Middleware and Web Services

Lecture 10: Service Orchestration

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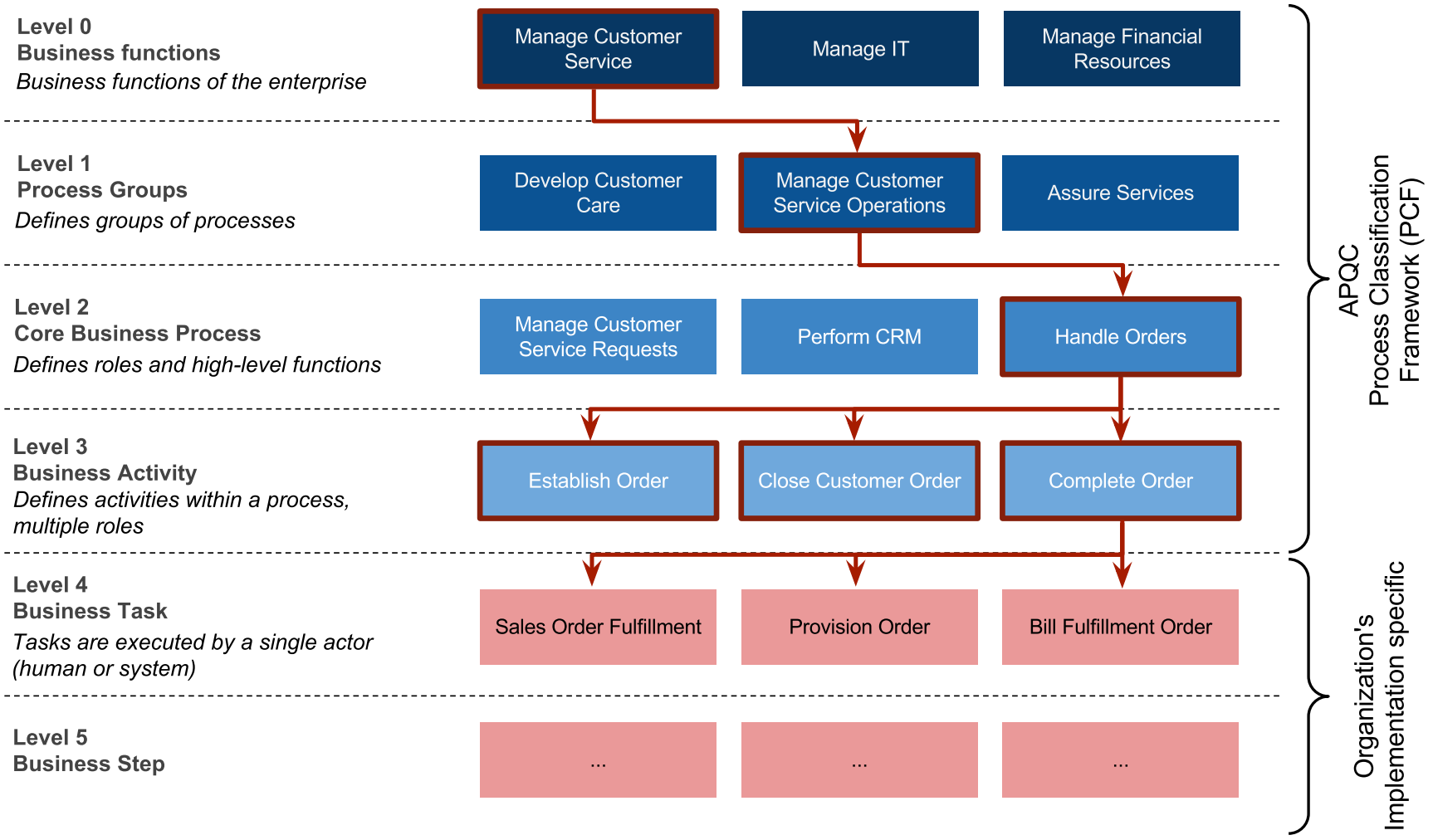
Overview

