

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 0
Business functions
Business functions of the enterprise

Manage Customer Service

Manage IT

Manage Financial Resources

Level 1
Process Groups
Defines groups of processes

Develop Customer Care

Manage Customer Service Operations

Assure Services

Level 2
Core Business Process
Defines roles and high-level functions

Manage Customer Service Requests

Perform CRM

Handle Orders

Level 3
Business Activity
Defines activities within a process, multiple roles

Establish Order

Close Customer Order

Complete Order

Level 4
Business Task
Tasks are executed by a single actor (human or system)

Sales Order Fulfillment

Provision Order

Bill Fulfillment Order

Level 5
Business Step

...

...

...

APQC
Process Classification
Framework (PCF)

Organization's
Implementation specific

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

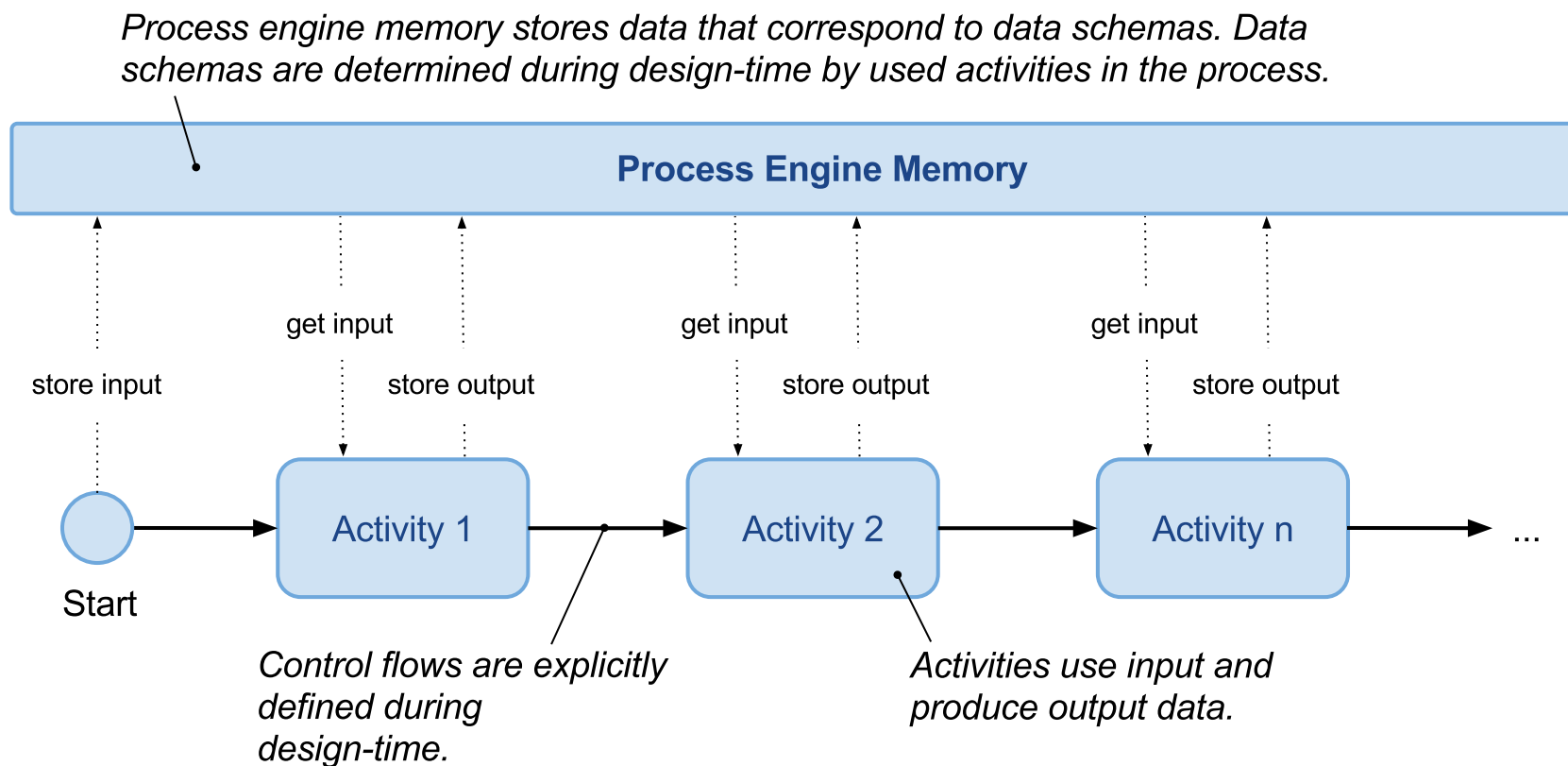
- Business Process Management Notation (BPMN)
 - *Easy to understand*
 - *Originally only a language for people to model processes*
 - *Now also possible to describe execution ready processes*
 - *Seamless transition from a business view to a technical view*
- Business Process Execution Language (BPEL)
 - *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*

