Choreography and Orchestration of Services

Oxford University
Software Engineering
Programme
June 2016

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.”

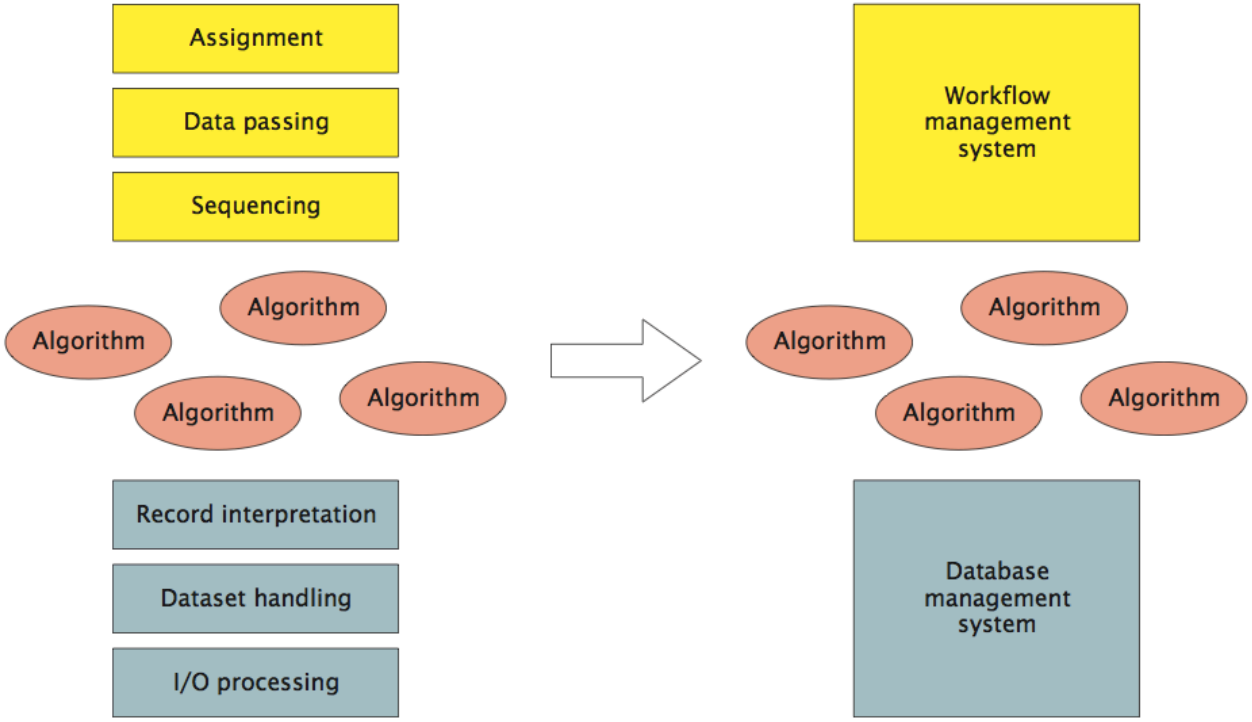
- Davenport [1992] “A structured, measured set of activities designed to produce a specific output for a particular customer or market. It implies a strong emphasis on how work is done within an organization, in contrast to a product focus’s emphasis on what.”

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

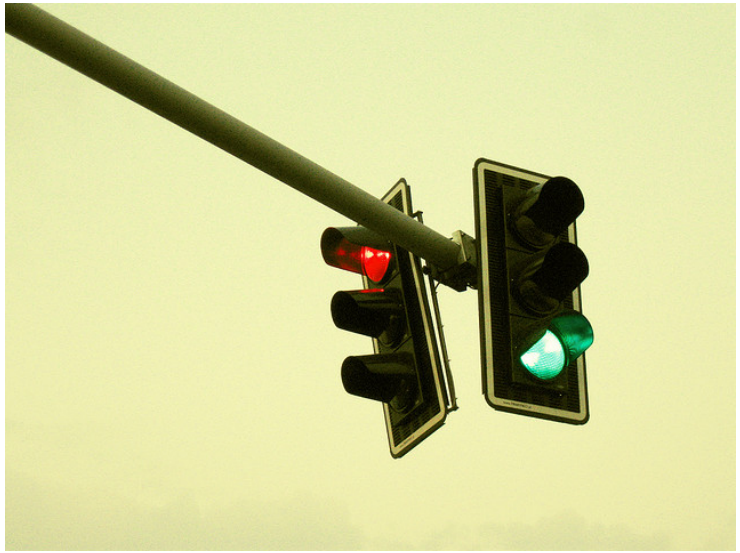
- E*nterprise application integration* (EAI)
  - resolving heterogeneity, typically via asynchronous *message brokers*
- *Workflow management systems* (WfMS): automating interactions
  - origins in *office automation*: admin processes
- P*roduction workflows*: from information between people to integration 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