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

Overview

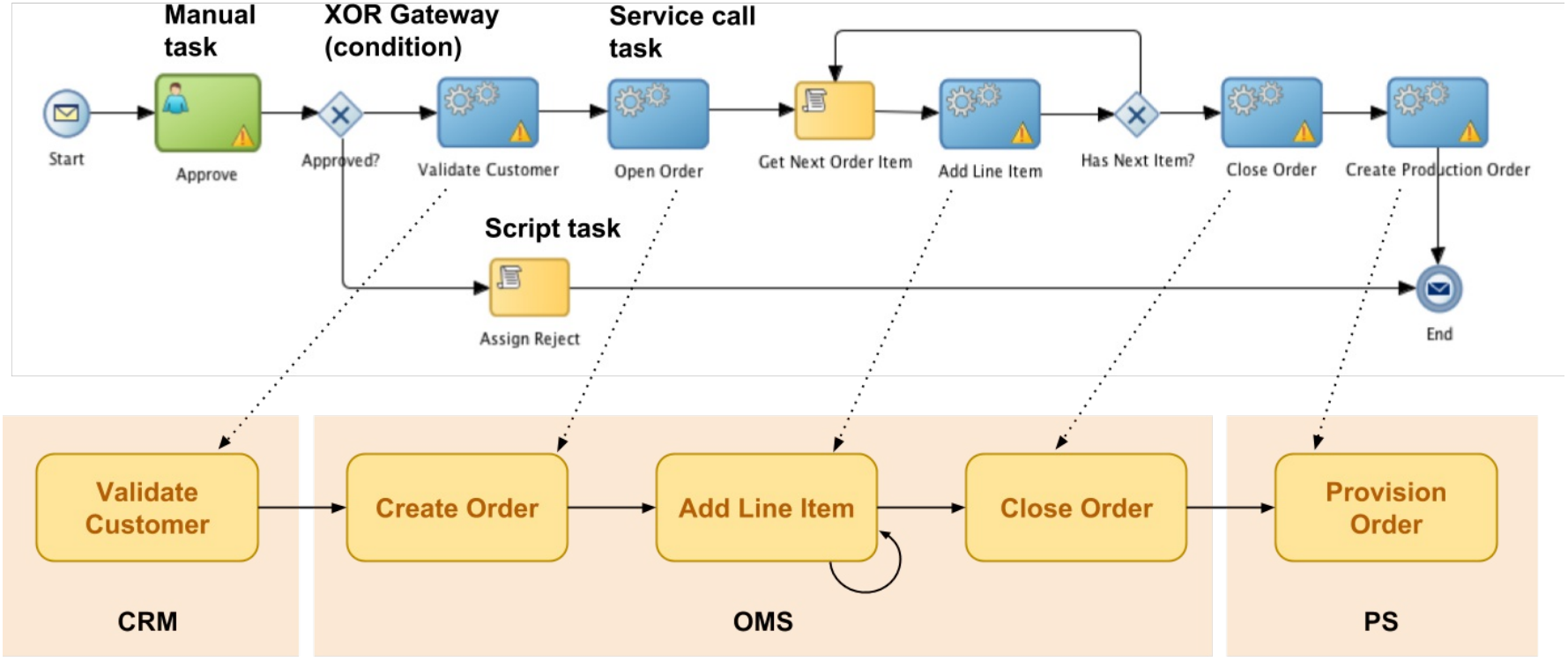
- Service Orchestration
  - *How a functionality of a service is realized by interactions with other services.*
  - *Business process is one possible form of a service orchestration that uses a business process language to describe the orchestration.*
- Business Process
  - *A set of activities and transitions 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*