Overview

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

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`

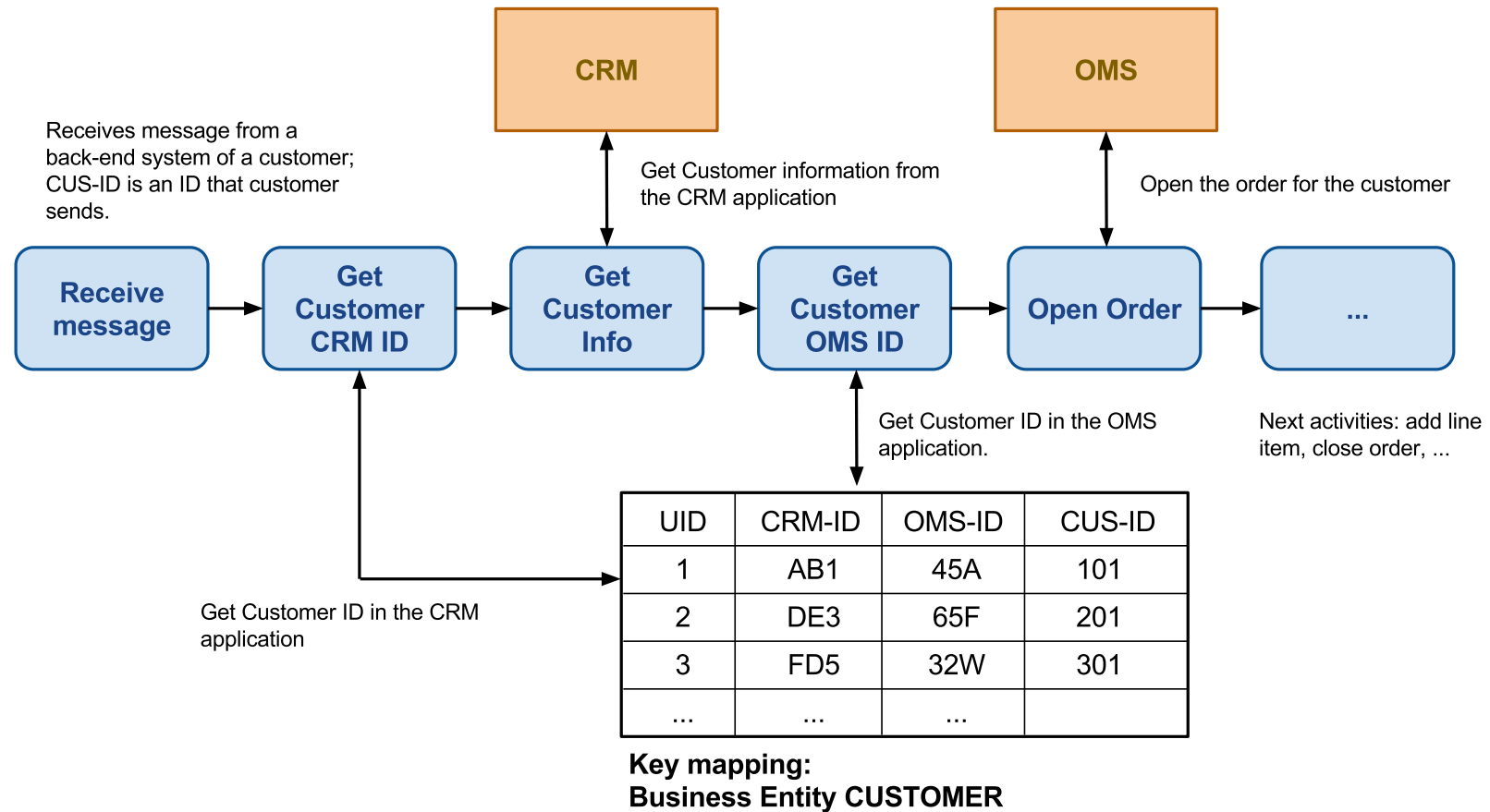
Overview

- Business Processes in SOA
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- Business Process Management Notation

