Composition and Orchestration of Services

Oxford University

Software Engineering Programme

Sep 2015

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Business Process Management

- Hammer & Champy [1993] "A collection of activities that takes one or more kinds of input and creates an output that is of value to the customer."
- Davenport [1992] "A structured, measured set of activities designed to produce a specific output for a particular customer or market. It implies a strong emphasis on how work is done within an organization, in contrast to a product focus's emphasis on what."

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Composition

- Services provide *platform- and language-independent access* to *software components*
- But these components are *isolated*: they need to be *assembled* into *service-oriented architectures*
- Ideally, they should be recursively *composable* to form composite services in their own right
- *Workflow* languages for scripting or 'glue' between individual services
- BPMN, WSCI, WSFL, XLANG, BPEL. . .
- beyond mere *business protocol specifications* like RosettaNet, which are essentially paper specifications so can't be automated and won't scale

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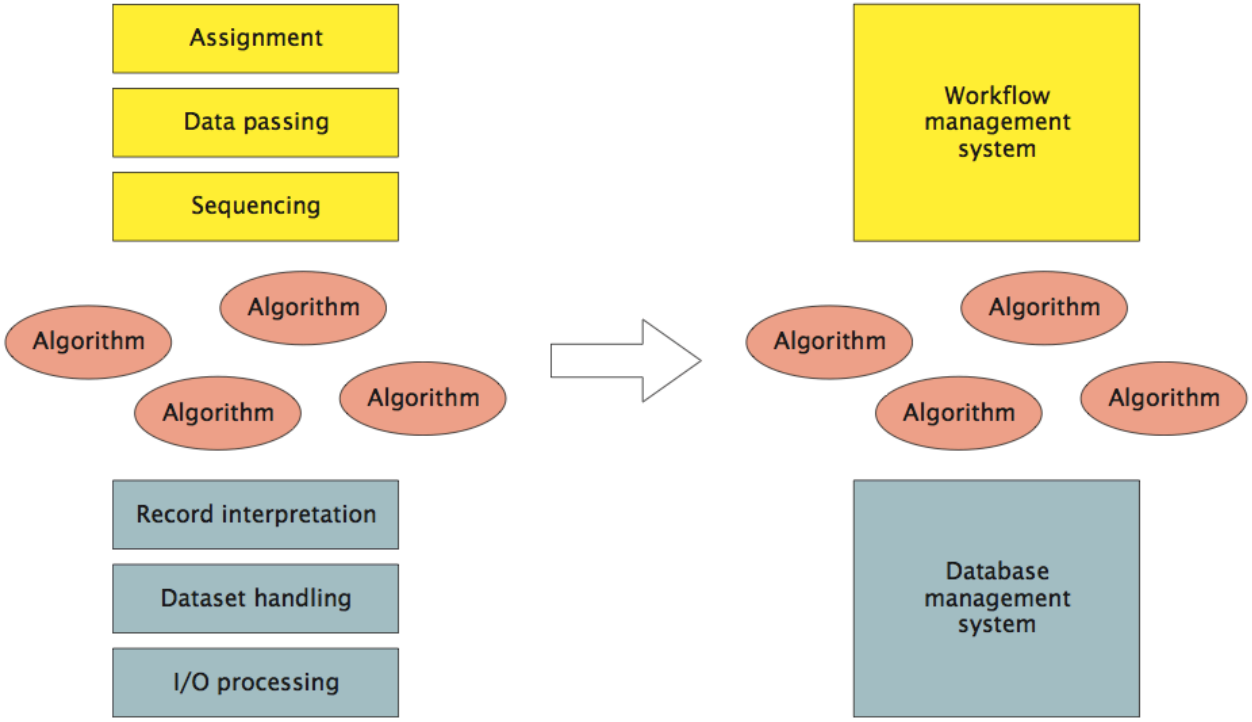
Removal of Dependencies (Leymann and Roller)

- DBMS provides independence from data *representation*; workflow provides independence from control or data *flow*.



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Heritage

- E*nterprise application integration* (EAI)
  - resolving heterogeneity, typically via asynchronous *message brokers*
- *Workflow management systems* (WfMS): automating interactions
  - origins in *office automation*: admin processes
- P*roduction workflows*: from information between people to integration of systems
  - often associated with *business process re-engineering*: assessment, analysis, modelling, definition, implementation
- Service composition = EAI + WfMS

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Motivations

- Model Business Processes
  - Understand what happens?
  - Who is responsible?
  - What is involved?
- Simulate
  - Improve and model
- Execute
  - Automate processes
  - Improve them more quickly
- Monitor
  - Get a real-time health status of processes

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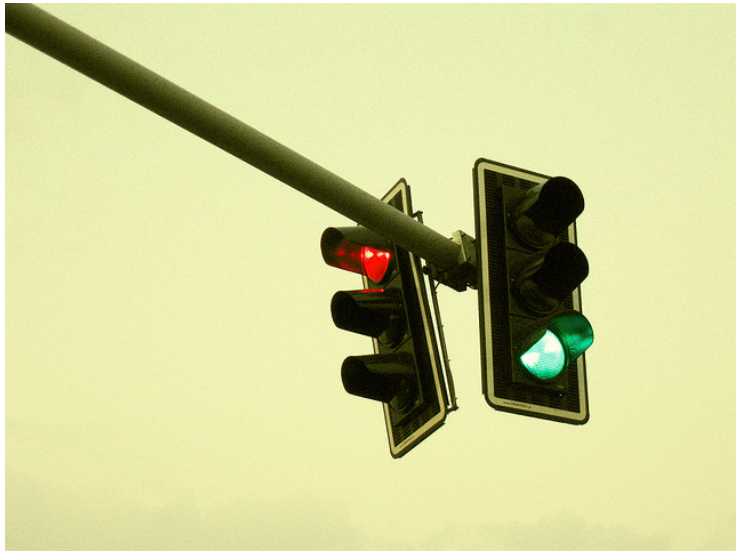
Orchestration vs Choreography

http://www.flickr.com/photos/herrolm/



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Orchestration vs Choreography

- *Orchestration*
  - Describes procedure
  - instructs participants globally – imperative; centralized
  - typically deterministic: ‘must’
- *Choreography*
  - Describes protocol
  - Constraints on interaction, but participants act locally – declarative; no ‘current state’
  - Usually non-deterministic: ‘may’
- Orchestra has a conductor, Ballet does not

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WS-Choreography Description Language

- http://www.w3.org/TR/ws-cdl-10/
- Never got past Candidate Recommendation
- Captures the flow of messages between parties
- Temporal and logical dependencies between messages
- features sequencing rules, correlation, exception handling and transactions
- Not executable

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BPMN 1.1

- Designed to allow process designers to communicate
  - Think UML
- Activities, Gateways, Events
- Control and Data Flow
- Organization modelling (Pools, Swimlanes)

