# Choreography and Orchestration of Services

Oxford University
Software Engineering
Programme
May 2017

# 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.”

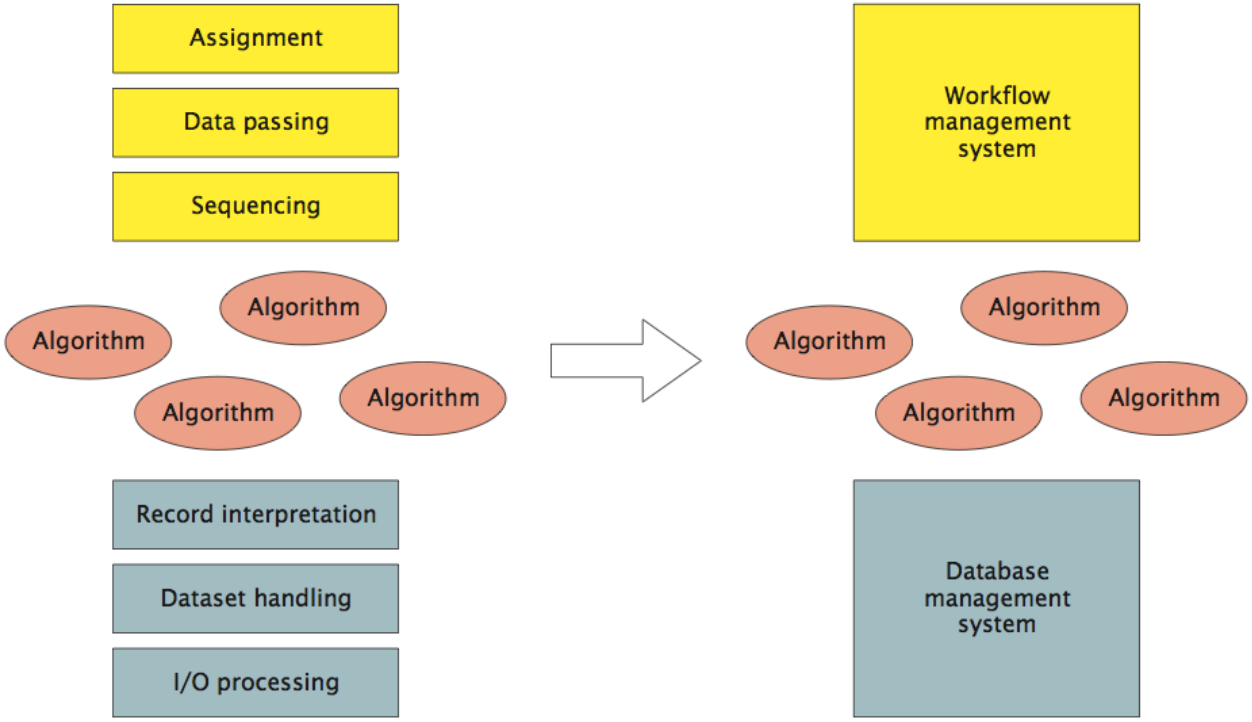
- Davenport [1992] “A structured, measured set of activities designed to produce a specific output for a particular customer or market. It implies a strong emphasis on how work is done within an organization, in contrast to a product focus’s emphasis on what.”

# 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

# Removal of Dependencies (Leymann and Roller)

- DBMS provides independence from data *representation*; workflow provides independence from



# Heritage

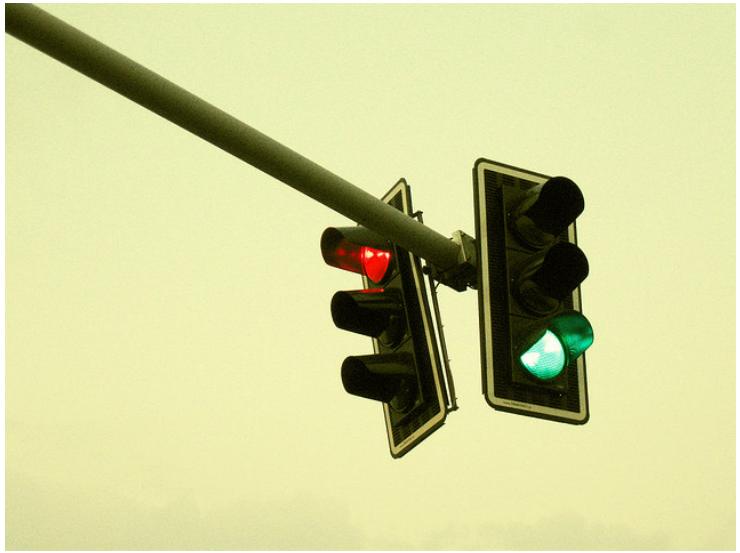
- E*nterprise application integration* (EAI)
  - resolving heterogeneity, typically via asynchronous *message brokers*
- *Workflow management systems* (WfMS): automating interactions
  - origins in *office automation*: admin processes
- P*roduction workflows*: from information between people to integration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