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 process 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

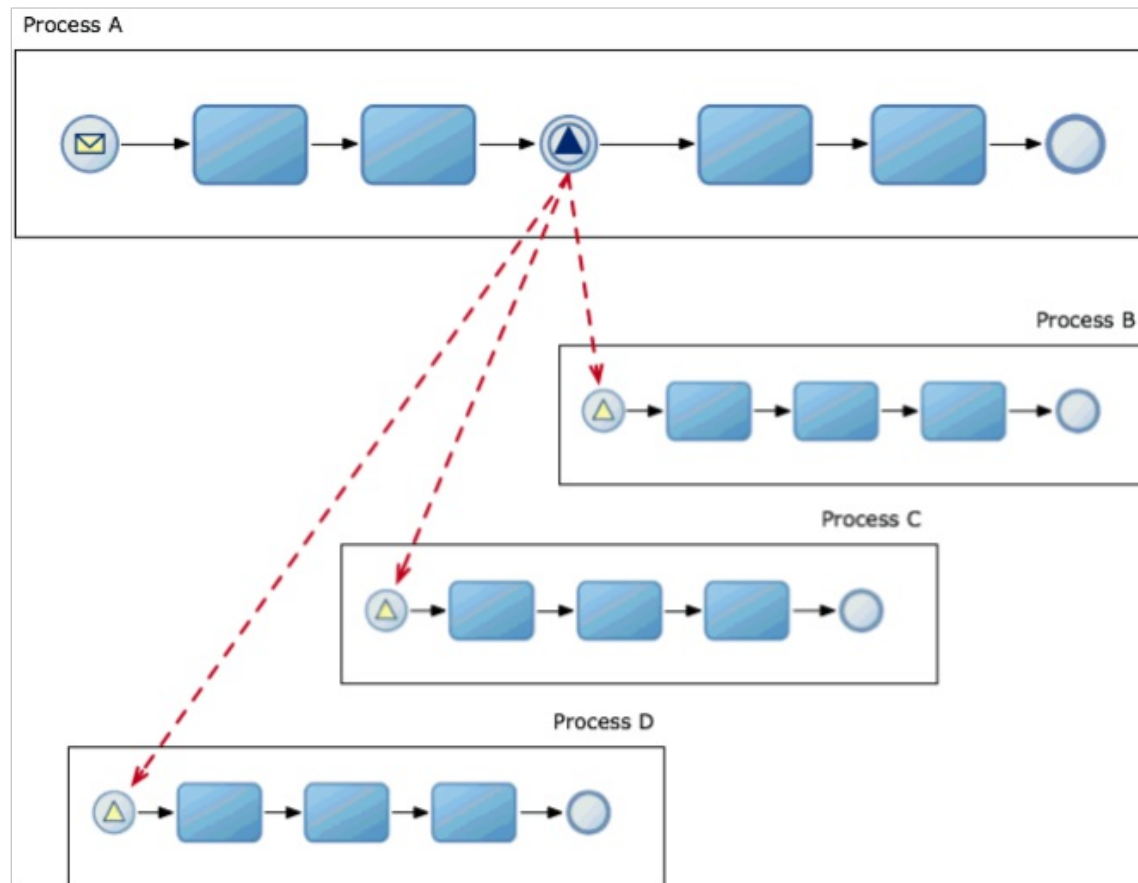
- Throw Events
 - *They end a process or a sub-process*