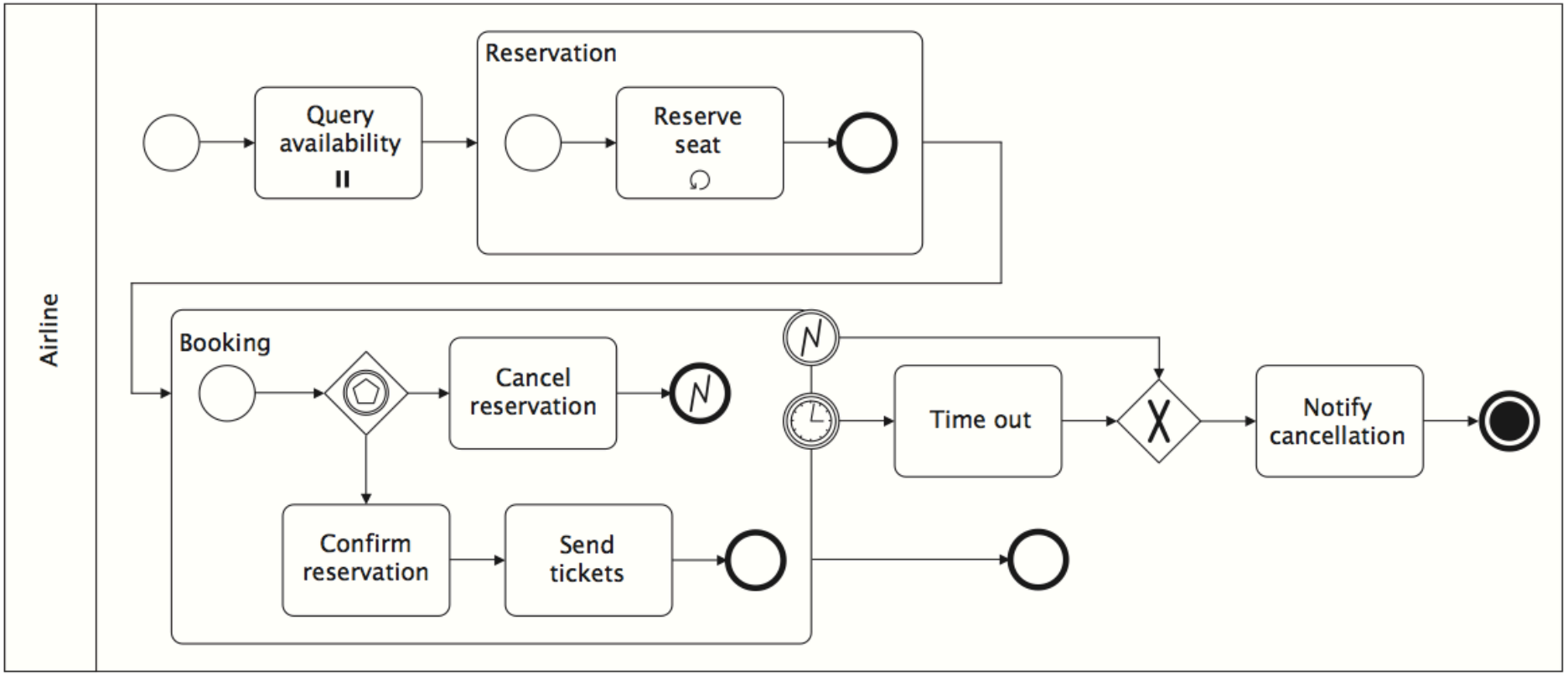
WS-Choreography Description Language

- 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

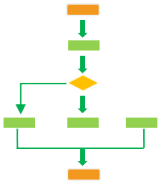
BPMN 1.1

- 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

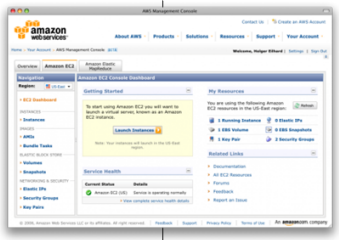
The decider implements the application's business logic