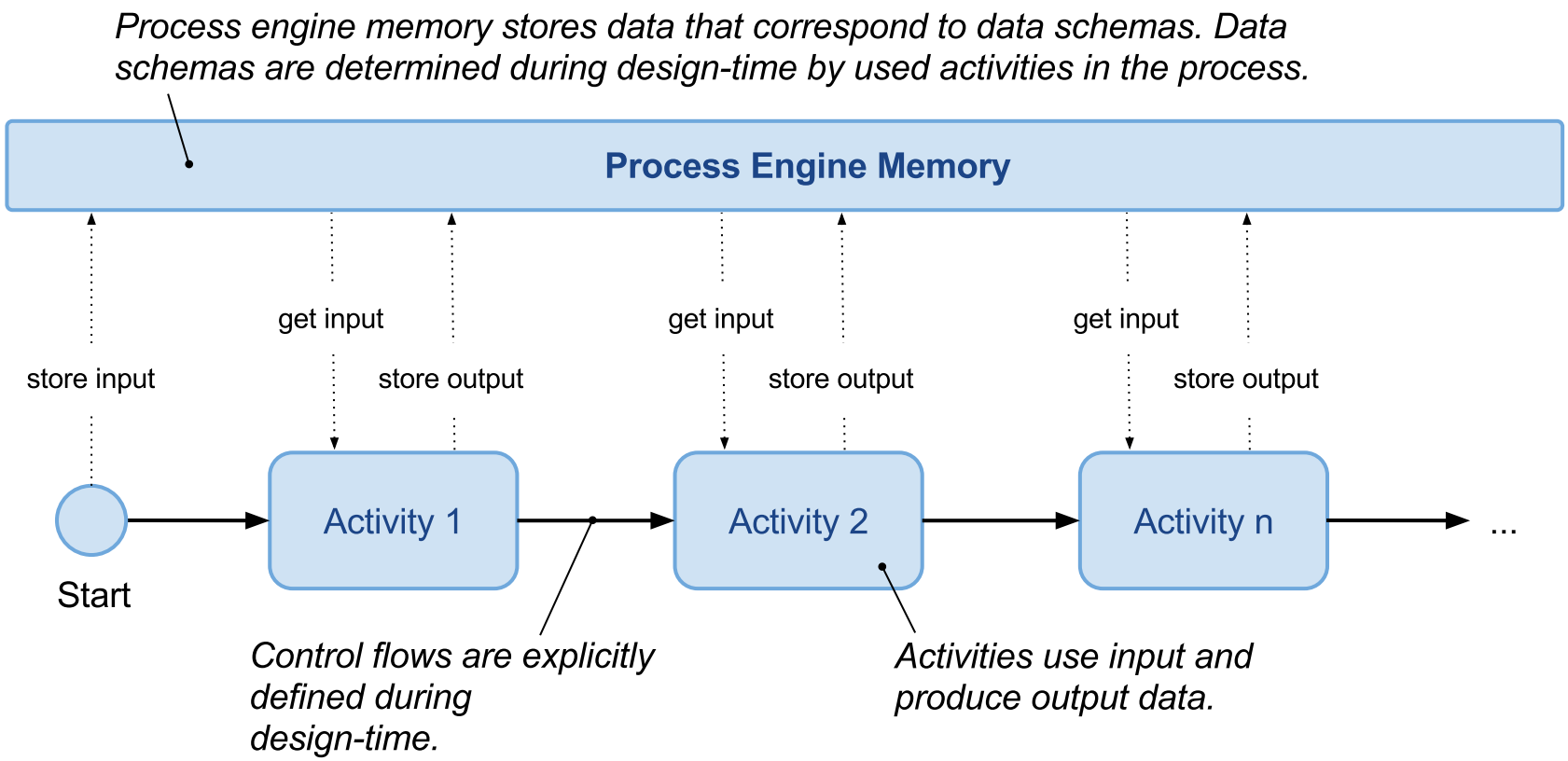
    → Part of technical SOA design

Overview

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

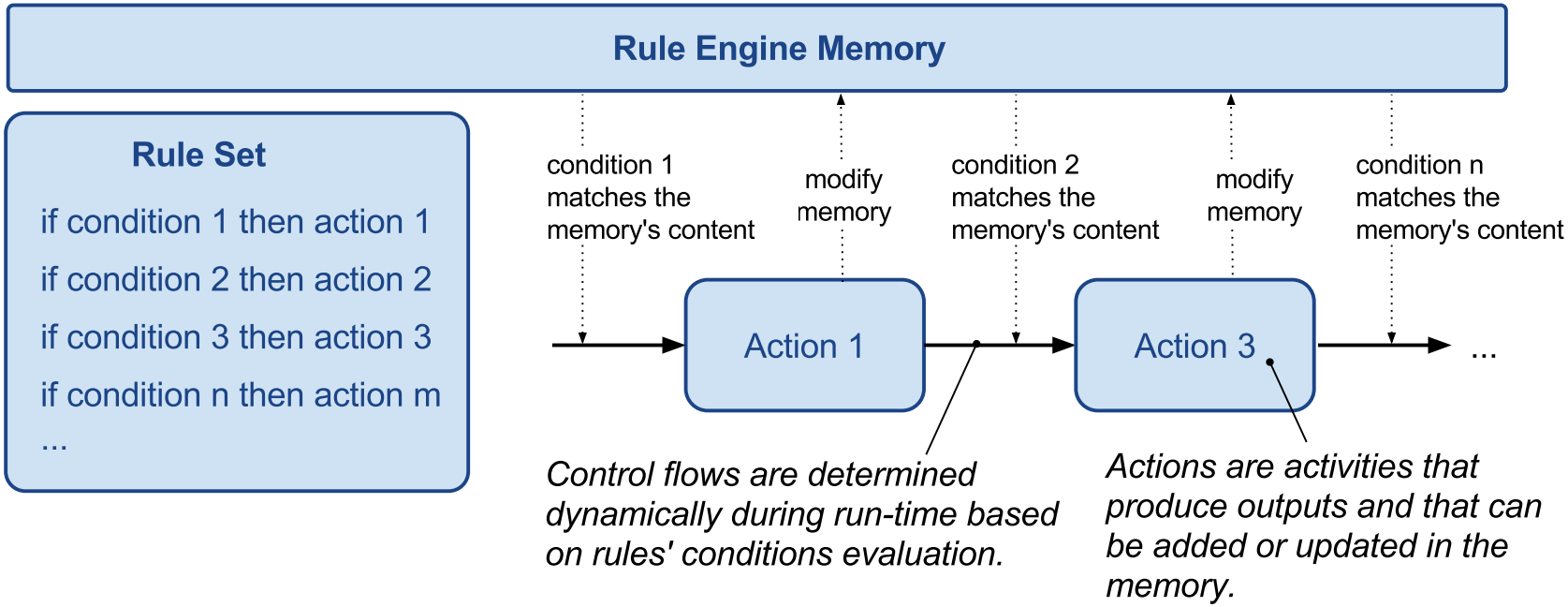
Static Process Execution

- 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

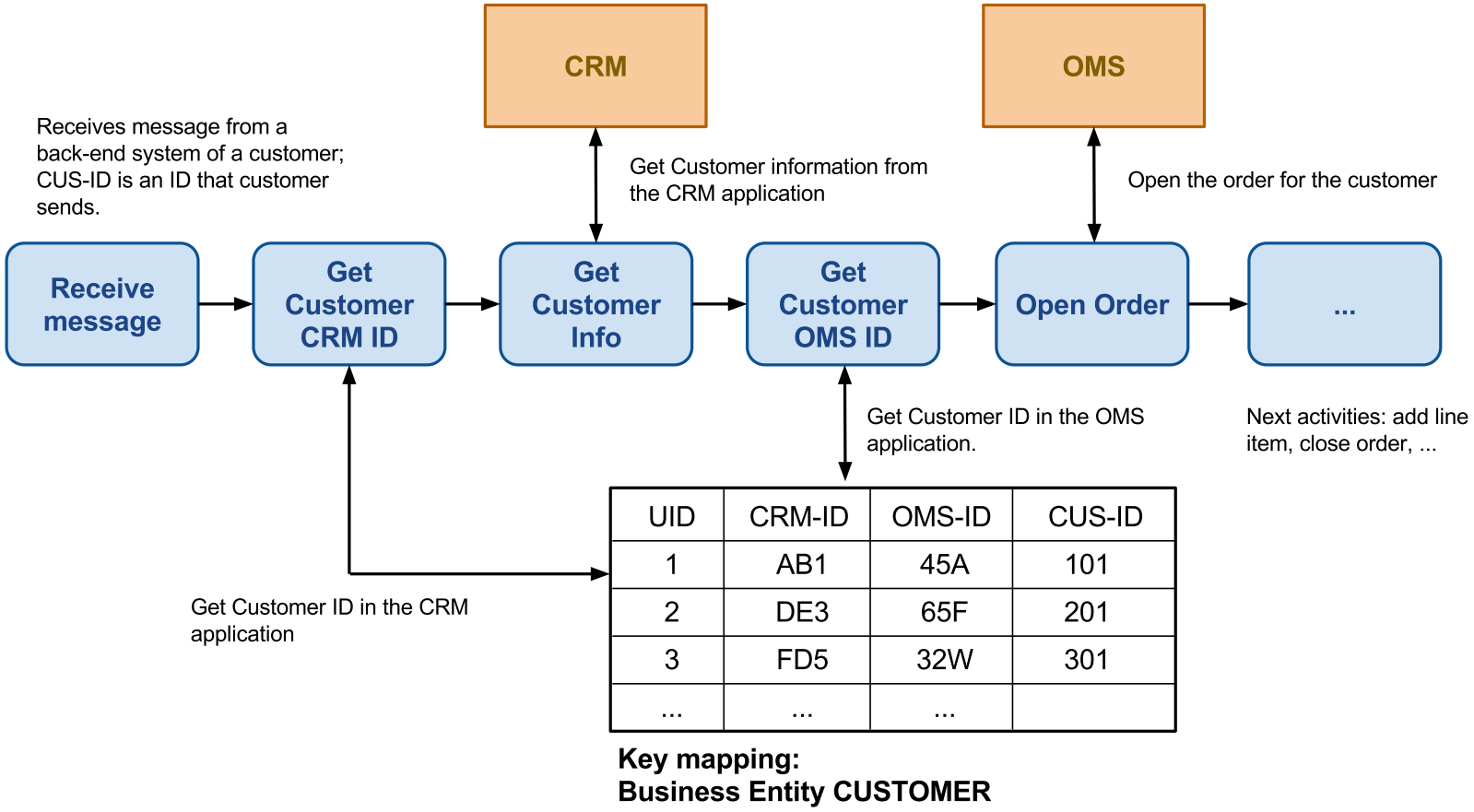
- Business Processes in SOA
  - *Process Execution Models*
  - *Key Mapping*
- Business Process Management Notation

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`

Key Mapping Example



Overview

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

BPMN Constructs – Activities and Gateways

- Activities (Tasks)