- *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*

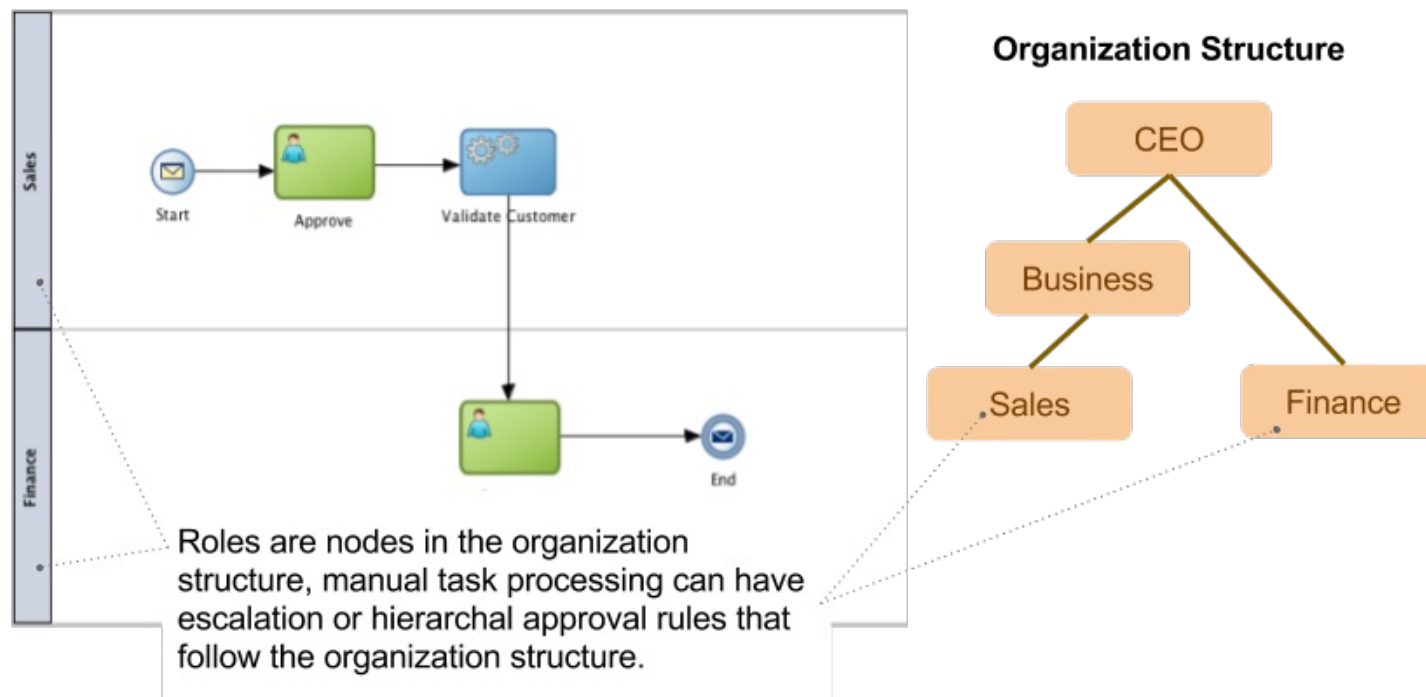
Throw and Catch Events

- 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