# 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

# Orchestration vs Choreography

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



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

# 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

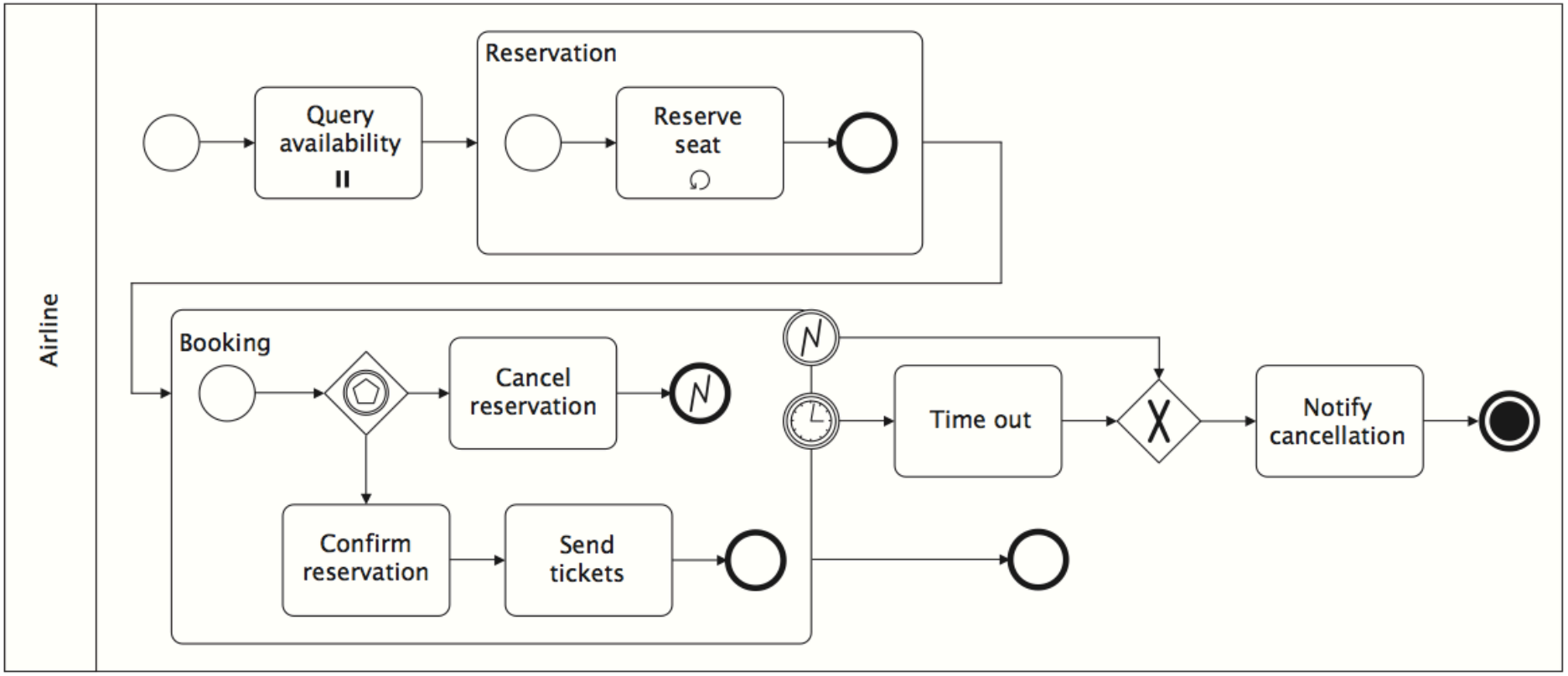
# WS-Choreography Description Language

- 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

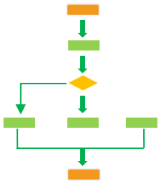
# BPMN 1.1

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

# BPMN Example



# Amazon Simple Workflow Service



**DECIDER**

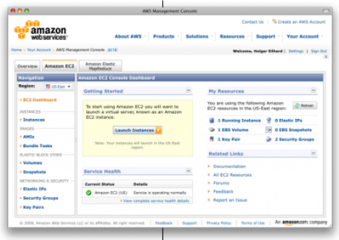
The decider implements the application's business logic

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

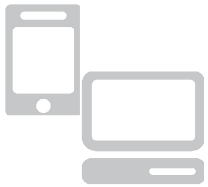
Get Activity Tasks / Return Results

**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/

# Turbine

Turbine is a JavaScript workflow engine. It vastly simplifies the development, deployment, and testing of complex web applications through the use of declarative workflows that express your app's program logic in a form that is simple to read and to understand.

## Why Turbine?

Turbine is the ideal solution for apps (or parts of apps) with multi-step processes involving many possible branches, sub-flows, or permutations. Examples include:

- Signup forms
- Login forms
- Interactive tours
- Shopping carts
- Checkout flows
- Asset creation (i.e. upload photo -> add filter -> add caption -> tag friends -> share)
- etc.

The programming of these types of apps usually involves a tangled nightmare of conditionals, switches, callbacks, promises, and other strands of spaghetti code.

This tightly coupled code makes it almost impossible to A/B/n test different flows or variations -- any attempt to do so usually makes the problem even worse. It is also very difficult to follow the program logic to trace all the possible flows through the code.

# 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

# 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

# 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

# BPMN + BPEL

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

# BPMN 2.0

- A notation for a subset of BPEL
- Execution semantics for BPMN
- Notational support for choreography
- The best of both worlds?
- Cons:
  - Need to write external logic in another language to implement a process