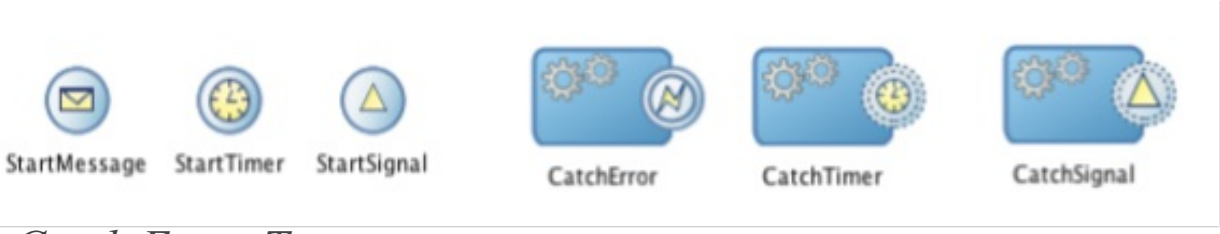
  - *Service Task – synchronous service invocation*
  - *Send and receive task – asynchronous service invocation*
  - *User task – human step, managed by workflow engine*
  - *Manual task – human step, not managed by workflow engine*
  - *Script task – automatic activity, assigning variables, modify variables' 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)*

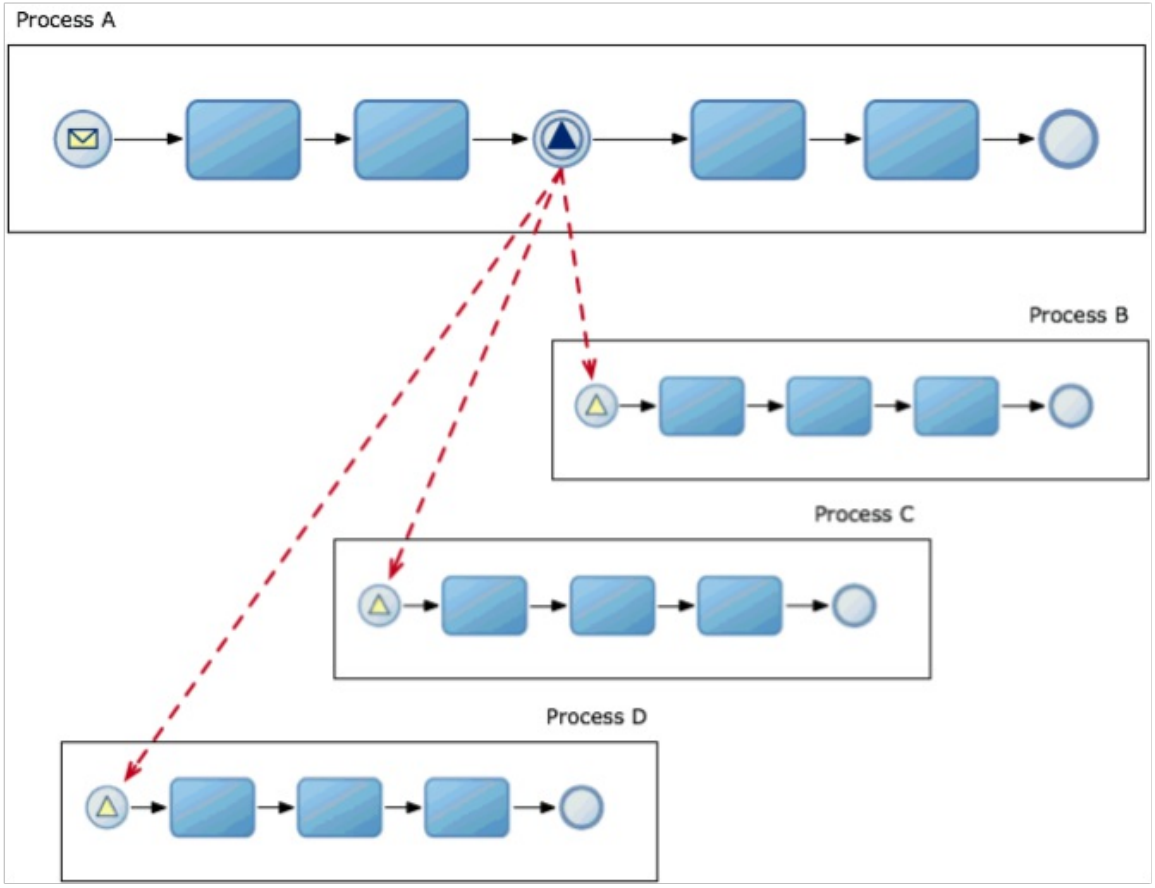
BPMN Constructs – Throw Events

- 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*

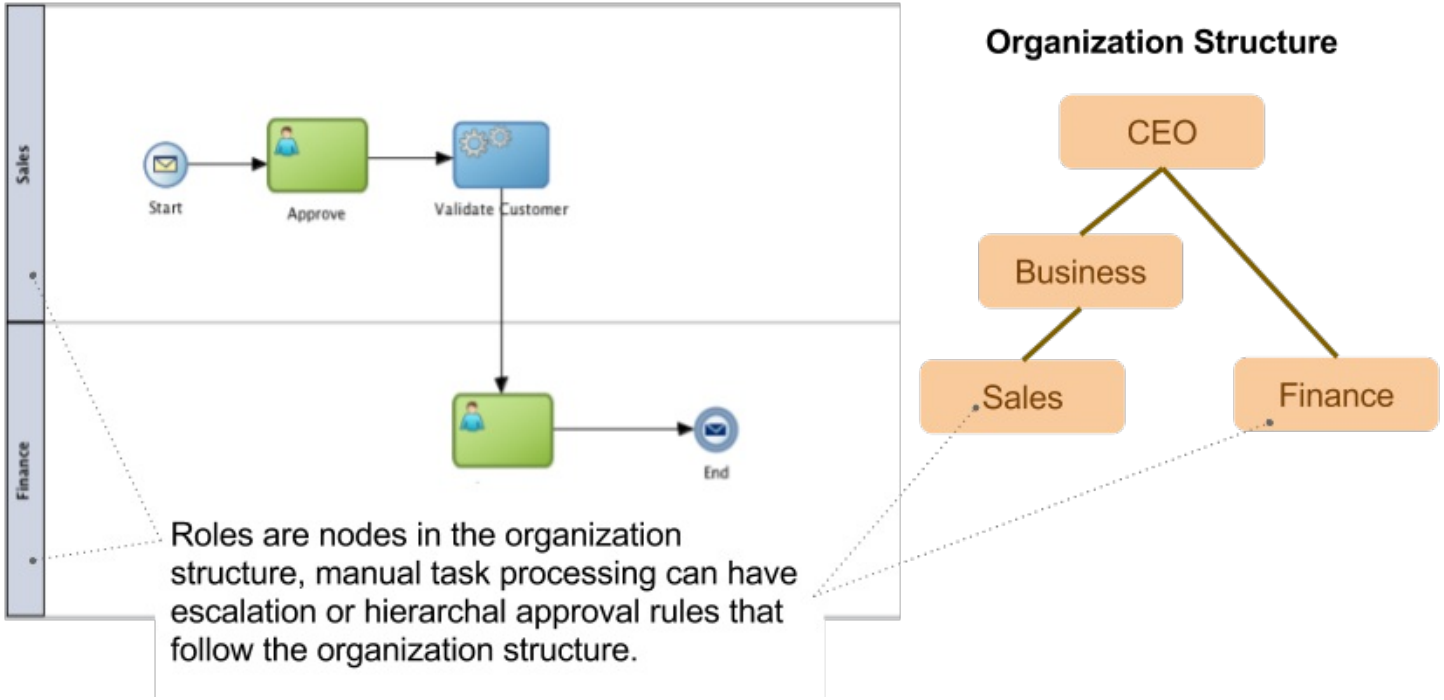
Throw and Catch Events

- 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 activites performed by the system, not humans.*
- Example