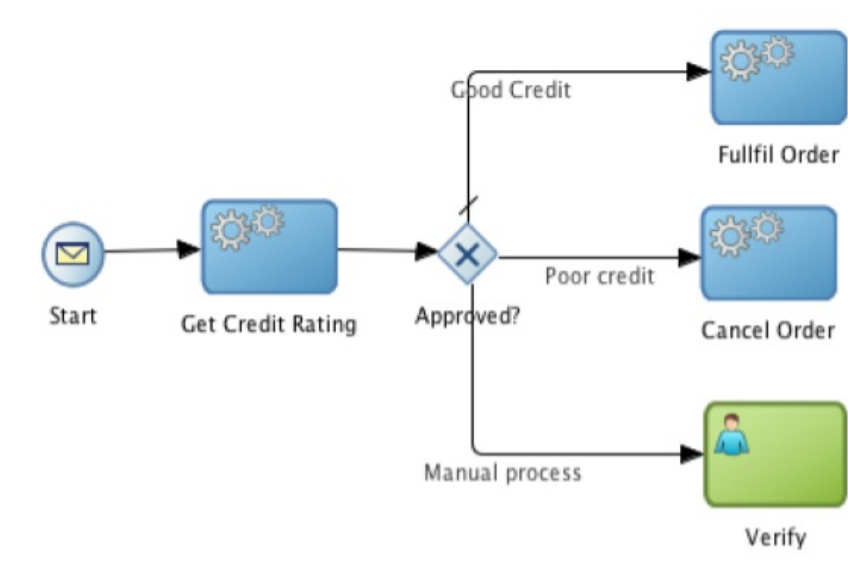


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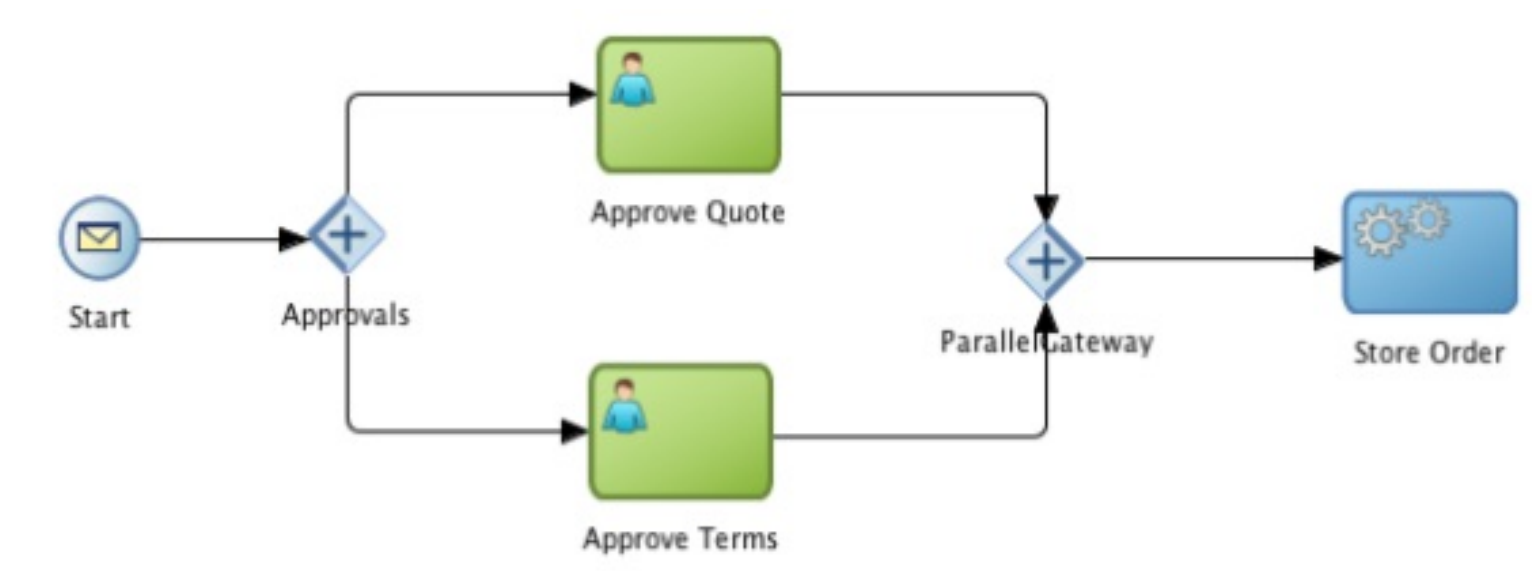
Exclusive OR