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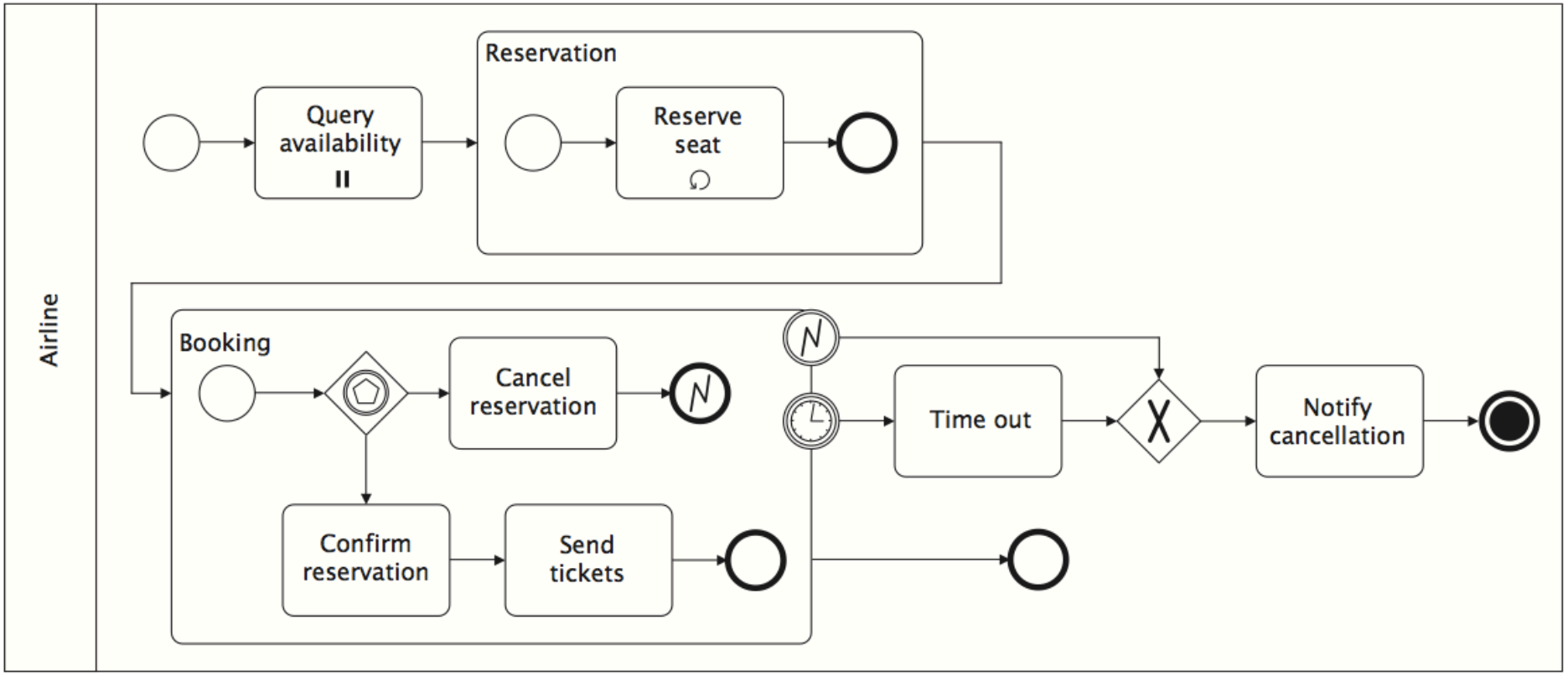
BPMN Example



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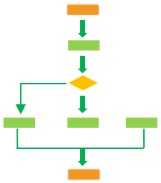
Amazon Simple Workflow Service



DECIDER

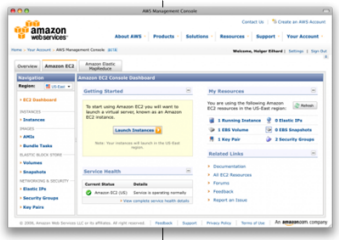
The decider implements the application's business logic

Gets Decision Tasks

Return Decisions

AWS

Amazon SWF



- Maintains distributed application state
- Tracks workflow executions
- Ensures consistency of execution history
- Provides visibility into executions
- Holds and dispatches tasks
- Provides control over task distribution
- Retains workflow execution history

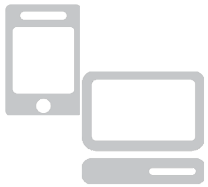
Get Activity Tasks / Return Results

Cloud

Workers for Activity 1

Get Activity Tasks / Return Results

Mobile



Workers for Activity 2

Get Activity Tasks / Return Results

On Premises

Workers for Activity 3

http://aws.amazon.com/swf/

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Business Process Execution Language (BPEL)

- Standardised XML language for executable processes
- Well defined execution
  - No deadlocks
  - Graphs must be acyclic
- Tied to WSDL concepts
- No built in support for human activities (though this has been added)
- No graphical notation

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The main strength of BPEL
(IMO)

- BPEL is a completely executable standalone language
  - PartnerLinks define places where you can call WSDL services
  - Or where other parties can call WSDL Services into the process
- Deployment descriptor + BPEL can be executed without any Java or other language

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The main weaknesses of BPEL
(IMO)

- Too much like a programming language
  - Need WS-HumanTask, BPEL4People and script or Java extensions to make it useful for real processes
- No swimlanes (explained in a minute)
- No common visual notation

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BPMN + BPEL

- In theory:
  - Process experts design and model in BPMN
  - Developers/Implementors implement in BPEL
- No standard bridging/mapping
  - Double the effort

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BPMN 2.0

- A notation for a subset of BPEL
- Execution semantics for BPMN
- Notational support for choreography
- The best of both worlds?

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CMMN

Case Management and Modelling Notation

- A specification from OMG for modelling how to handle cases
- A more flexible approach to workflow that BPMN or BPEL
  - Certain workflows are very clear
    - Building a car
  - Others are more flexible
    - Hand building a mandolin
- Imperative vs “Causative”