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

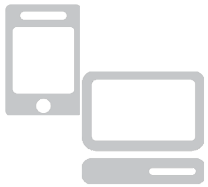
Get Activity Tasks / Return Results

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

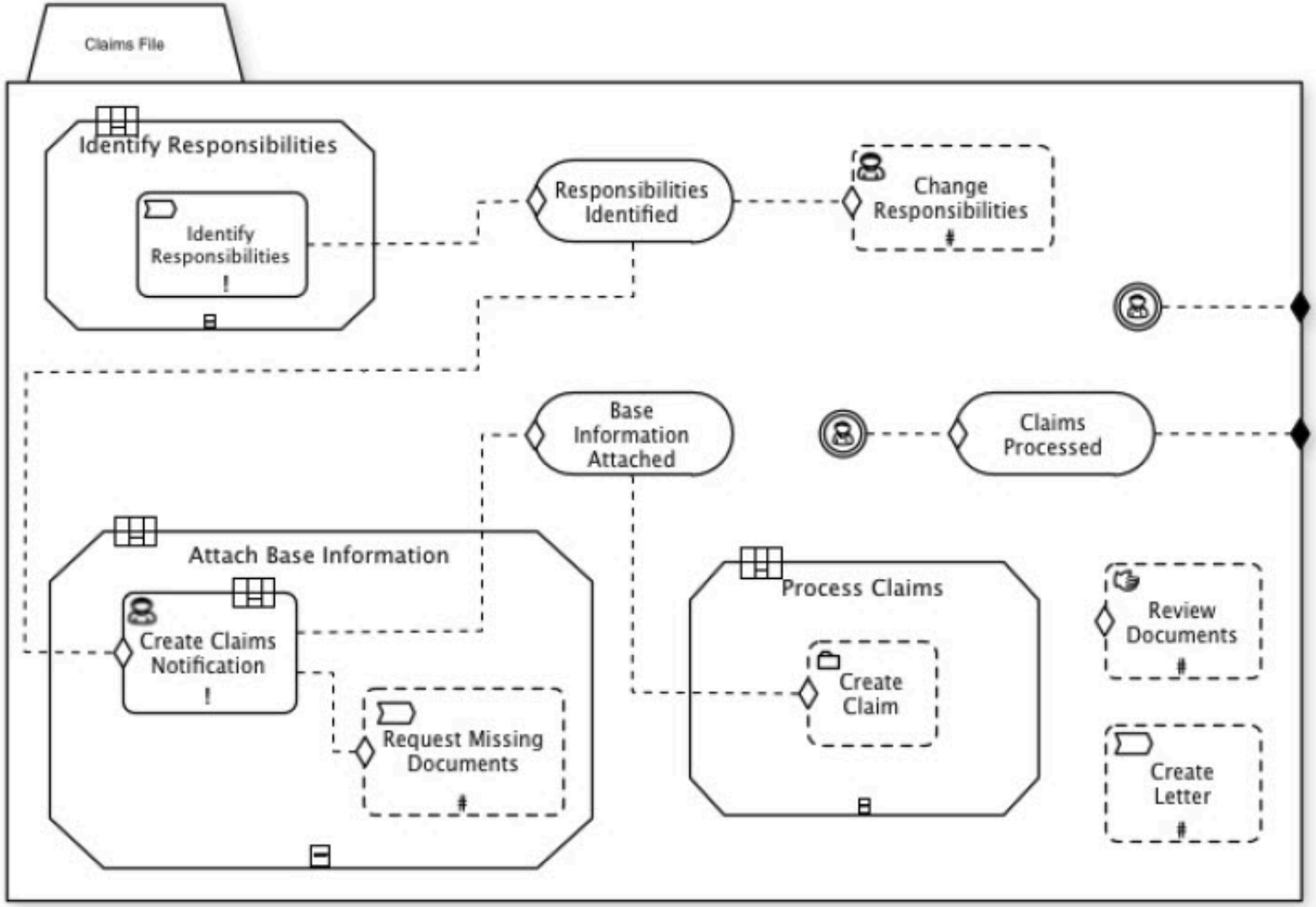
CMMN

Case Management and Modelling Notation

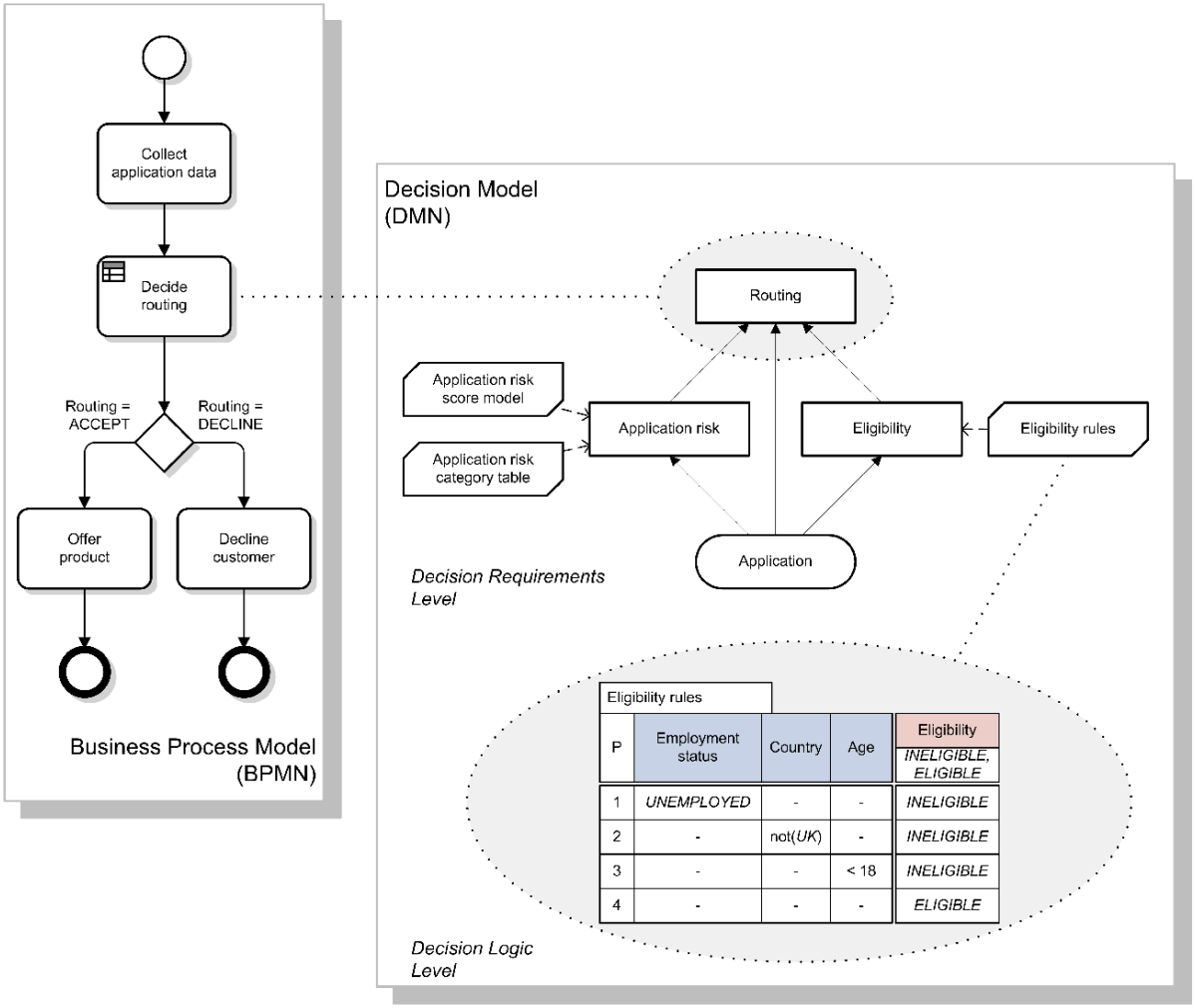
- A specification from OMG for modelling how to handle cases
- A more flexible approach to workflow that BPMN or BPEL
  - Certain workflows are very clear
    - Building a car
  - Others are more flexible
    - Hand building a mandolin
- Imperative vs “Causative”

CMMN example

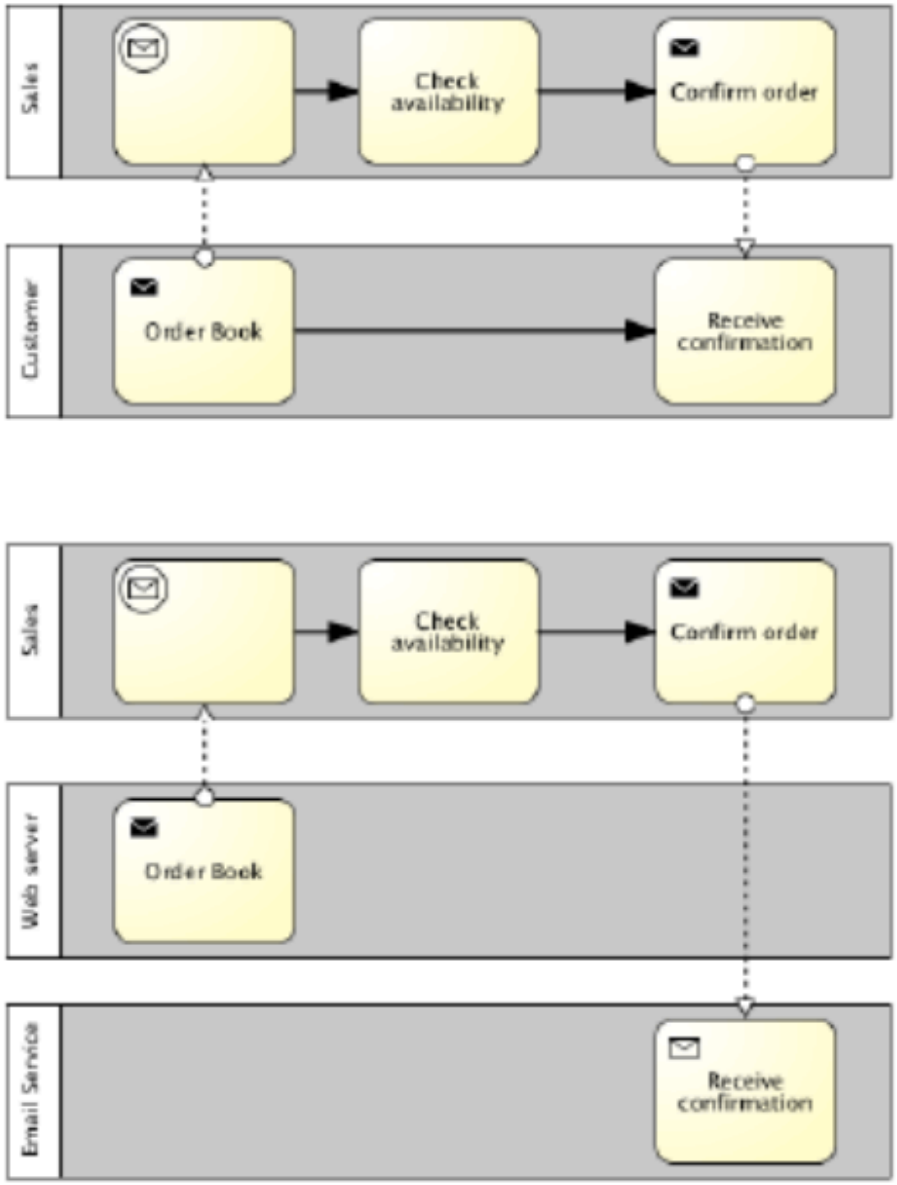
Source: http://brsilver.com/bpmn-cmmn-compared/