Overview

- Business Processes in SOA
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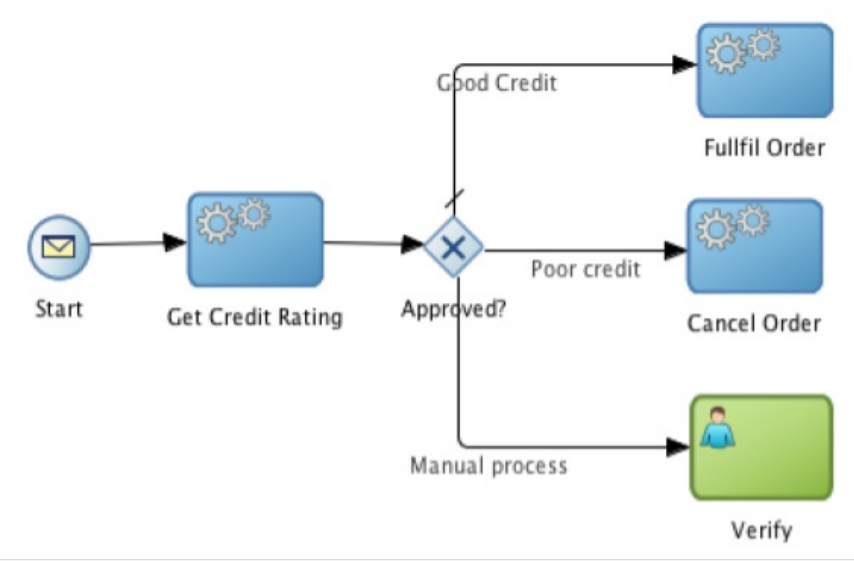
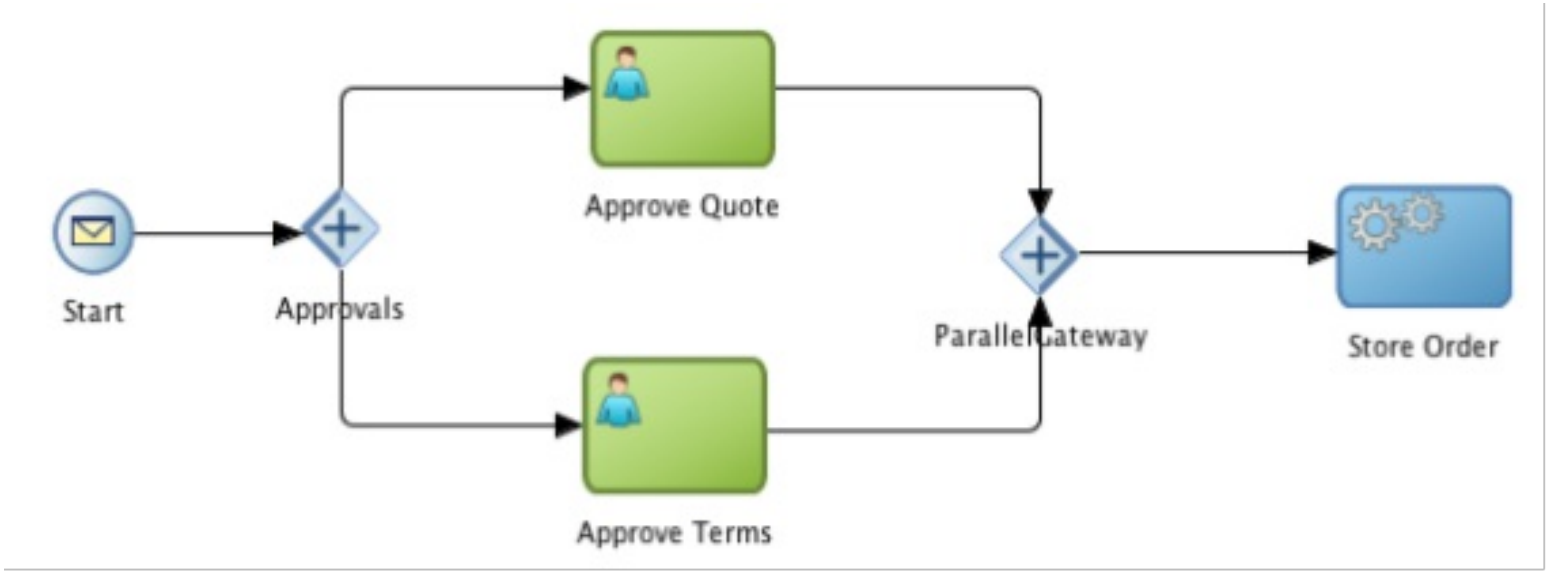
Exclusive OR