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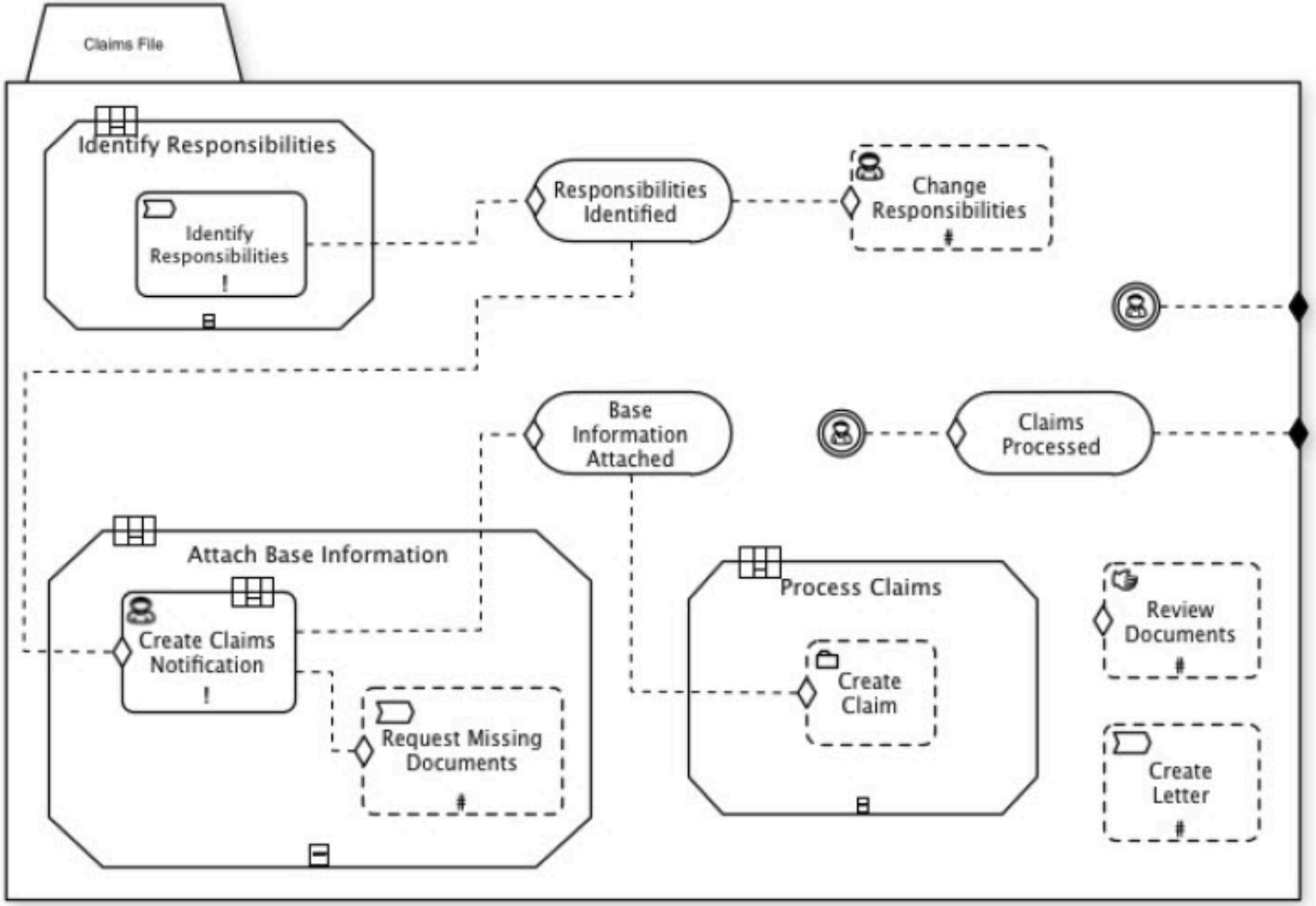
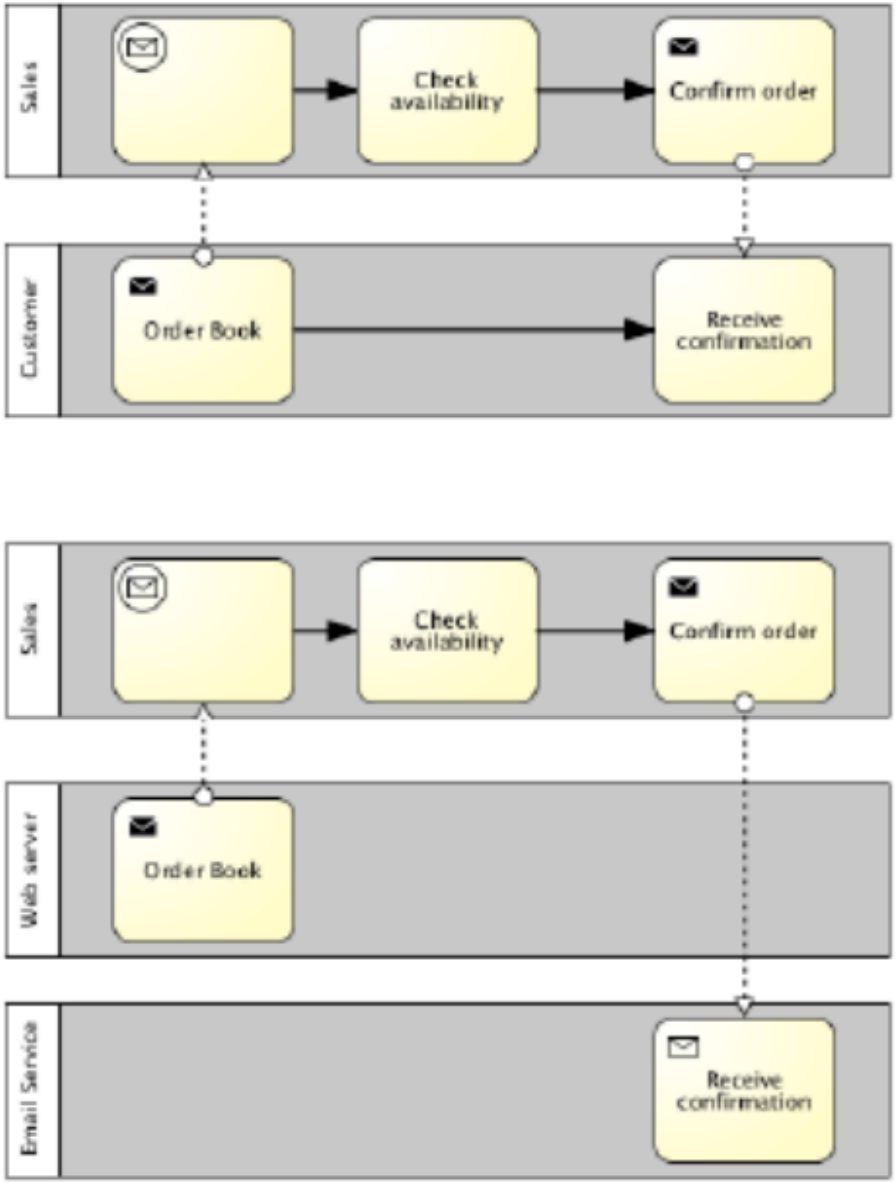
CMMN example