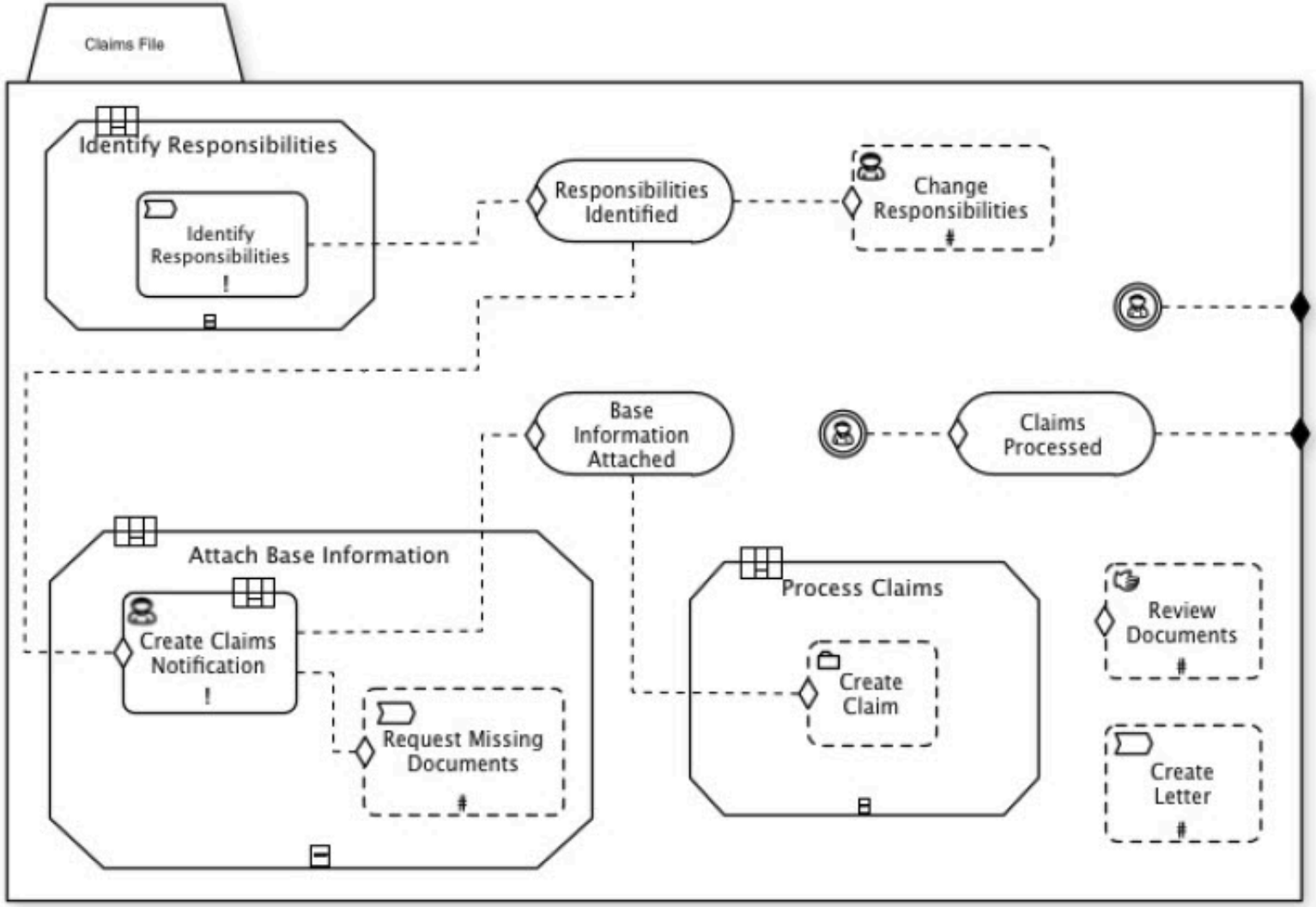
# CMMN

## Case Management and Modelling Notation

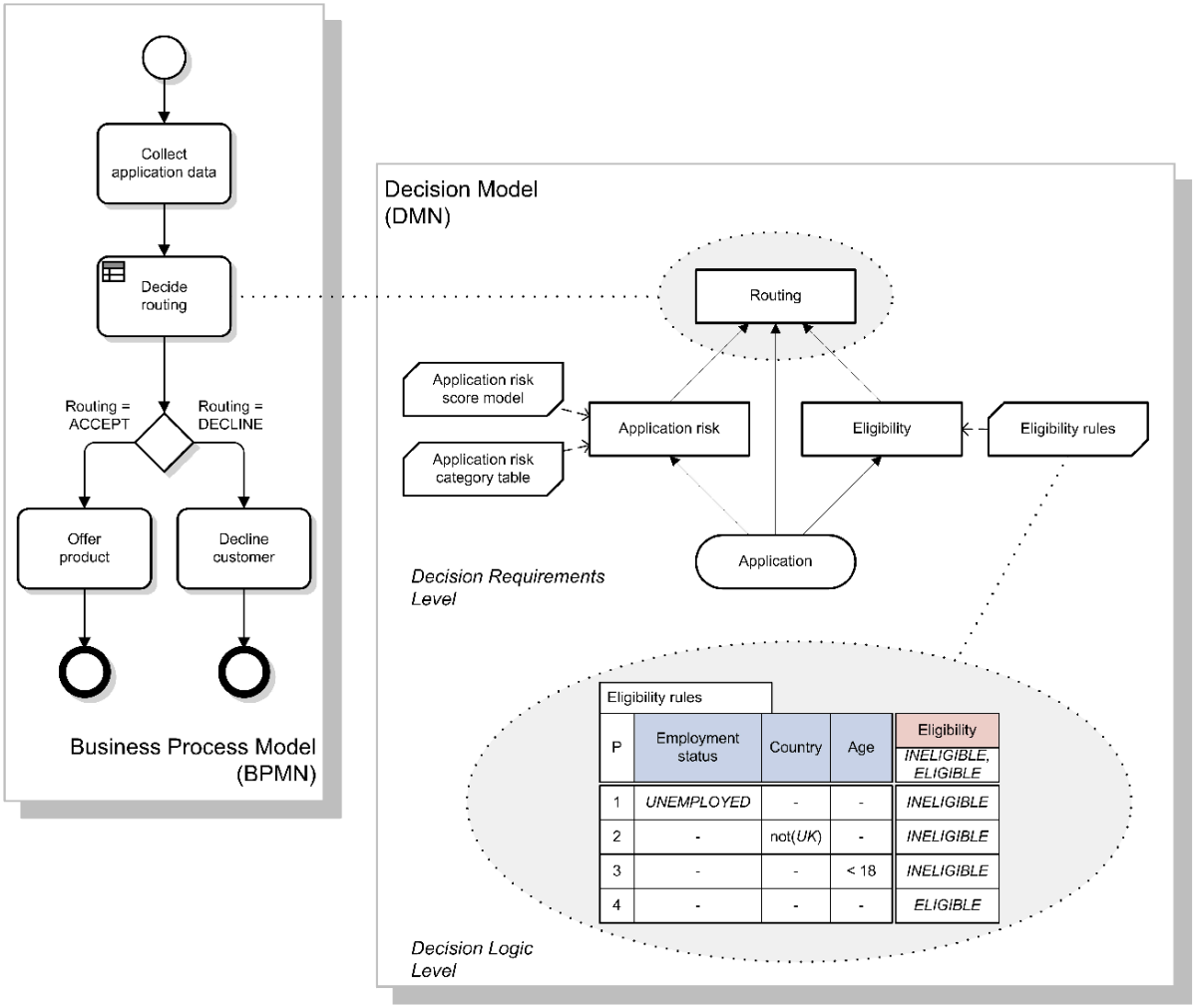
- A specification from OMG for modelling how to handle cases
- A more flexible approach to workflow that BPMN or BPEL
  - Certain workflows are very clear
    - Building a car
  - Others are more flexible
    - Hand building a mandolin
- Imperative vs “Causative”

# CMMN example

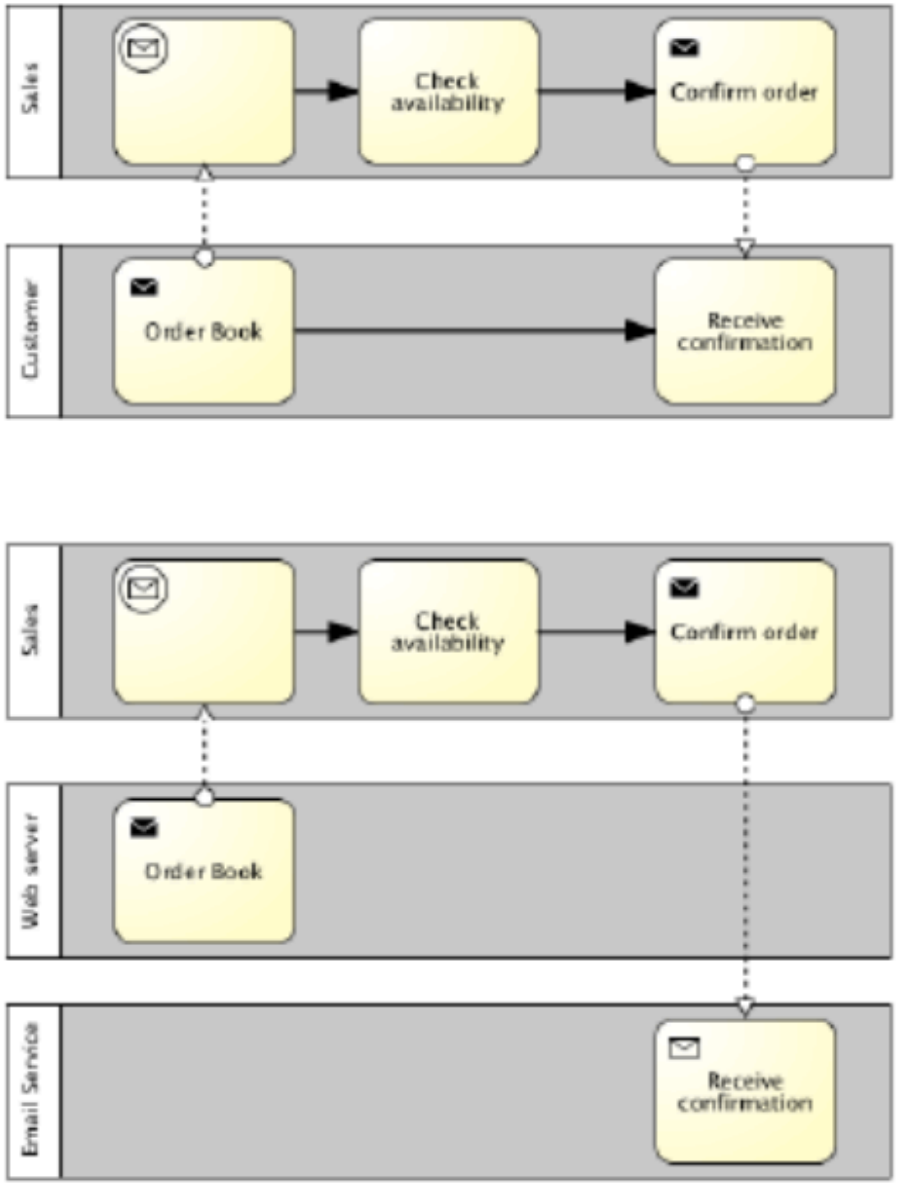
Source: http://brsilver.com/bpmn-cmmn-compared/