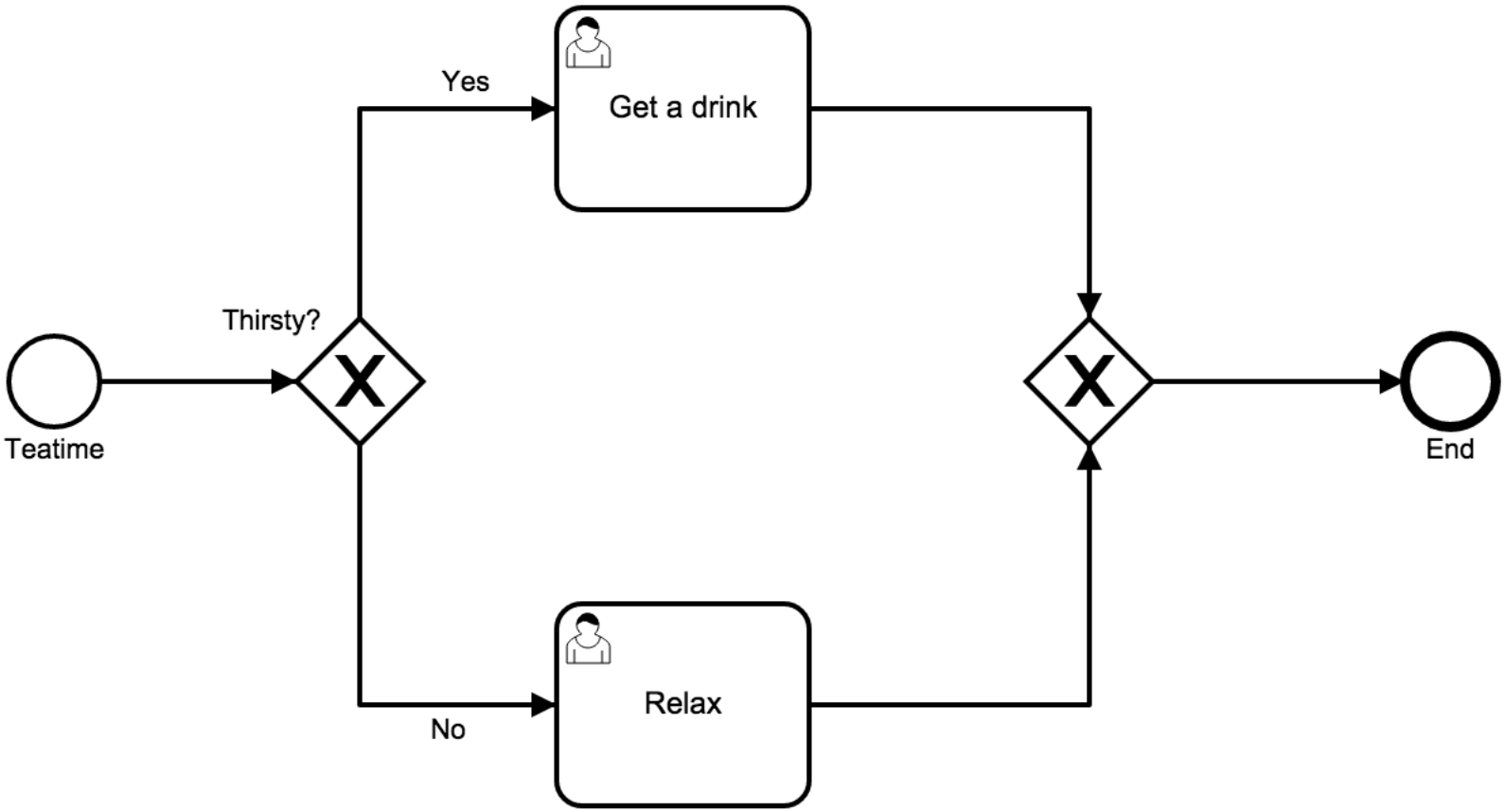
Decision Modeling Notation DMN 1.1



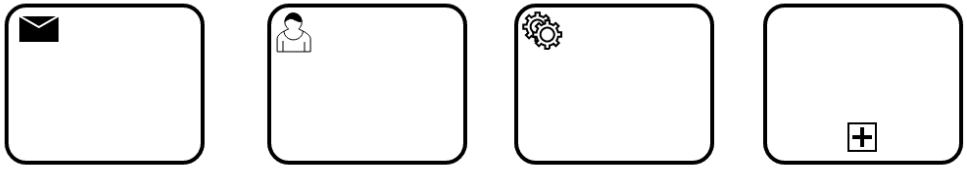
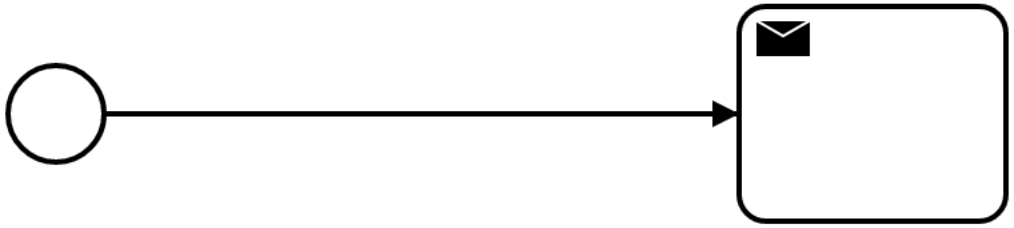
BPMN 2.0