- 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



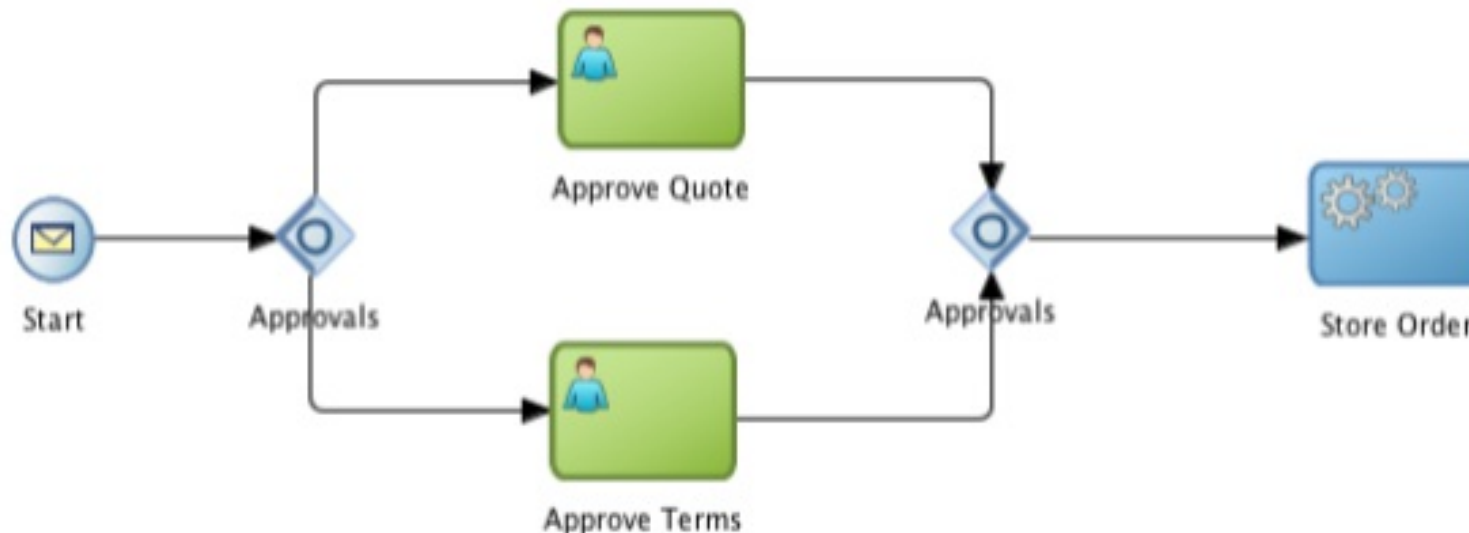
Parallel Fork and Join

- 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



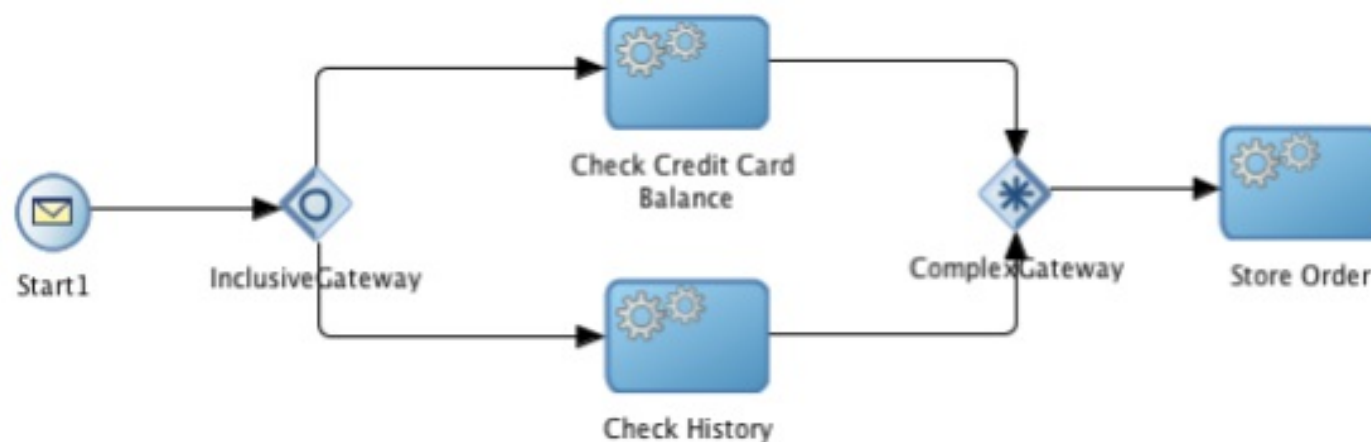
Inclusive OR

- 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() > 10`

→ *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
```