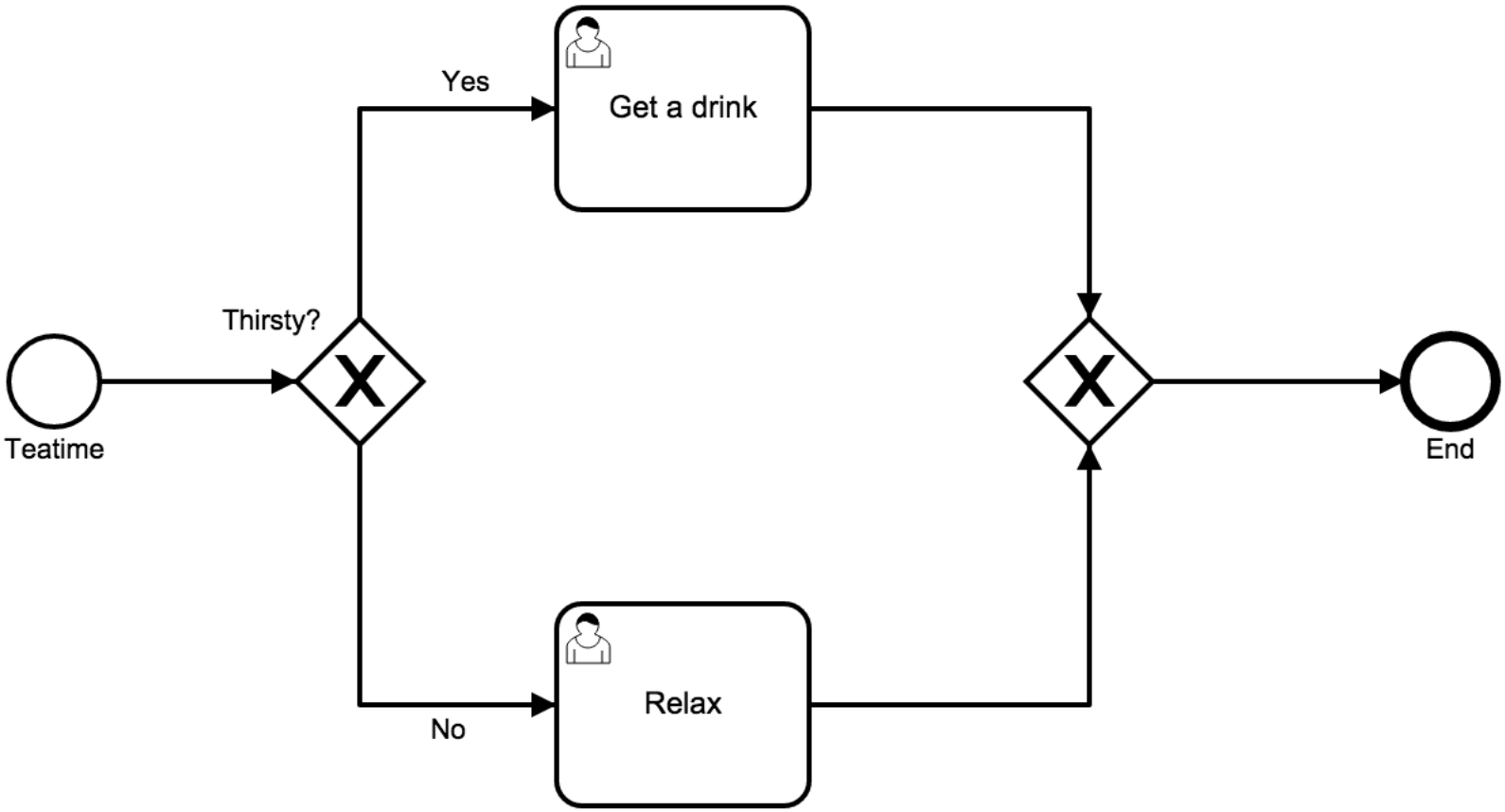
# Decision Modeling Notation DMN 1.1



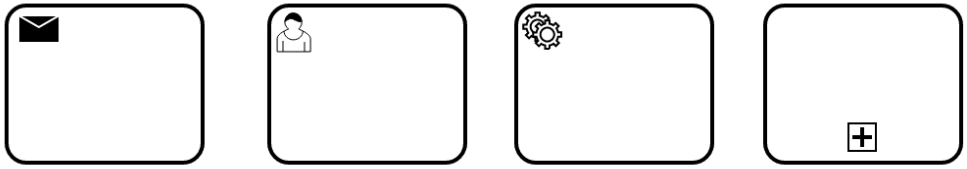
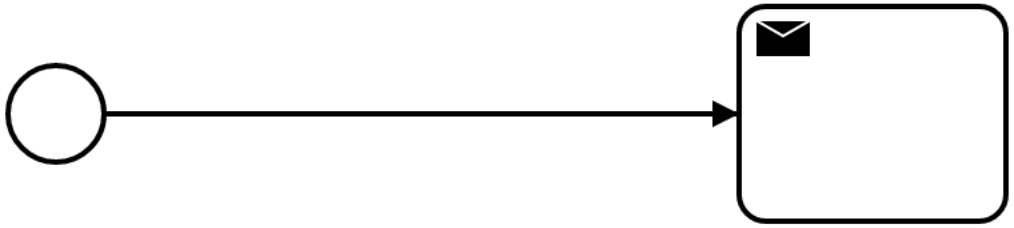
# BPMN 2.0



# BPMN 2.0 Basics

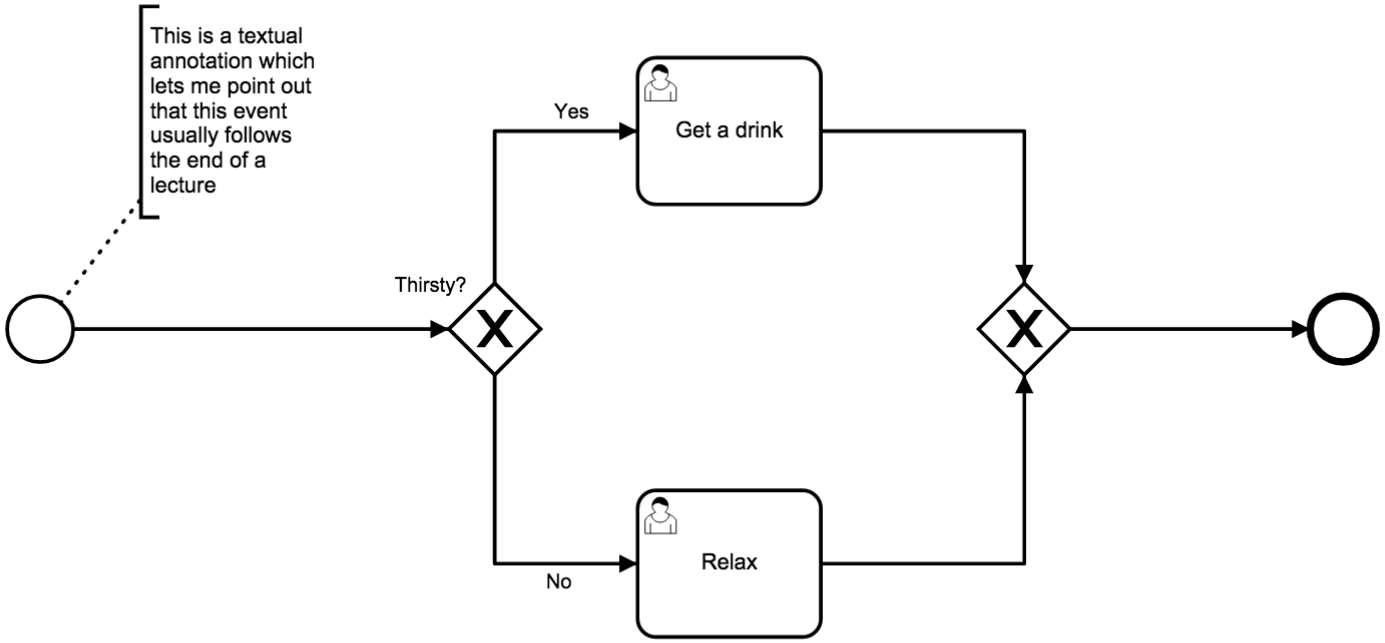


# BPMN Basic Constructs

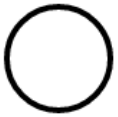
- Events 
- Activities 
- Gateways 
- Sequence Flow 