BPMN 2.0 Basics

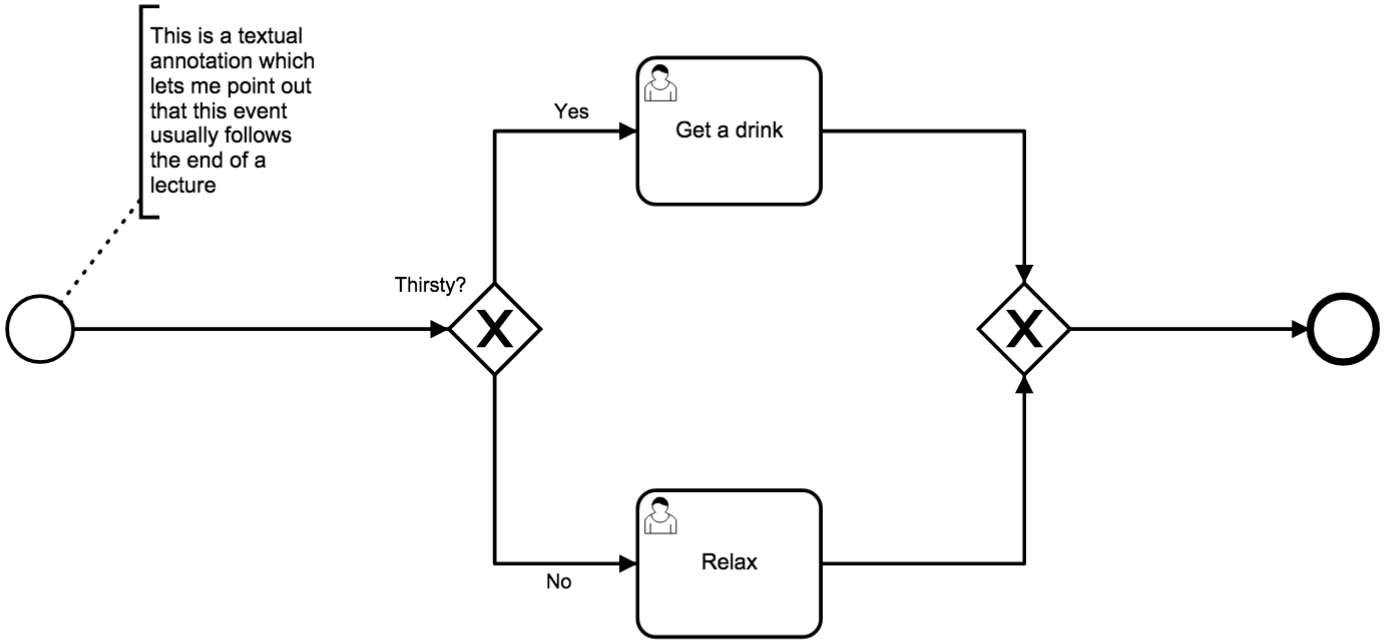


BPMN Basic Constructs

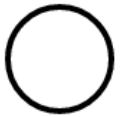
- Events 
- Activities 
- Gateways 
- Sequence Flow 

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

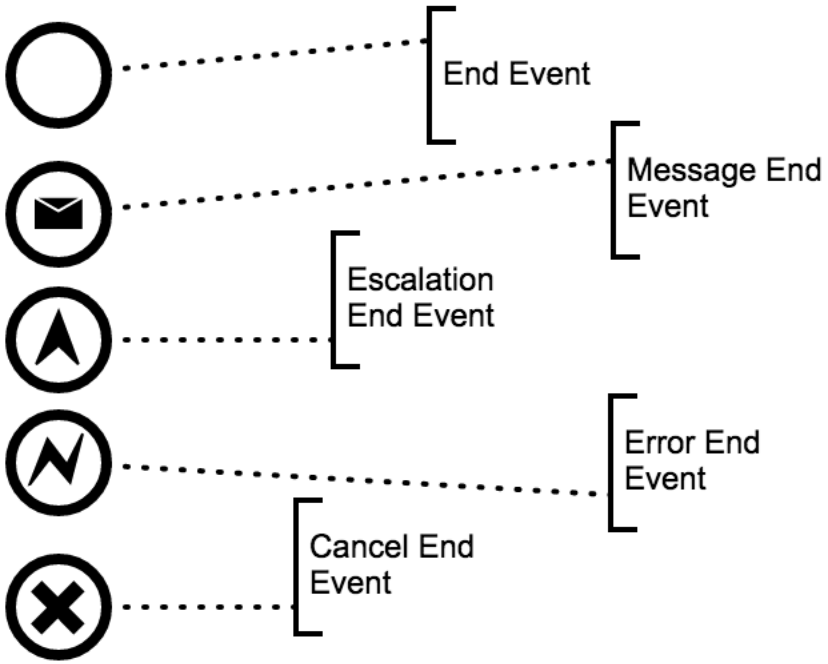
Message Catch

Message Throw

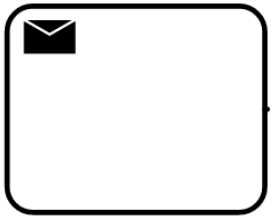
Timer

Escalation

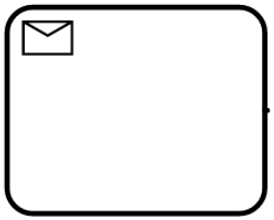
Some End Events



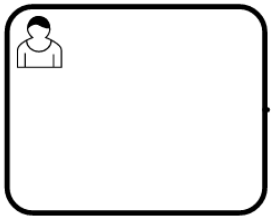
Activities



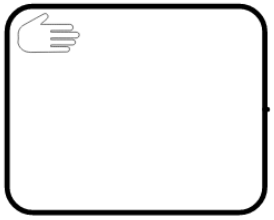
Send Task
- sends a message



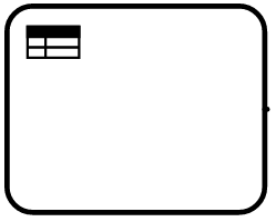
Receive Task
- receives a message



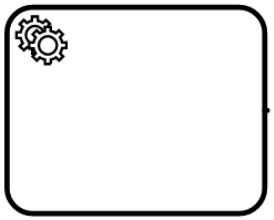
User Task
- requires input or action from a user, mediated by the engine



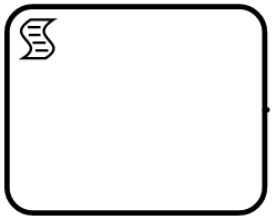
Manual Task
- completely manual task (out side the engine)



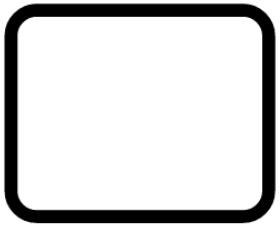
Business Rule Task
- implemented by a BR engine