Source: http://brsilver.com/bpmn-cmmn-compared/



BPMN 2.0



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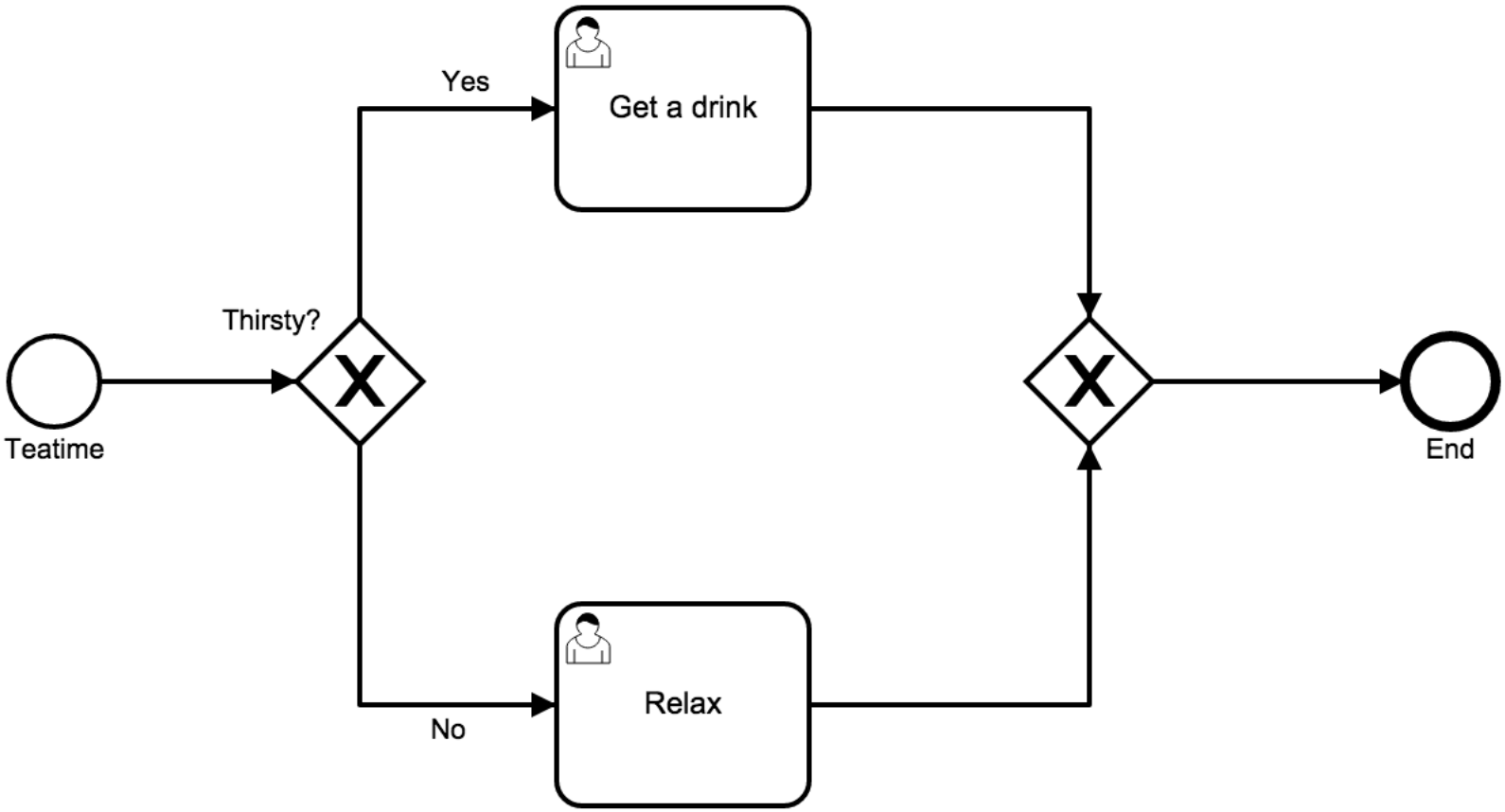
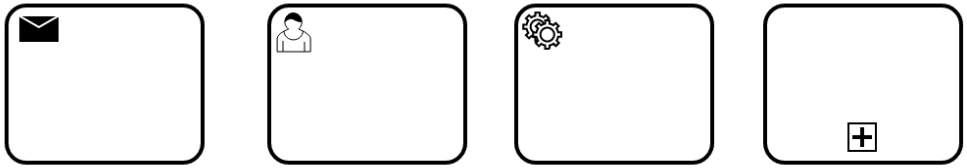
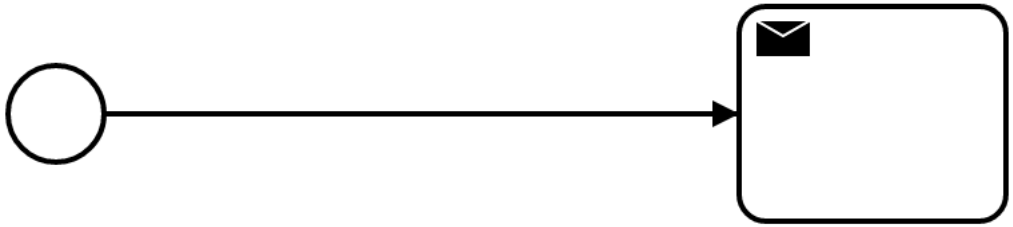
BPMN 2.0 Basics



BPMN Basic Constructs

- Events
- Activities
- Gateways
- Sequence Flows





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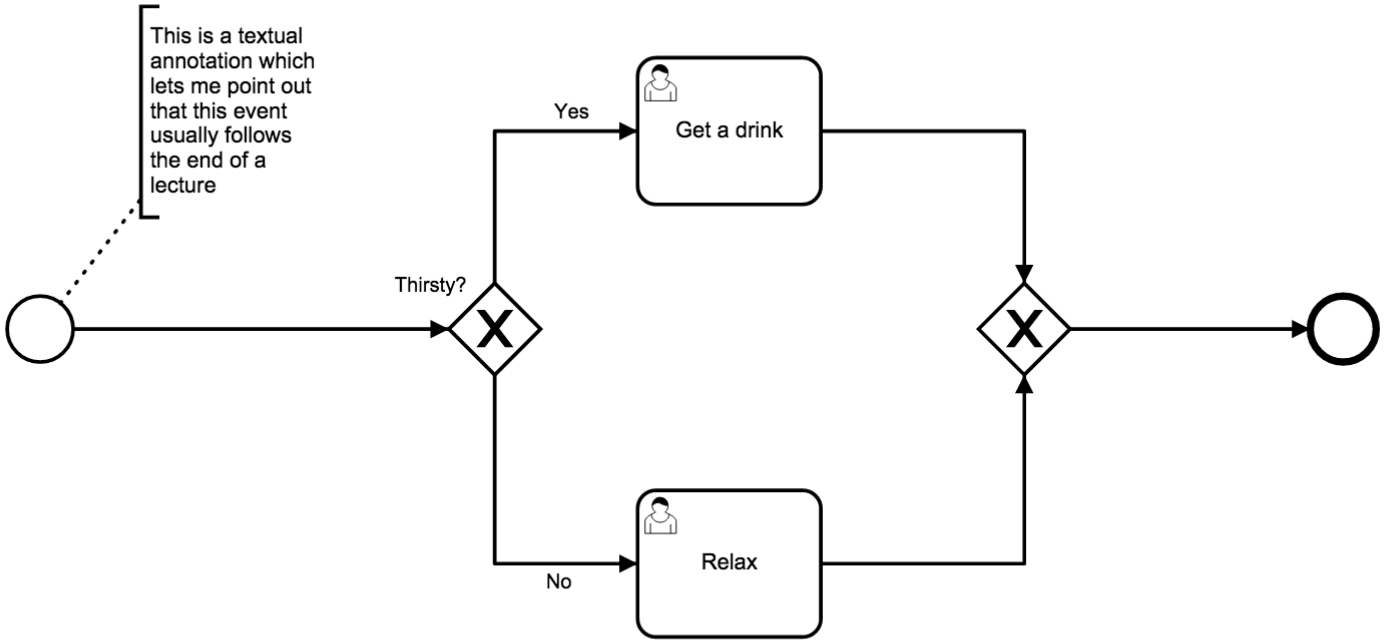
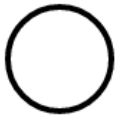
Text Annotations

- How you document your processes



Start Events

- Start Event 
  - Message Start
  - Timer Start
  - Conditional Start
  - Signal Start

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Some Intermediate Events

Basic Intermediate Event

Message Catch

Message Throw

Timer

Escalation

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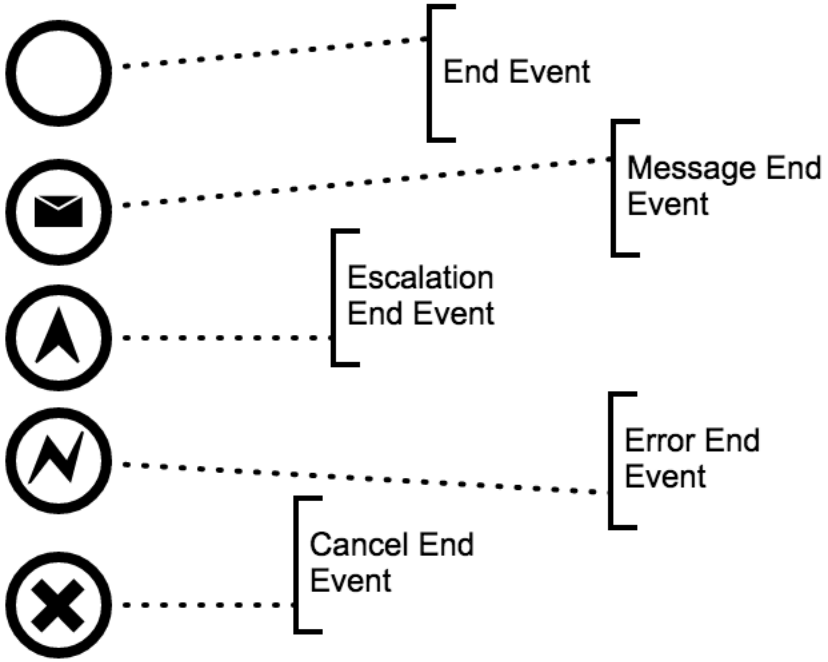
Some End Events