# Text Annotations

- How you document your processes



# Start Events

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

# Some Intermediate Events

Basic Intermediate Event

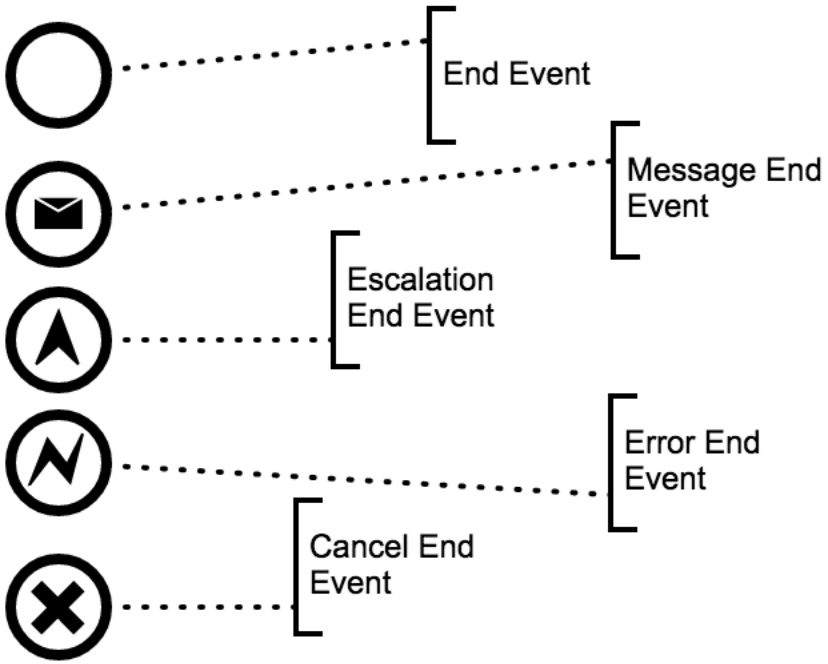
Message Catch

Message Throw

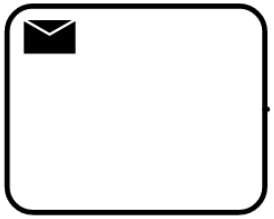
Timer

Escalation

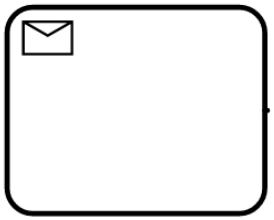
# Some End Events



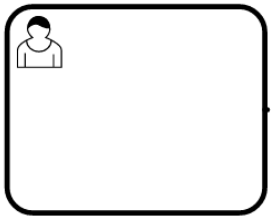
# Activities



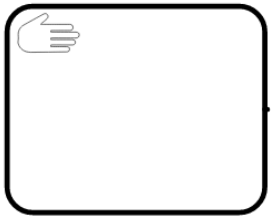
Send Task
- sends a message



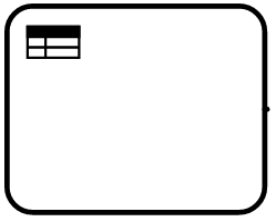
Receive Task
- receives a message



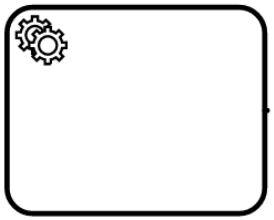
User Task
- requires input or action from a user, mediated by the engine



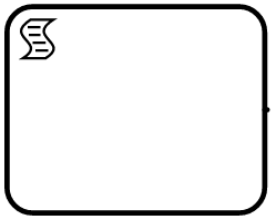
Manual Task
- completely manual task (out side the engine)



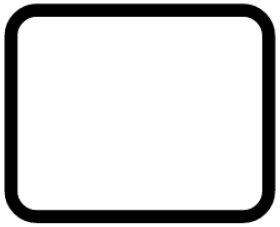
Business Rule Task
- implemented by a BR engine