Service Task
- implemented by a service



Script Task
- implemented by a script



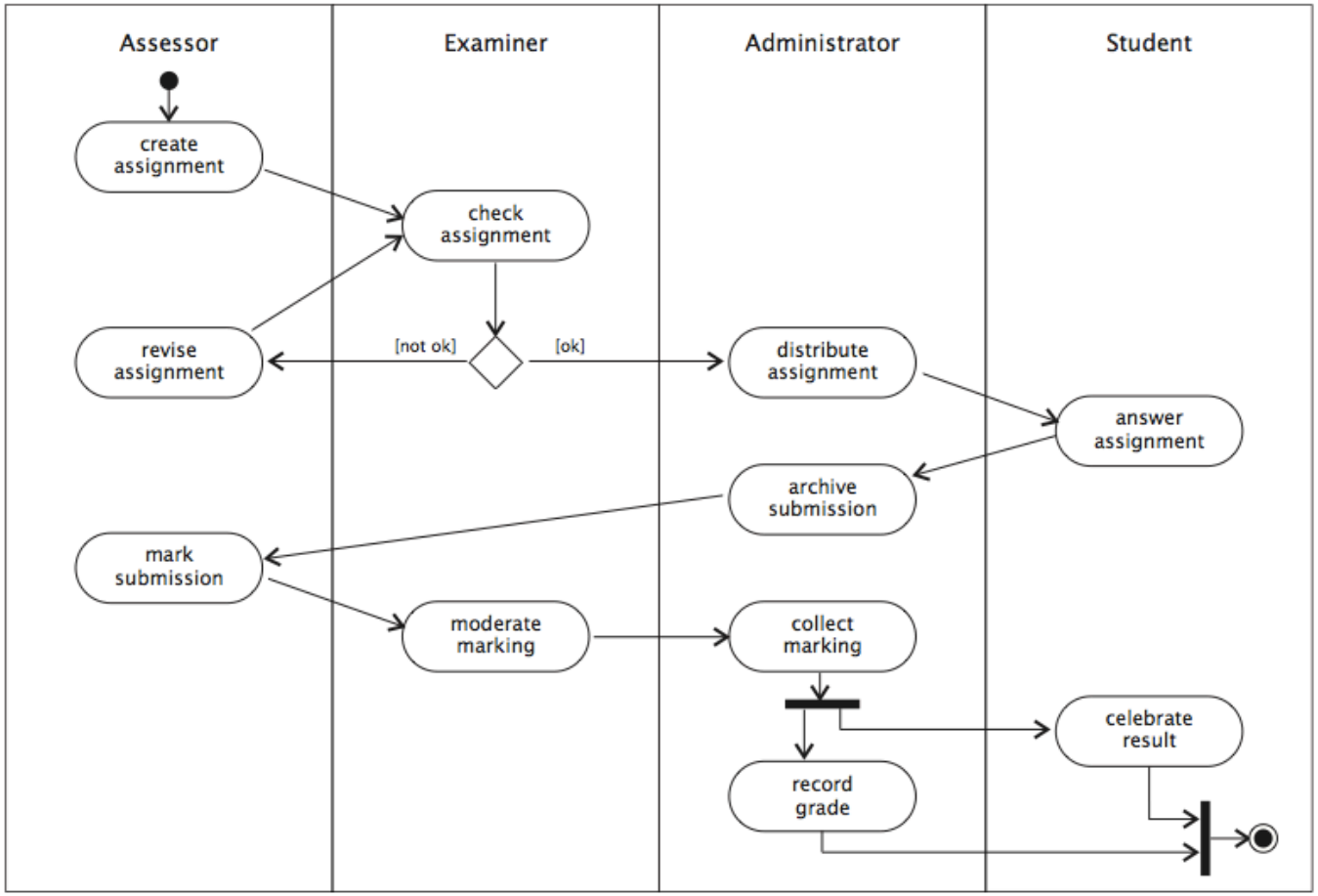
Call Activity-
calls another process

Service Task

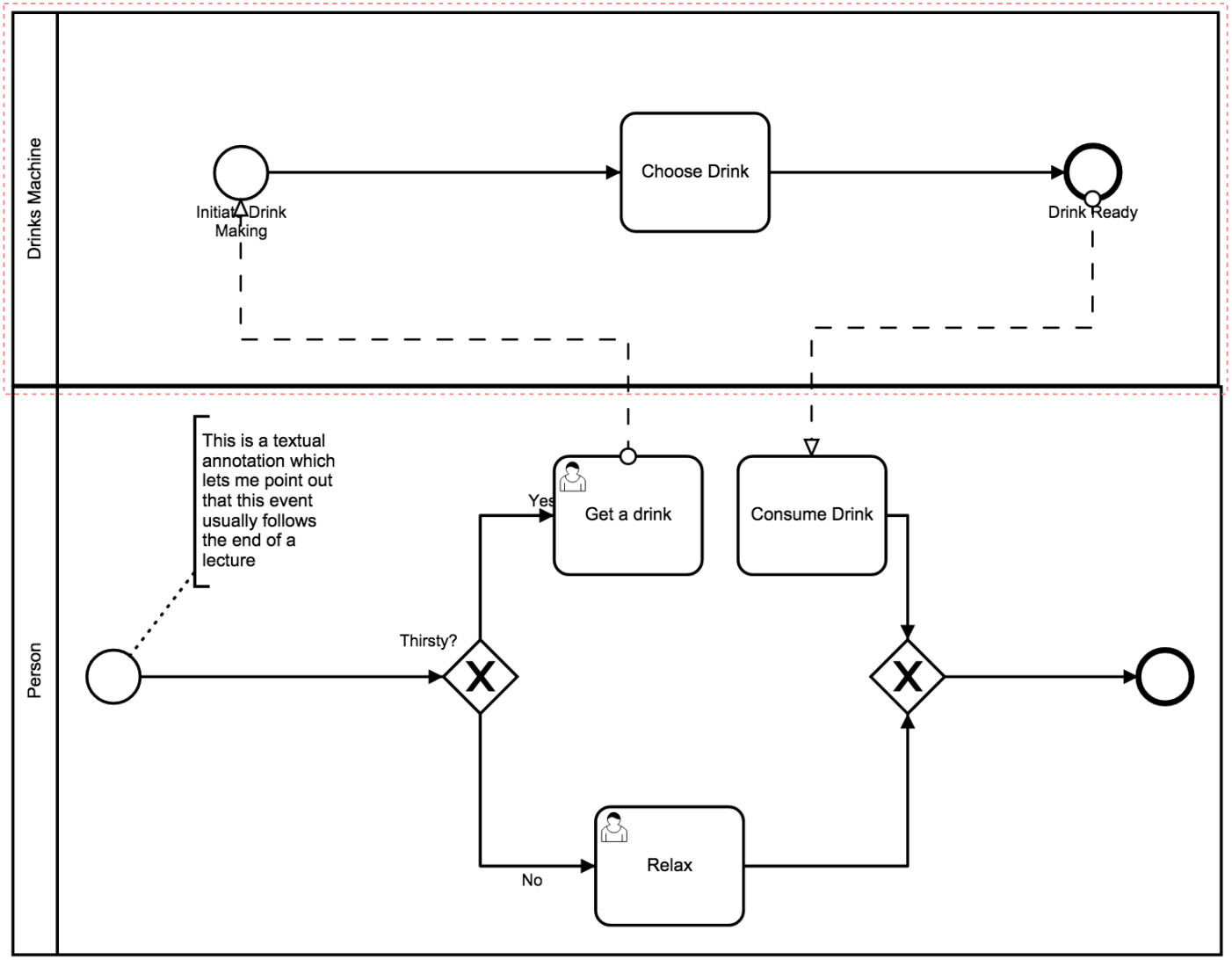
- Call a service
  - Unlike BPEL there is no direct way of capturing