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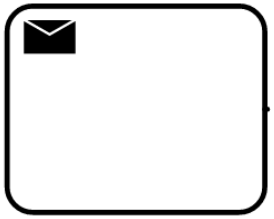
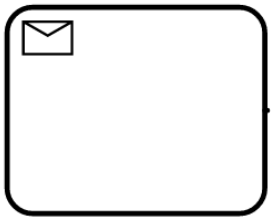
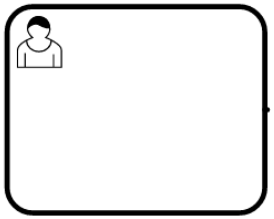
Activities



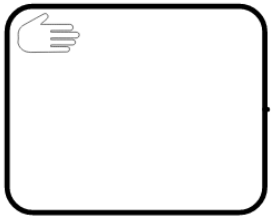
Send Task
- sends a message



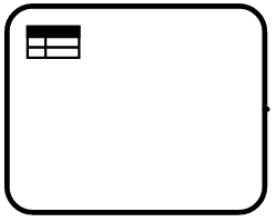
Receive Task
- receives a message



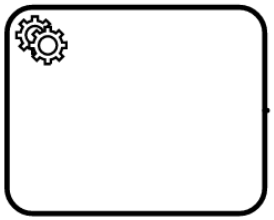
User Task
- requires input or action from a user, mediated by the engine



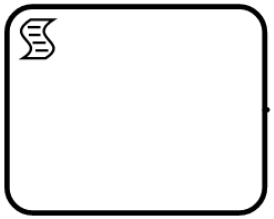
Manual Task
- completely manual task (out side the engine)



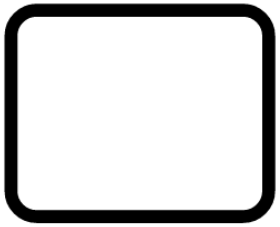
Business Rule Task
- implemented by a BR engine



Service Task
- implemented by a service



Script Task
- implemented by a script



Call Activity-
calls another process

Service Task

- Call a service
  - Unlike BPEL there is no direct way of capturing

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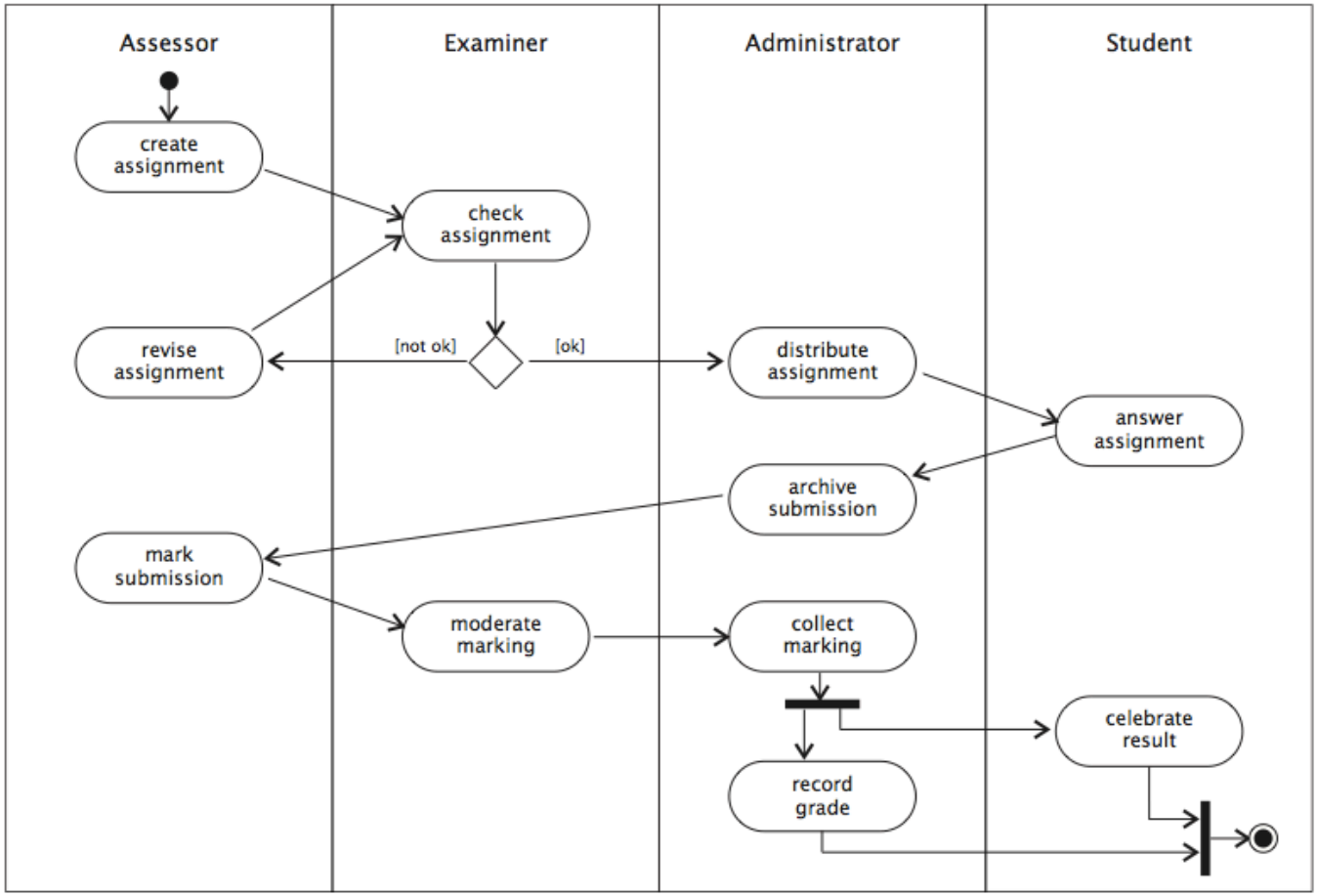
Swimlanes:

partition an activity diagram into the responsibilities of different entities



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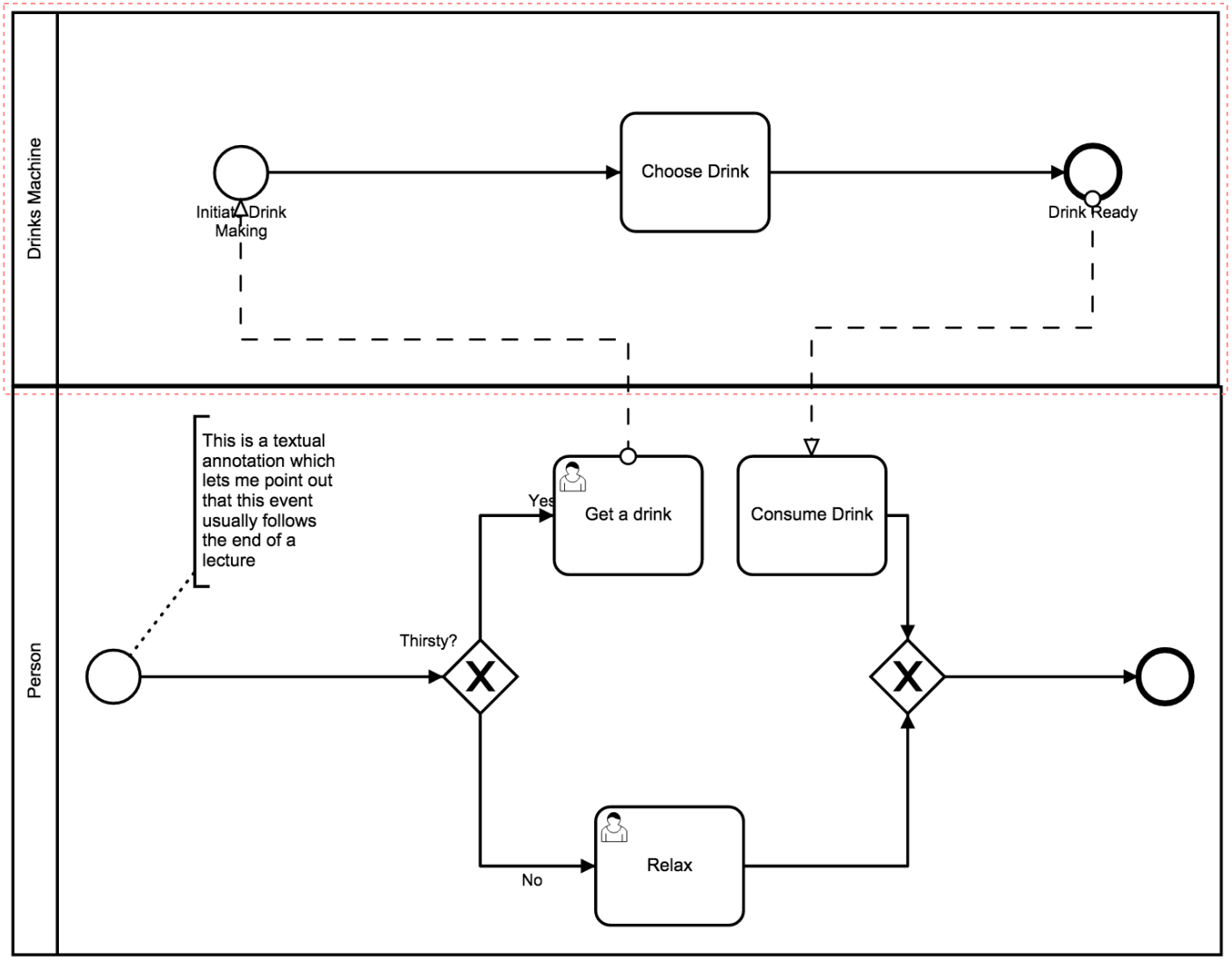
Swimlanes represent different participants



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Data Flow

- Transitions between activities represent *control dependencies*: one activity must complete before another can start
- Workflows also have *data dependencies*: one activity produces a result that another requires
- UML activity diagrams allow *object flow* as well as *control flow*
- Dependent data is shown as an object icon (rectangle with underlined name and type)
  - *dependencies* shown as dashed arrows from generating activity to object, and from object to consuming activity(s)
  - same object may occur multiple times in an activity diagram, typically in different *states* (shown in square brackets after object name)

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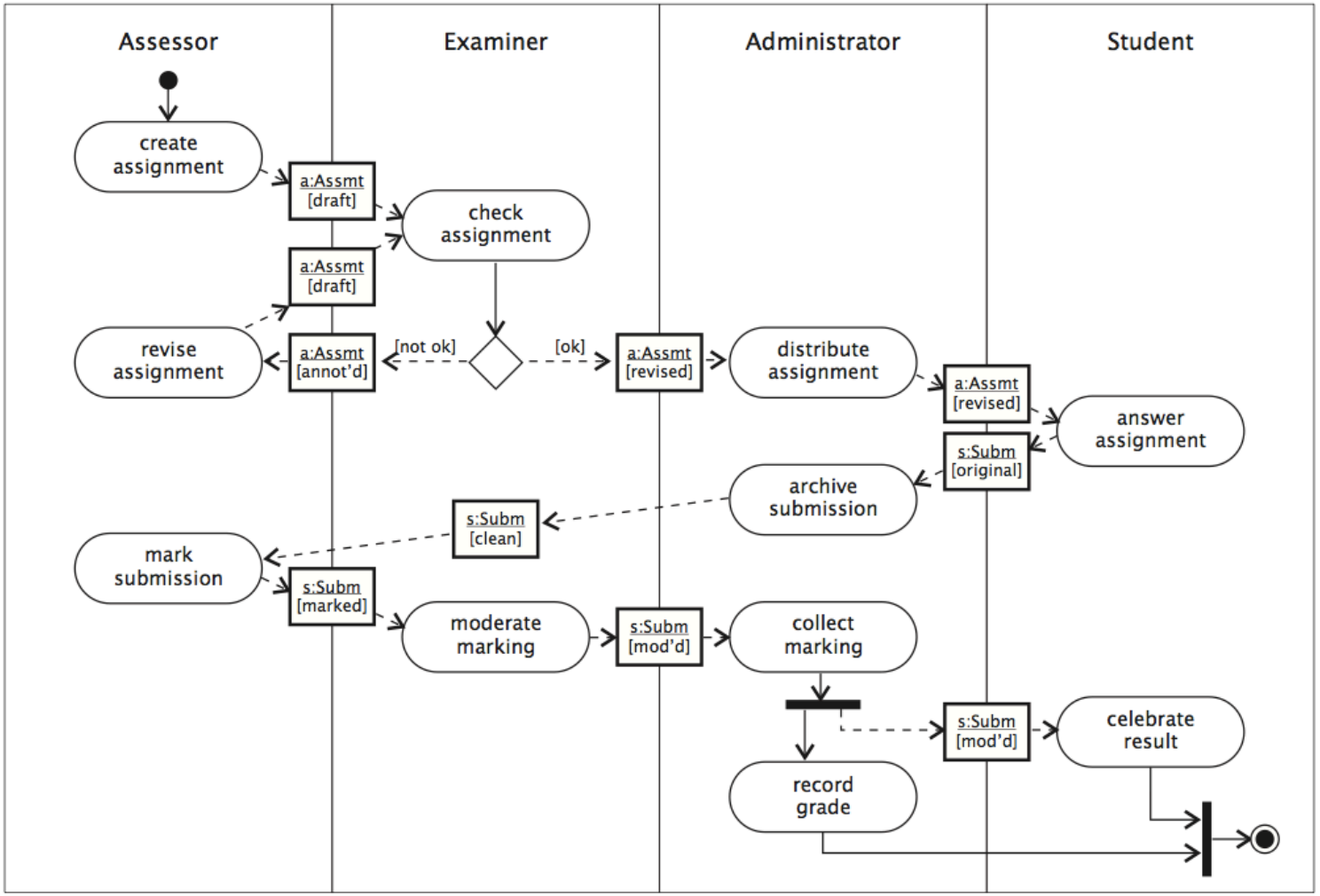
Example Object Flow