Service Task
- implemented by a service



Script Task
- implemented by a script



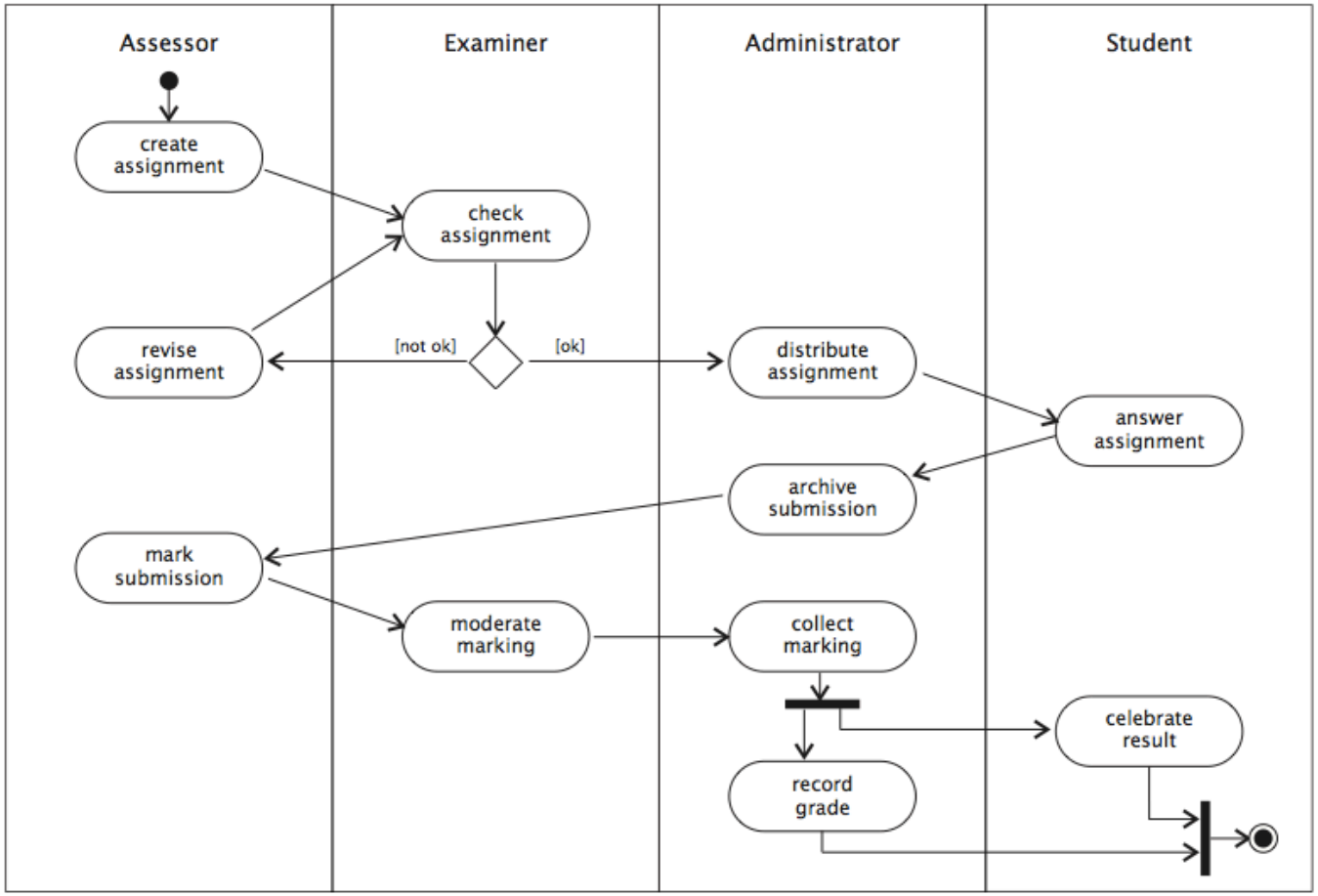
Call Activity-
calls another process

# Service Task

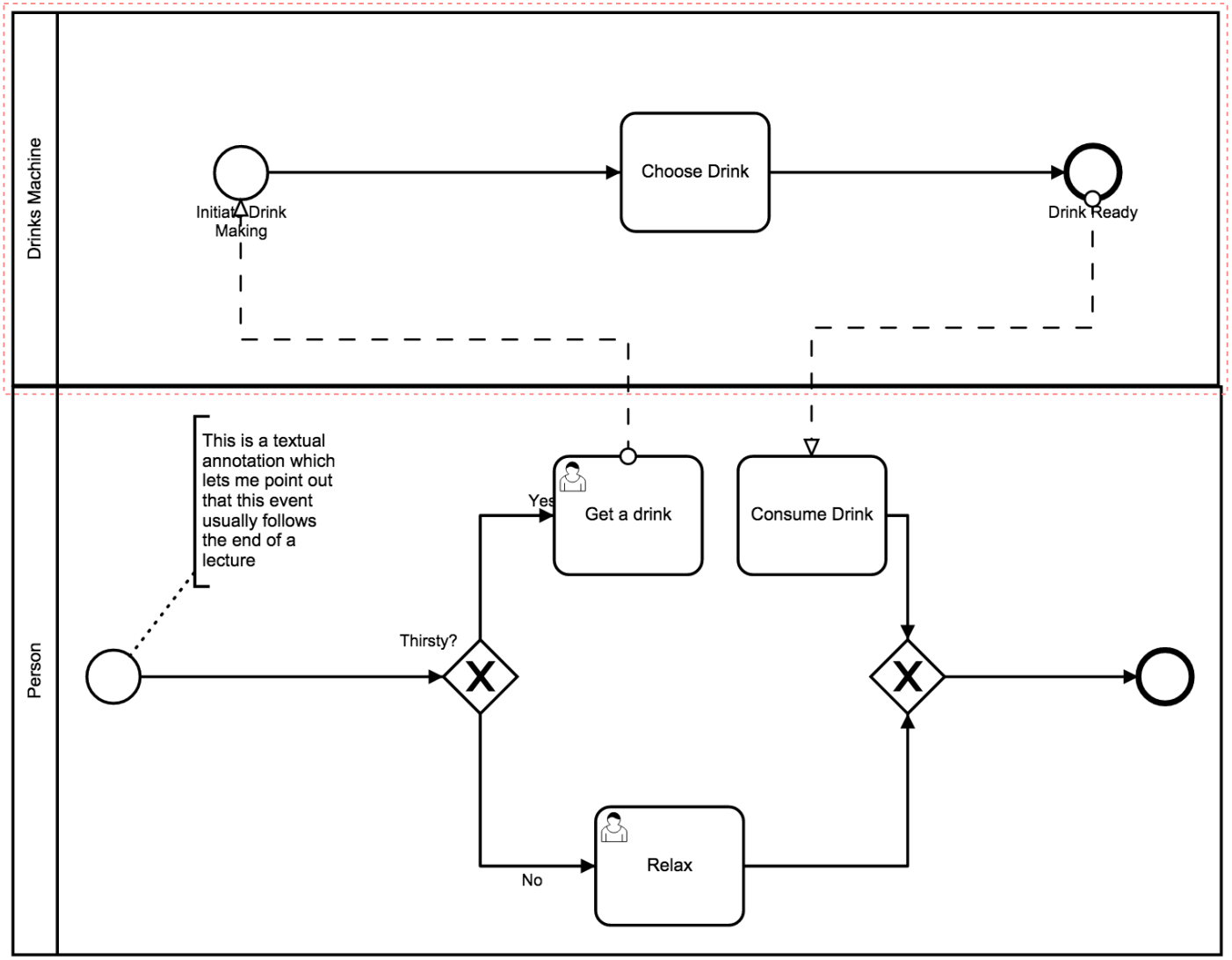
- Call a service
  - Unlike BPEL there is no direct way of capturing

# Swimlanes:

## partition an activity diagram into the responsibilities of different entities



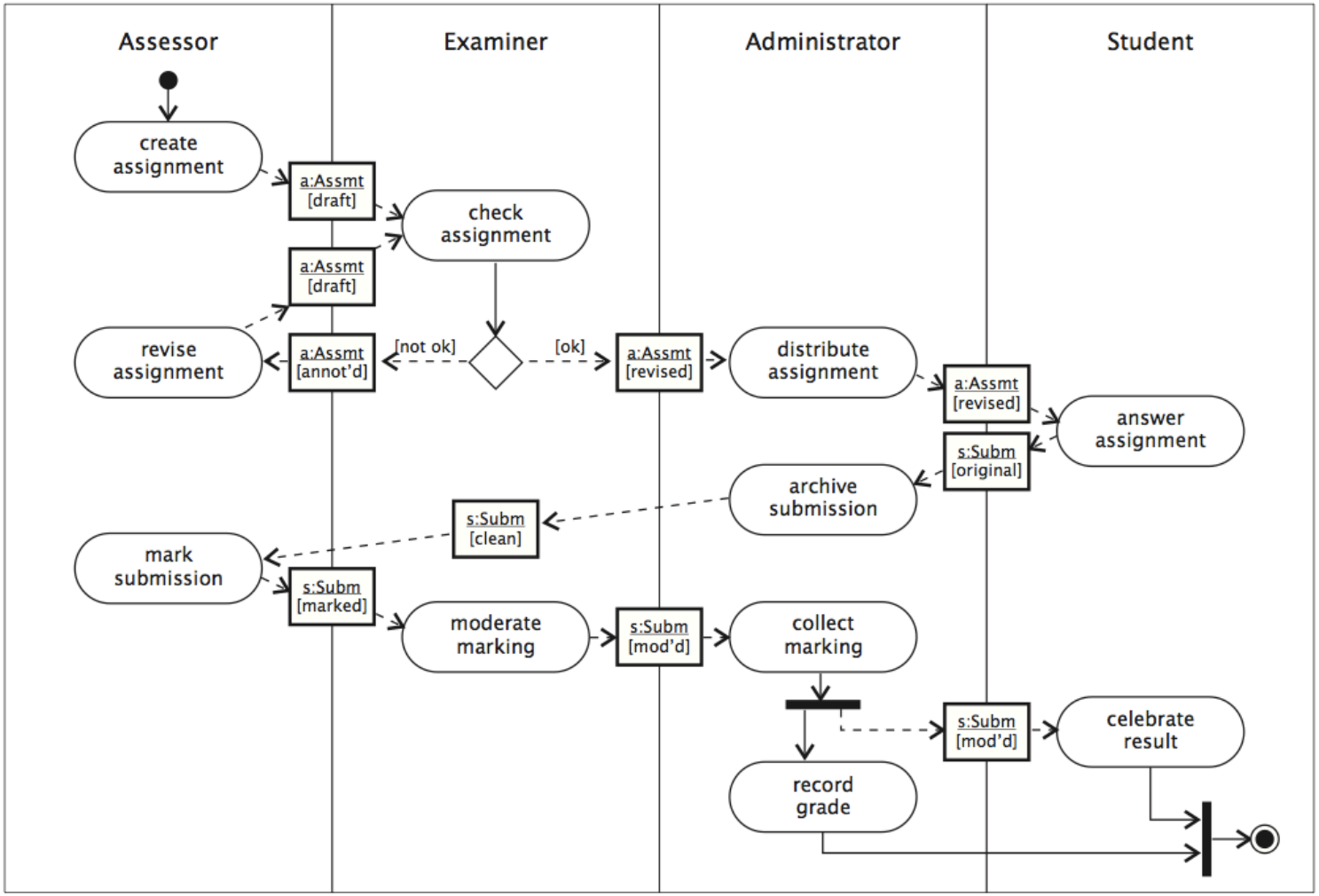
# Swimlanes represent different participants