Swimlanes:

partition an activity diagram into the responsibilities of different entities



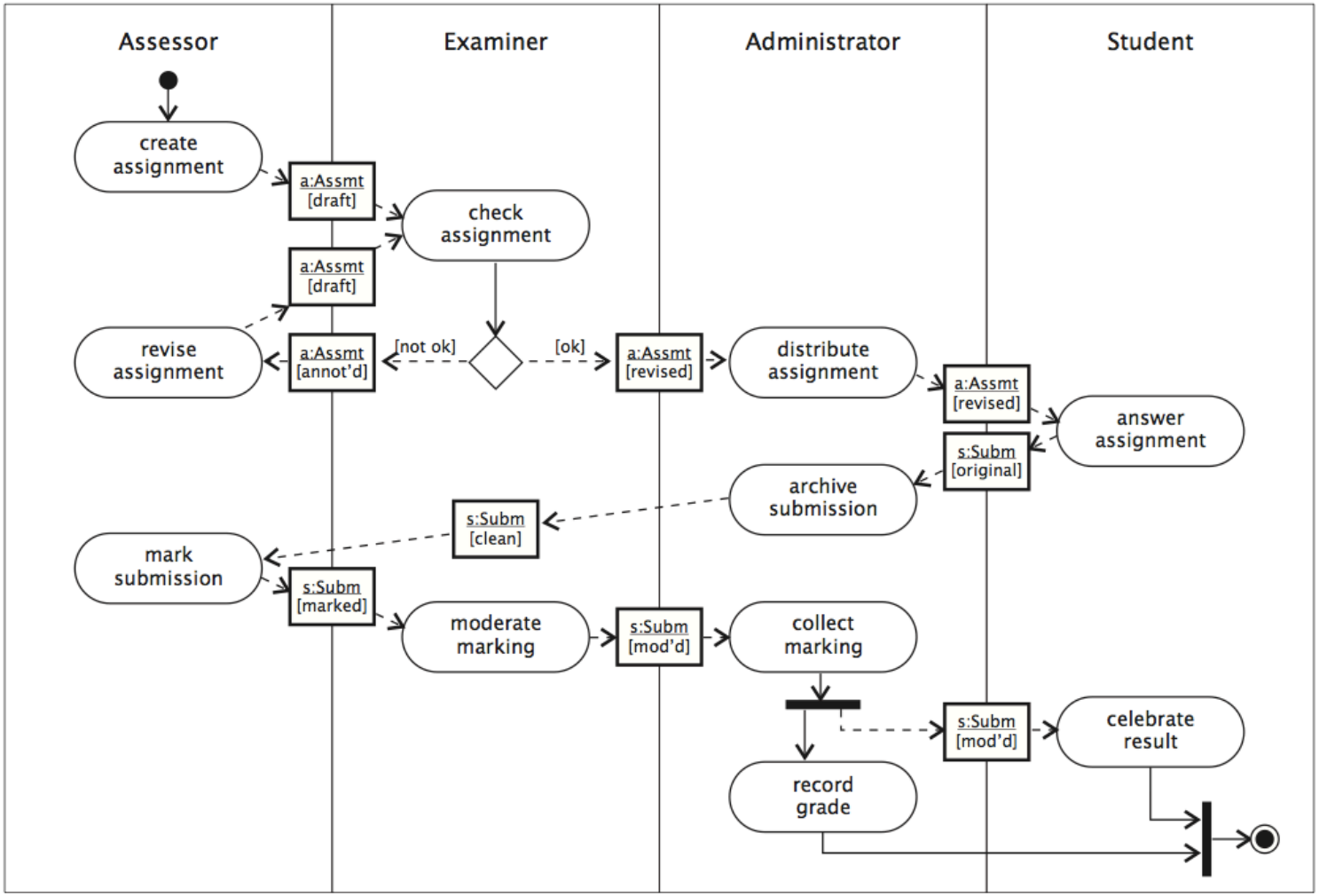
Swimlanes represent different participants