- 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



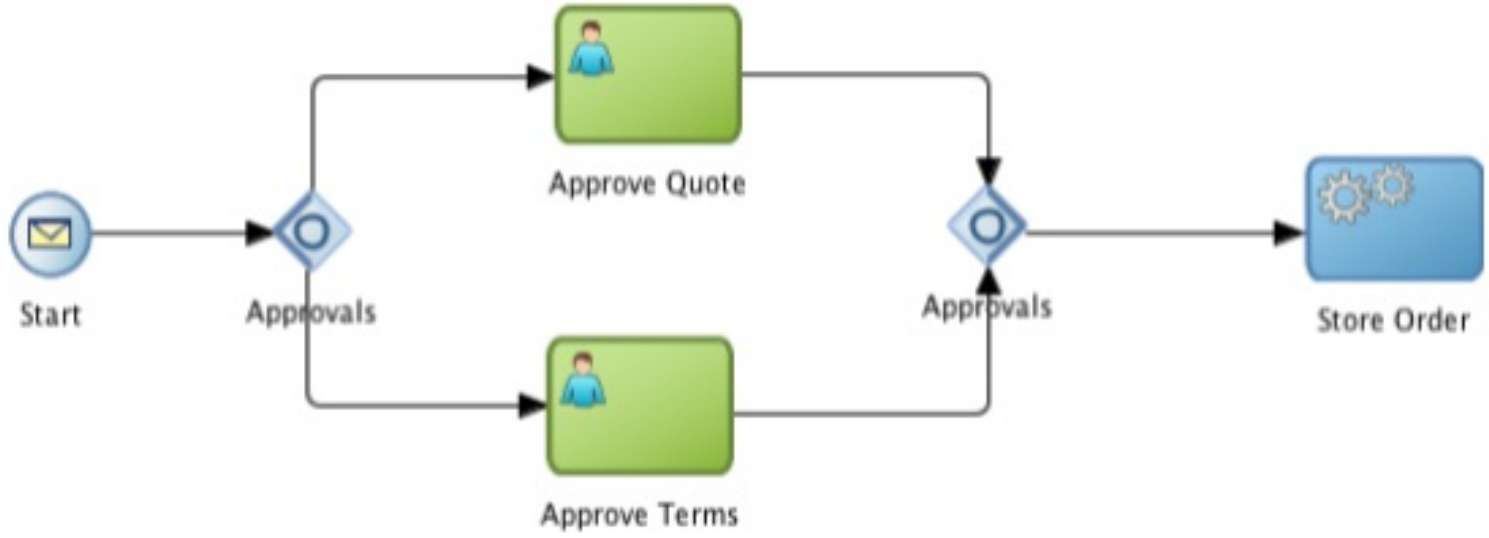
Parallel Fork and Join

- 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



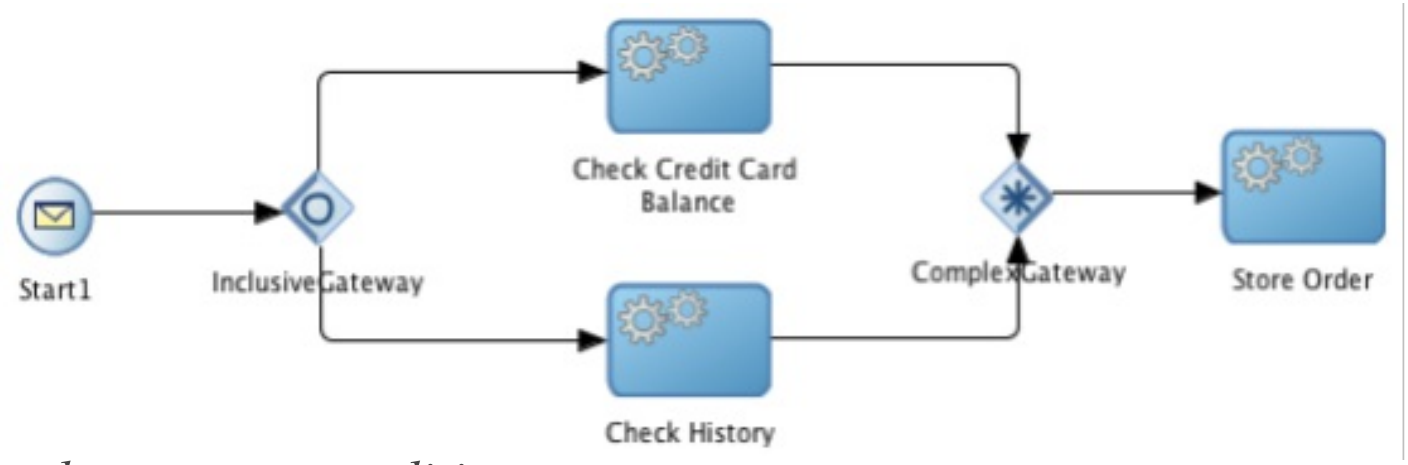
Inclusive OR

- 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



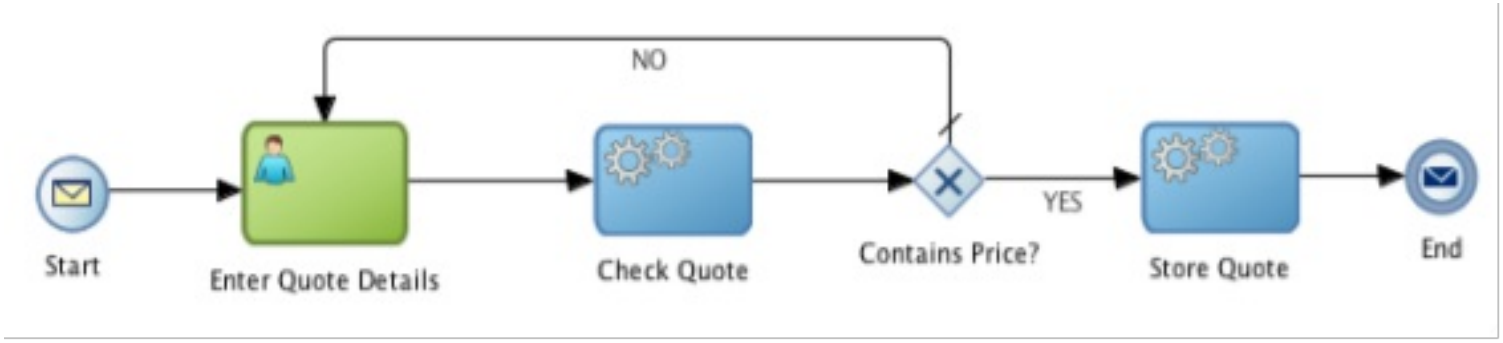
  - *Complex gatway condition*

```
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*

Overview

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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*

```
<s:Envelope xmlns:s="http://schemas.xmlsoap.org/soap/envelope/">
    <s:Body>
        <ns1:submitOrder xmlns:ns1="http://xmlns.oracle.com/bpmn/bpmnProcess/Process"
                         xmlns:ns2="http://www.example.org/order">
            <ns2:Order>
                <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
```