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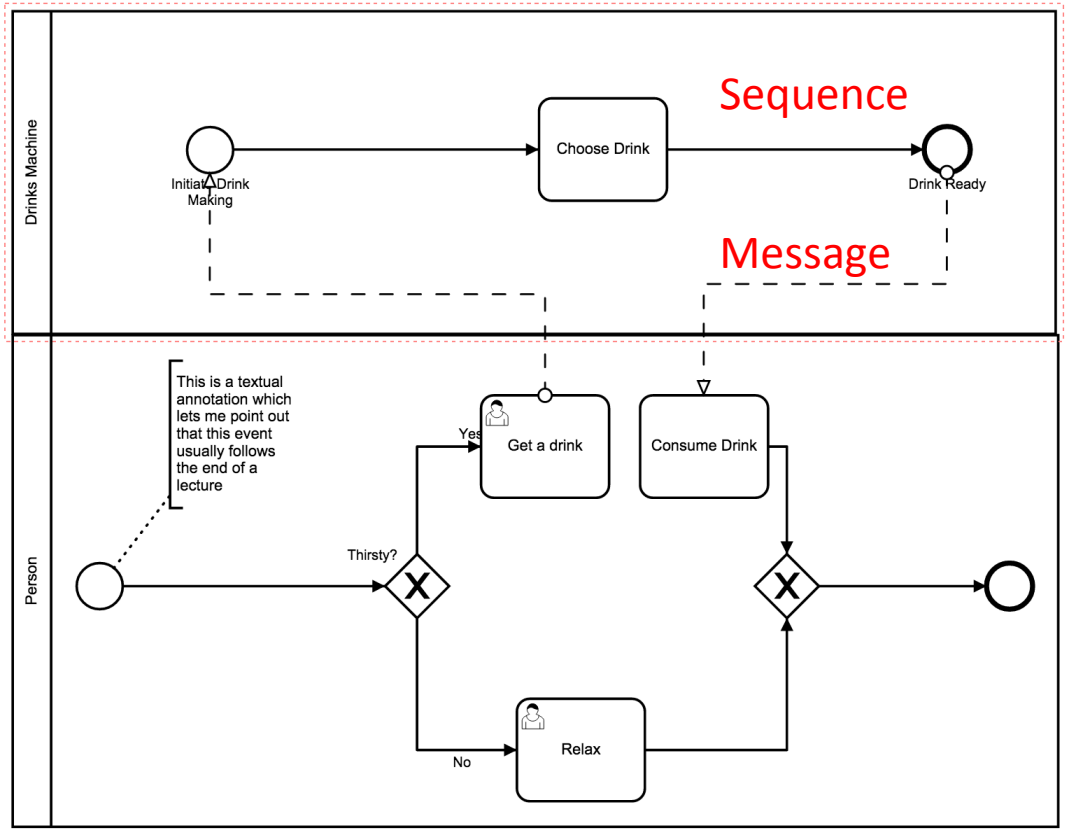
Flows



Sequence flows are within a Swimlane

Message flows between swimlanes

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Gateways

- Exclusive Gateway

  - Fork – choose one path (if/else)
  - Join – wait for a single event
- Parallel Gateway

  - Fork – do both / all paths
  - Join – wait for all inputs

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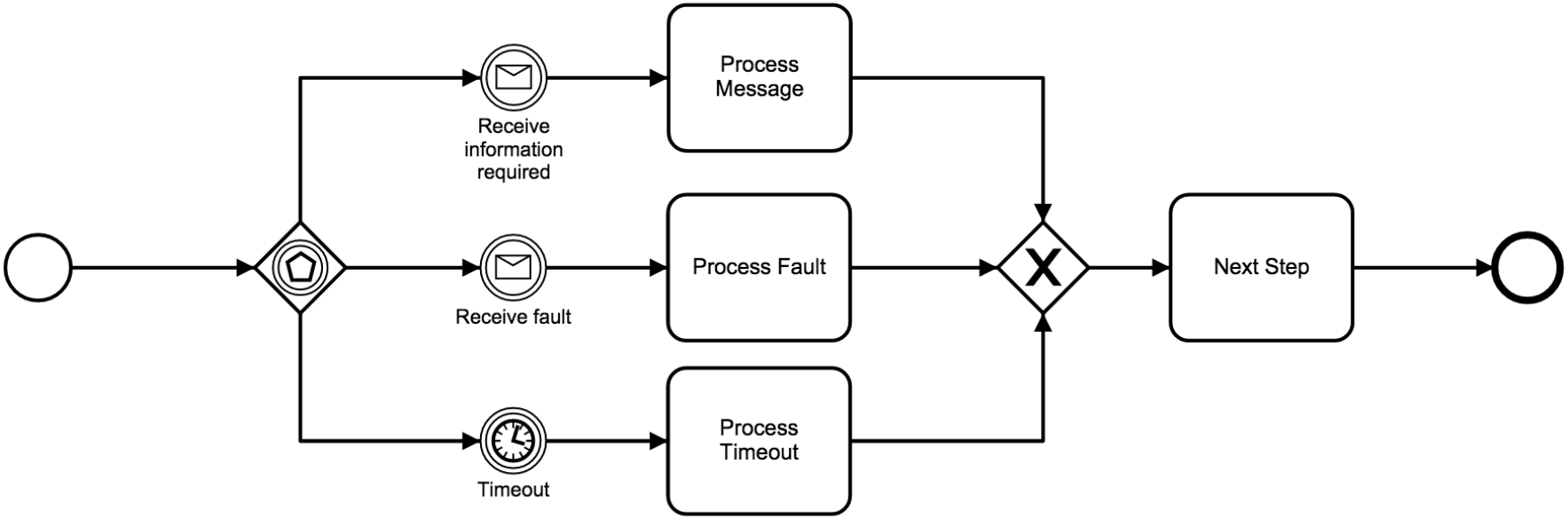
Event Gateway



An Event Gateway allows different events to trigger different actions

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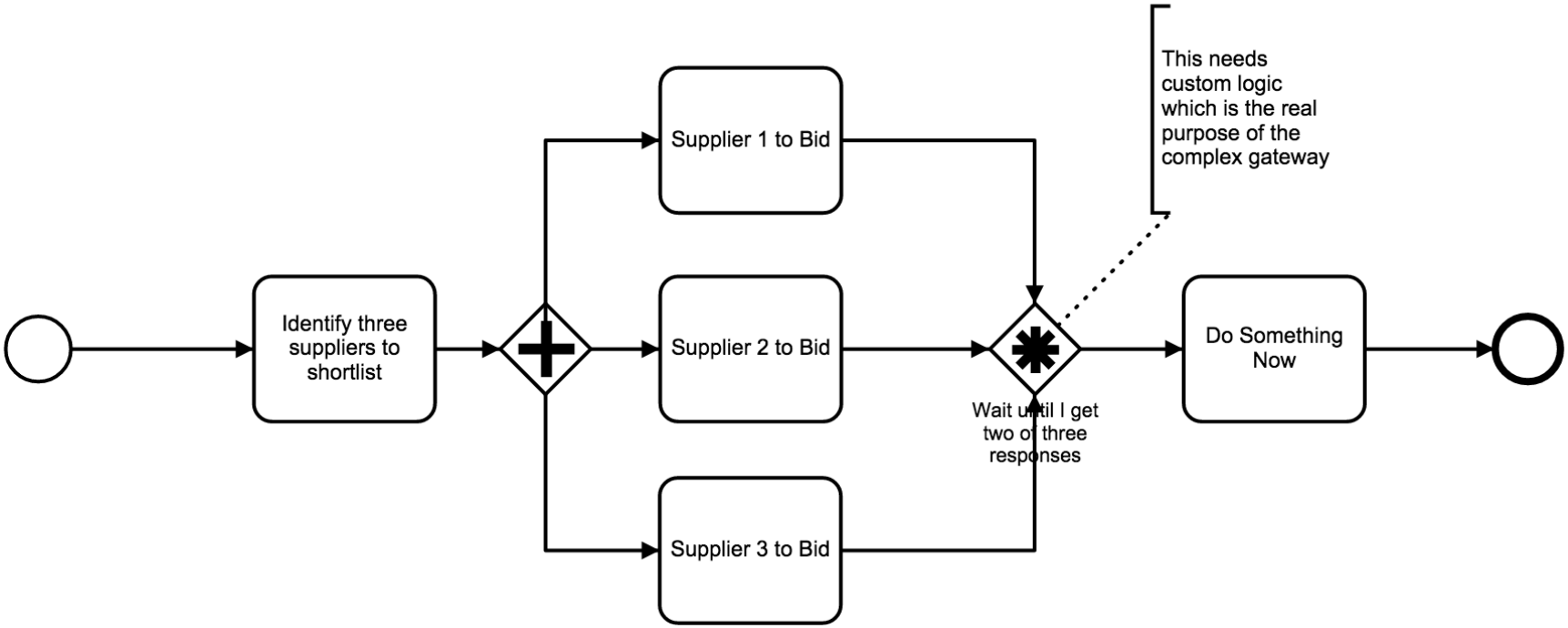
Complex Gateway



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How much BPMN do you need?