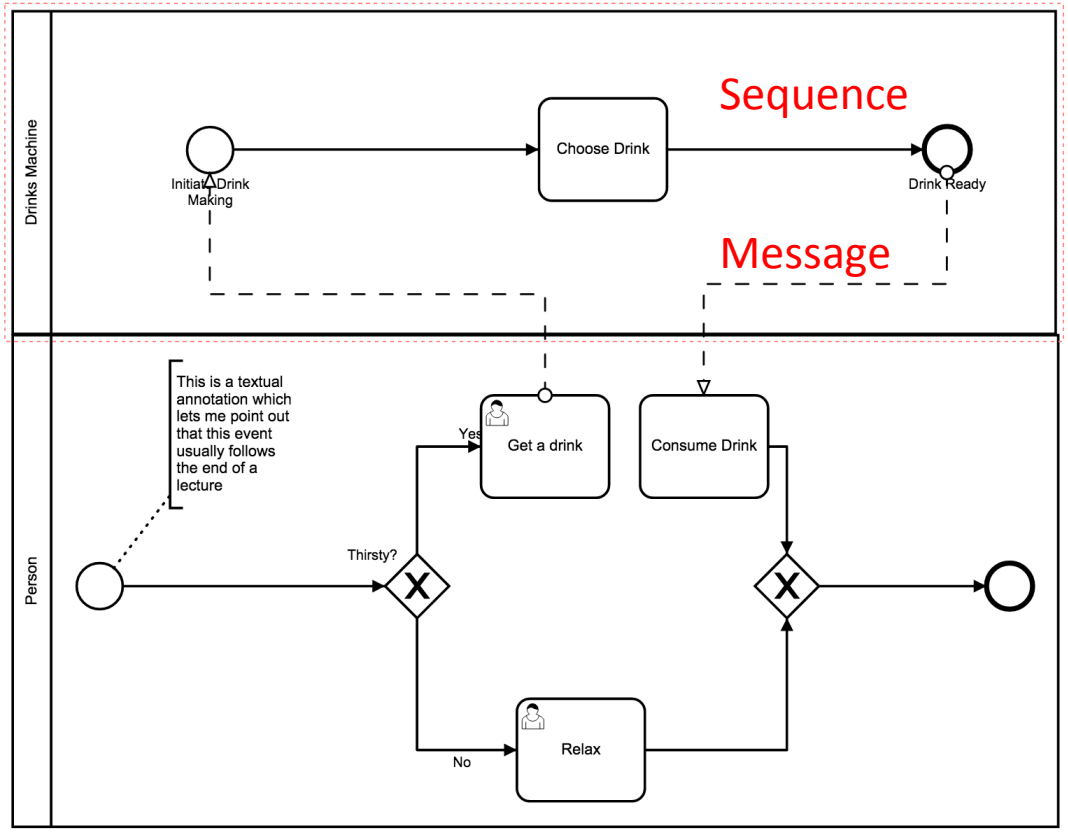
# Data Flow

- 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)

# Example Object Flow



# Flows



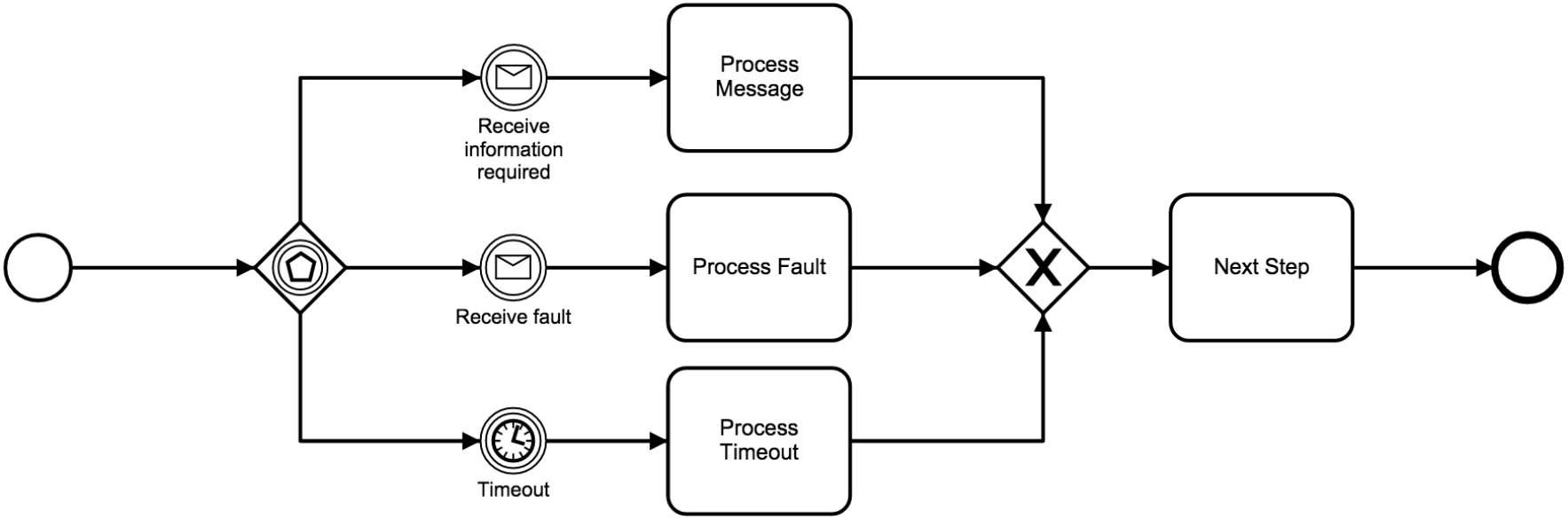

Sequence flows are within a Swimlane

Message flows between swimlanes

# Gateways

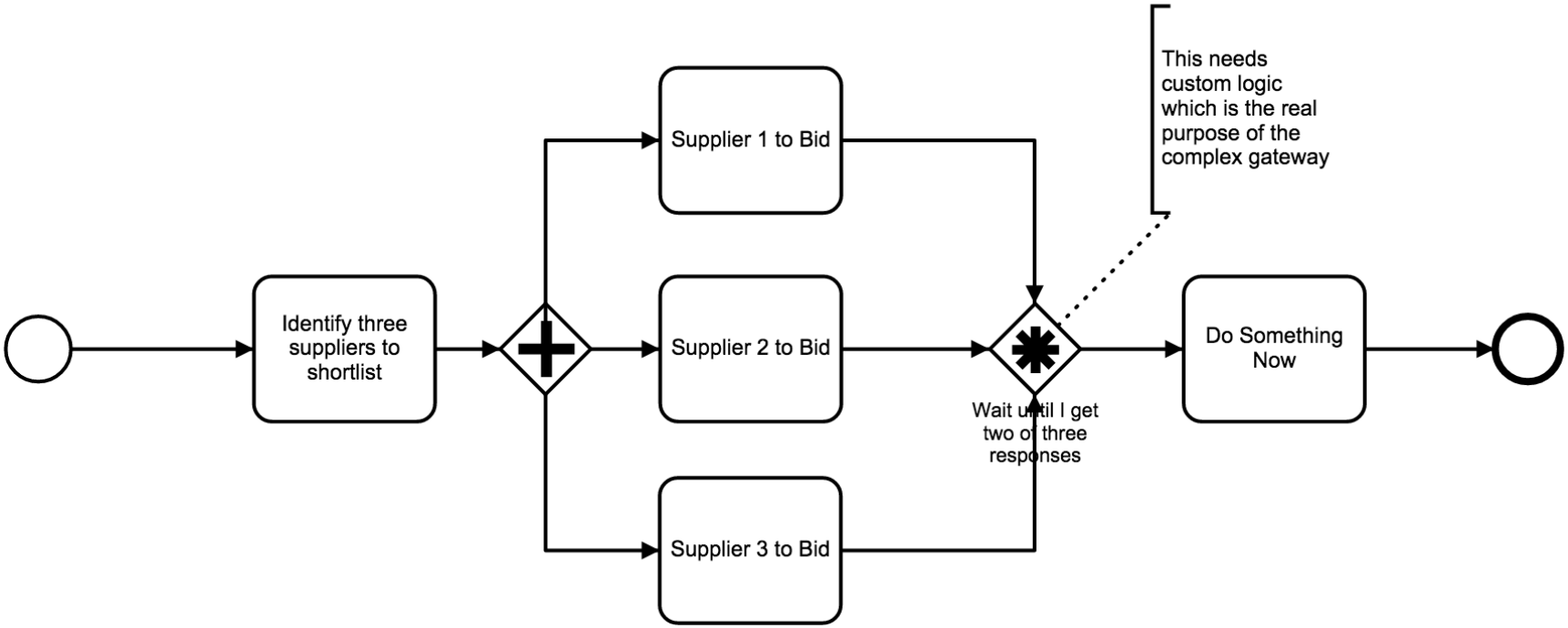
- Exclusive Gateway 
  - Fork – choose one path (if/else)
  - Join – wait for a single event
- Parallel Gateway 
  - Fork – do both / all paths
  - Join – wait for all inputs

