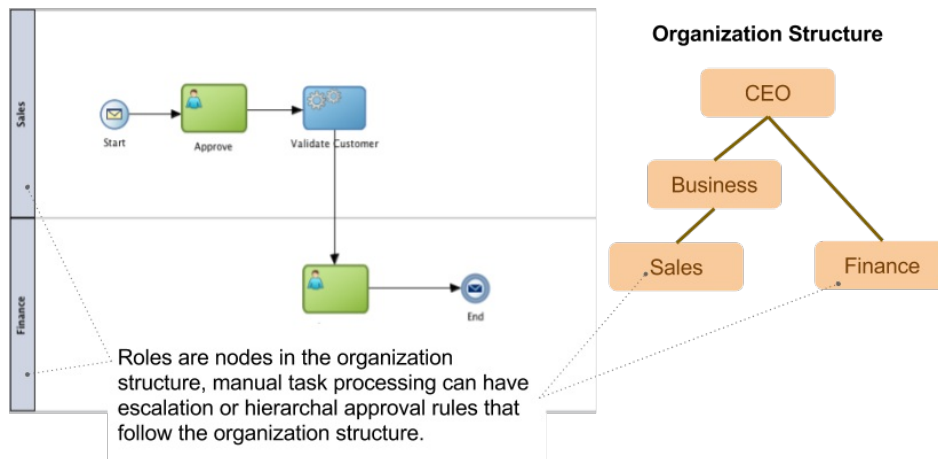
- Broadcasting a signal

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



## 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 activities performed by the system, not humans.
- Example

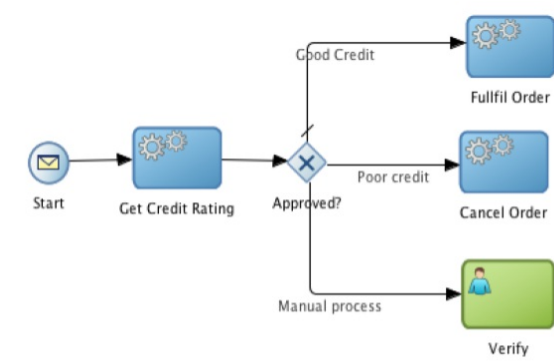


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  - *Patterns*
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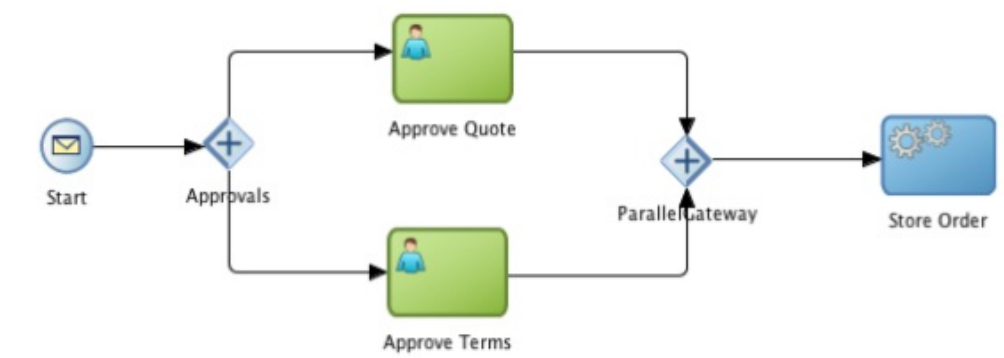
## Exclusive OR

- 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



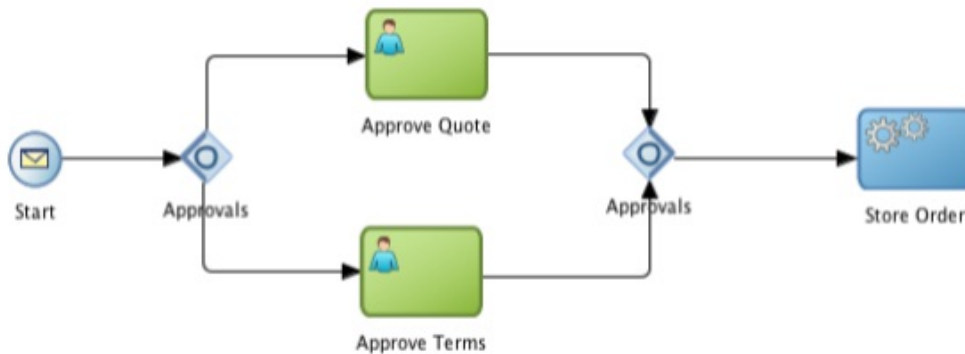
## Parallel Fork and Join

- 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



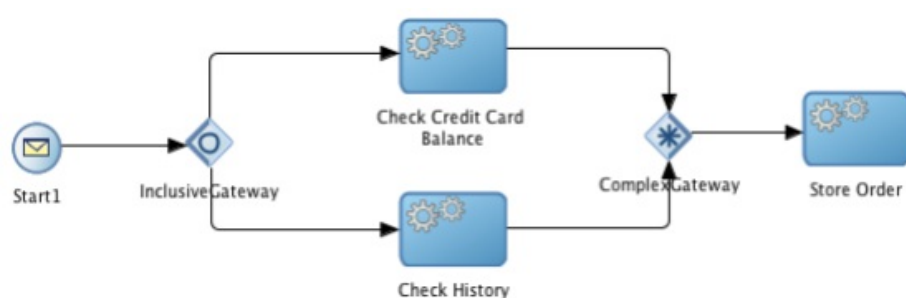
## Inclusive OR

- 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



## 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 gateway 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

→ Other parallel flows are canceled

## Loops

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



- Example condition on "YES" path

```
1 | quote/price/text() > 0
```

## Error Handling

- Definition
  - Mechanism to handle errors during process executions
  - Throwing errors
    - On evaluation of conditions
    - 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](#)*

# 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
    - Key: **order\_correlation**
    - Property 1: **customer\_id**
    - Property 2: **order\_id**

## Correlation Example

- Correlation key for Order message
  - Order message

```
1  <s:Envelope xmlns:s="http://schemas.xmlsoap.org/soap/envelope/">
2    <s:Body>
3      <ns1:submitOrder xmlns:ns1="http://xmlns.oracle.com/bpmn/bpmnProcess/Process"
4                        xmlns:ns2="http://www.example.org/order">
5        <ns2:Order>
6          <ns2:OrderId>566</ns2:OrderId>
7          <ns2:CustomerId>4354</ns2:CustomerId>
8          <ns2:Address>Thakourova 6</ns2:Address>
9          <ns2:Phone>+42024537765</ns2:Phone>
10         <ns2:LineItems>
11           <ns2:item>
12             <ns2:name>HP ProBook 4540s</ns2:name>
13             <ns2:price>900</ns2:price>
14           </ns2:item>
15         </ns2:LineItems>
16       </ns2:Order>
17     </ns1:submitOrder>
18   </s:Body>
19 </s:Envelope>
```

- Correlation key **order\_correlation**, xpath definition

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