How Much Language is Enough? Theoretical and Practical Use of the Business Process Management Notation
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2038665

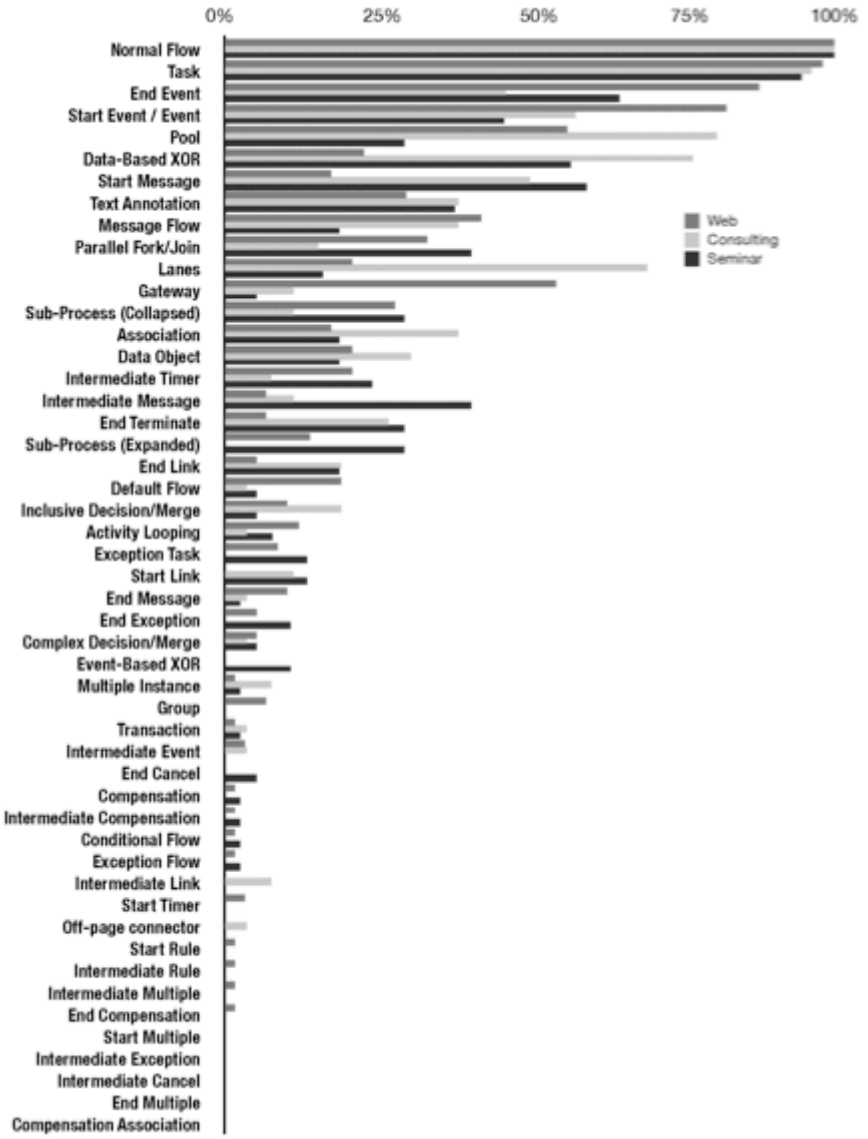

Fig. 1. Occurrence Frequency of BPMN Constructs

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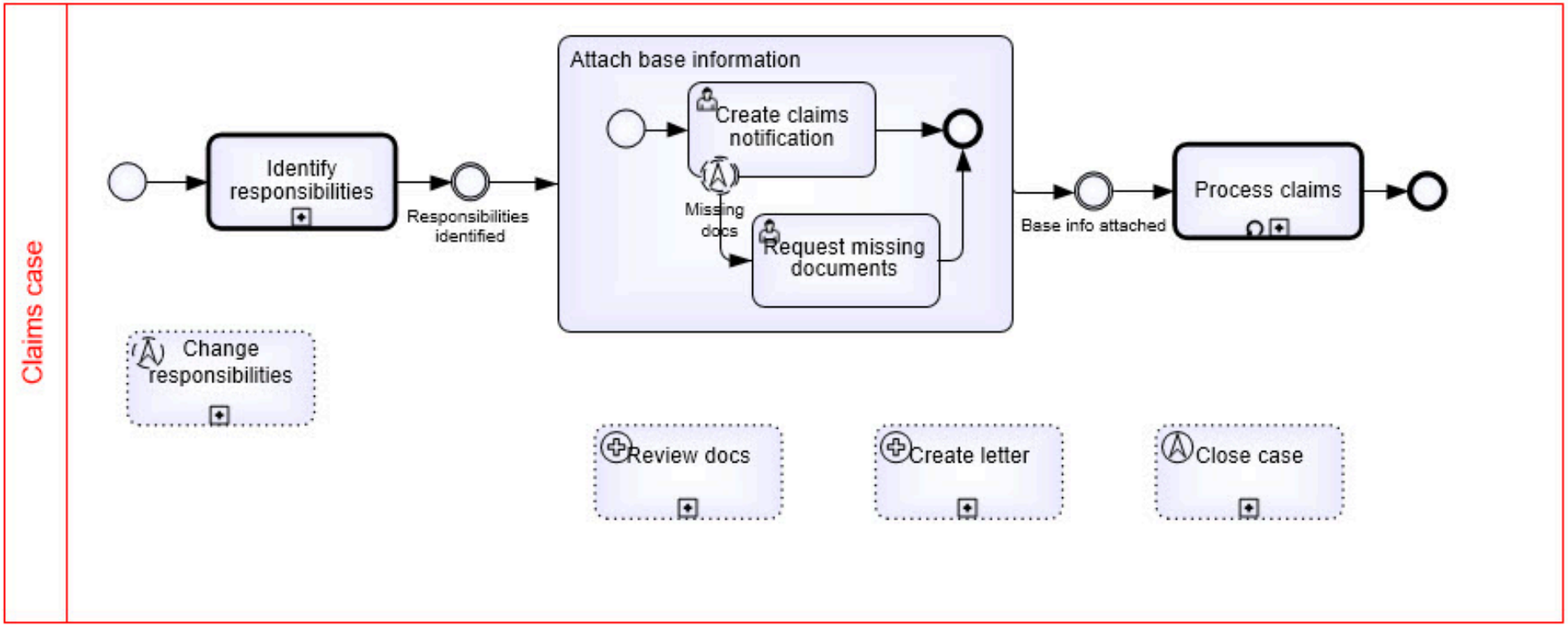
BPMN Case example

Source: http://brsilver.com/bpmn-cmmn-compared/



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Summary

- Process Management has a strong place in composing SOA systems
  - Externalising dependencies
  - Agility
  - Sharing with the business owners
- BPEL is still widely used, but
- BPMN 2.0 is gaining a lot of mindshare
- CMMN also has a smaller but active following
- Other approaches like Amazon SWF may also gain traction

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