# Event Gateway




*An Event Gateway allows different events to trigger different actions*

# Complex Gateway



# 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

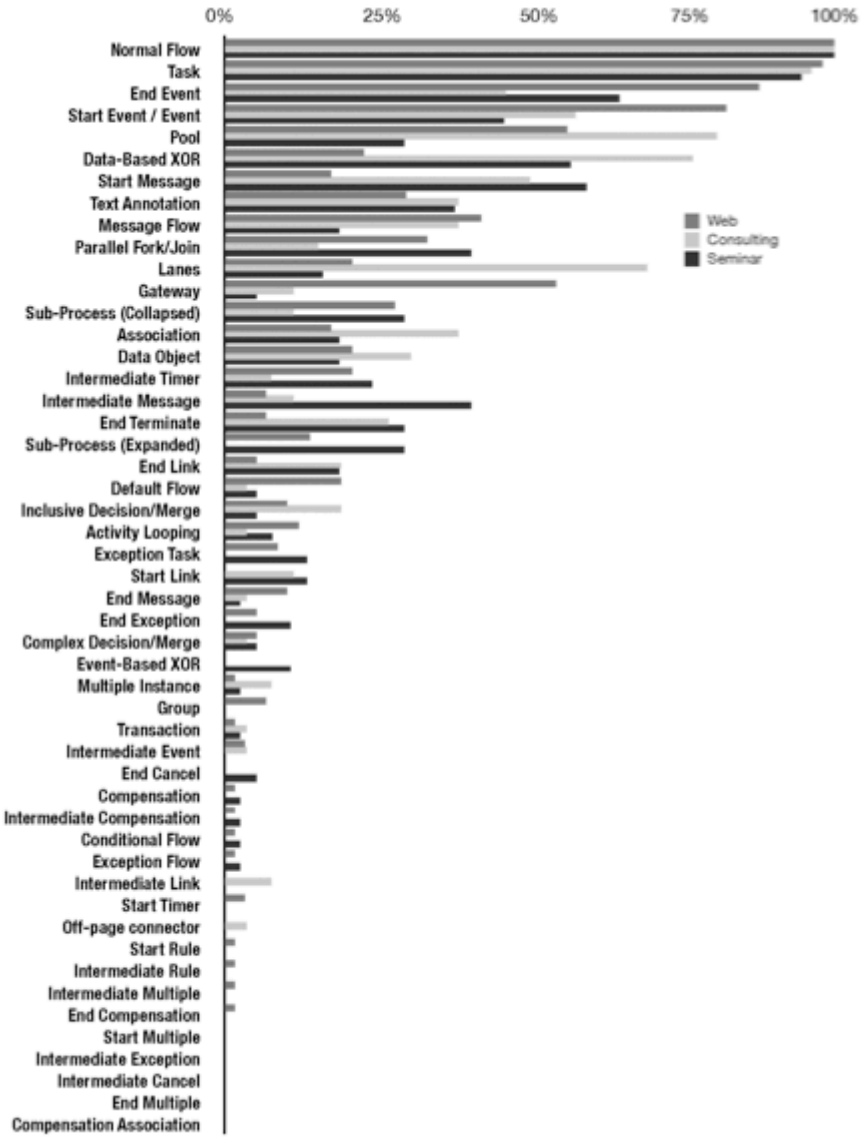
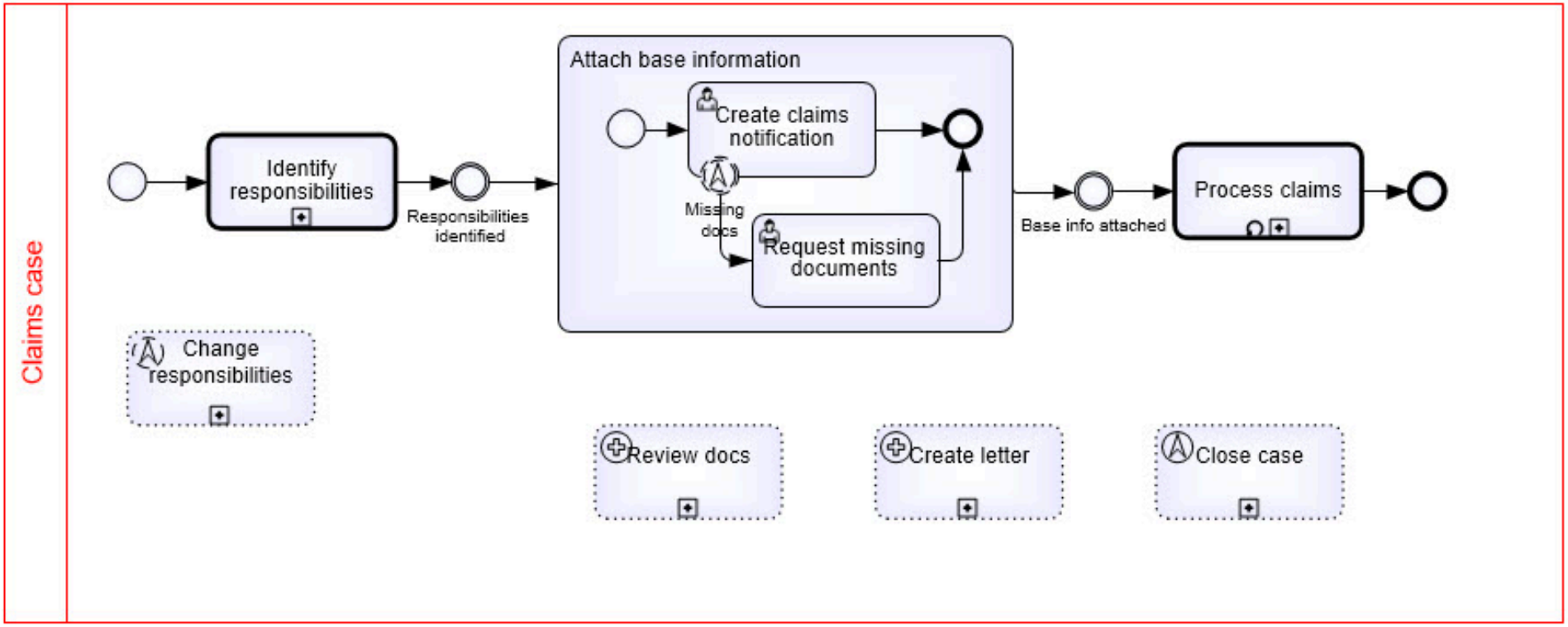



**Fig. 1.** Occurrence Frequency of BPMN Constructs

# BPMN Case example

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



# 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 Turbine are gaining traction