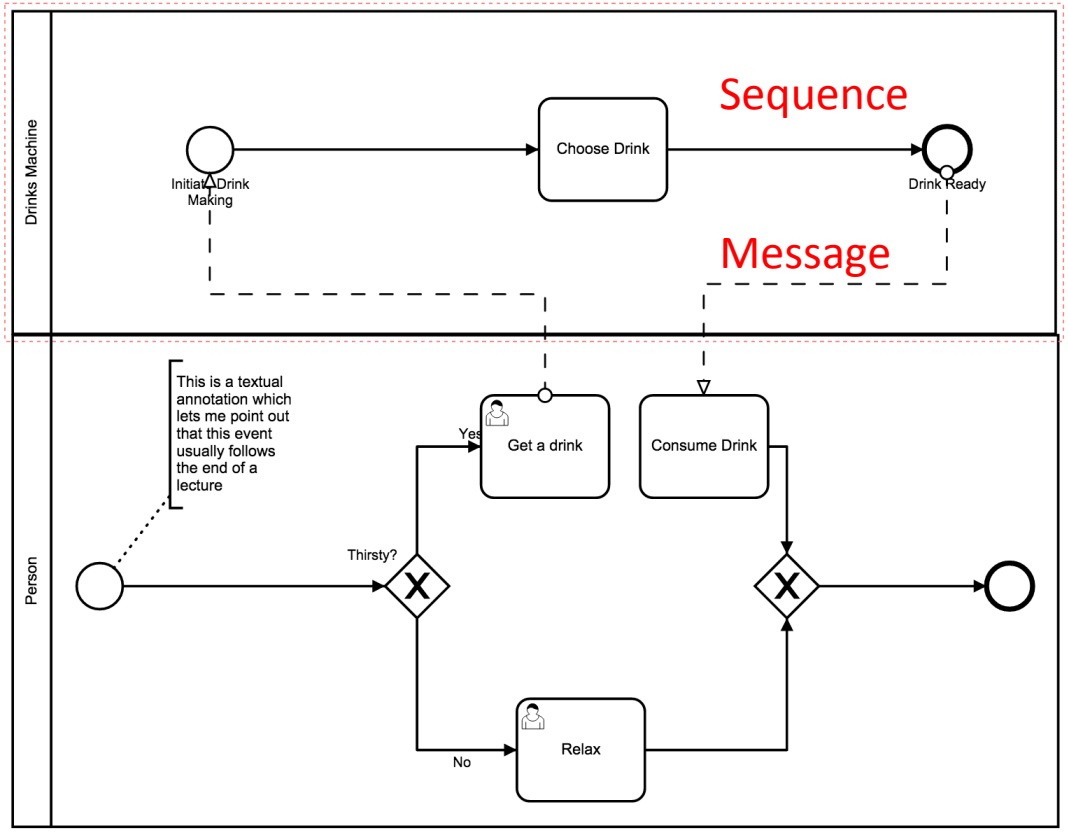
Data Flow

- 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



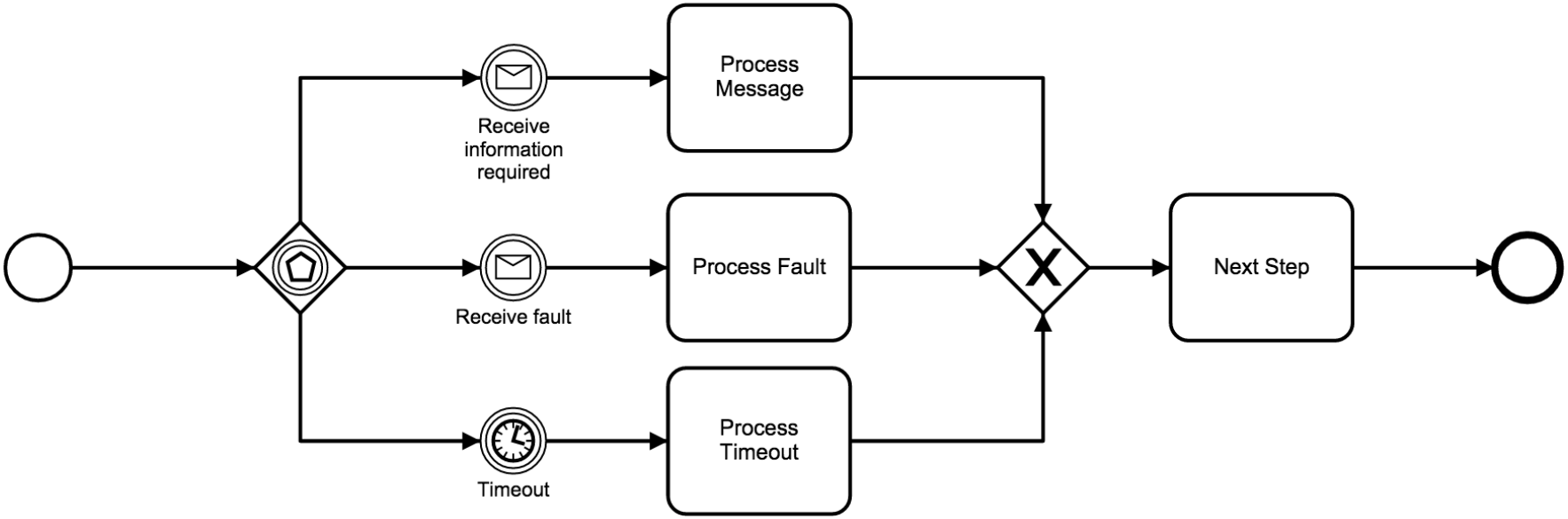
Sequence flows are within a Swimlane

Message flows between swimlanes

Gateways

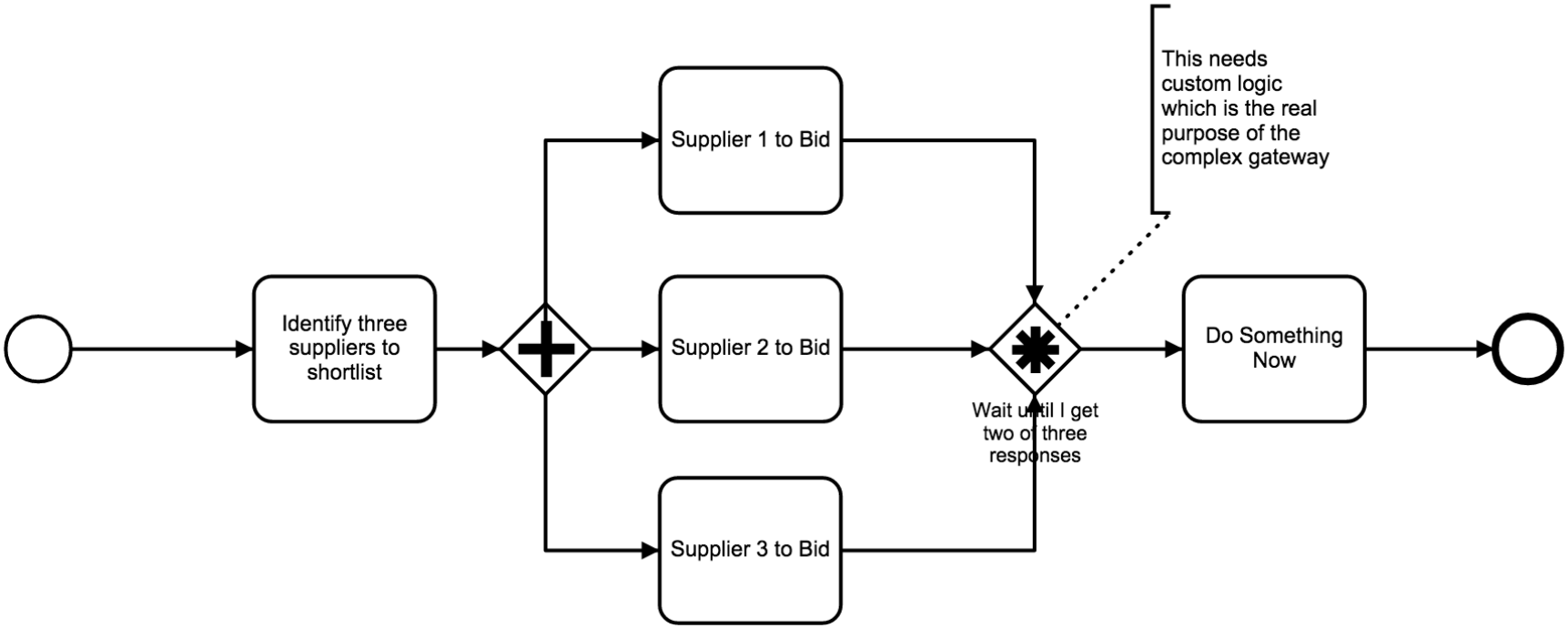
- Exclusive Gateway 
  - Fork – choose one path (if/else)
  - Join – wait for a single event
- Parallel Gateway 
  - Fork – do both / all paths
  - Join – wait for all inputs

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

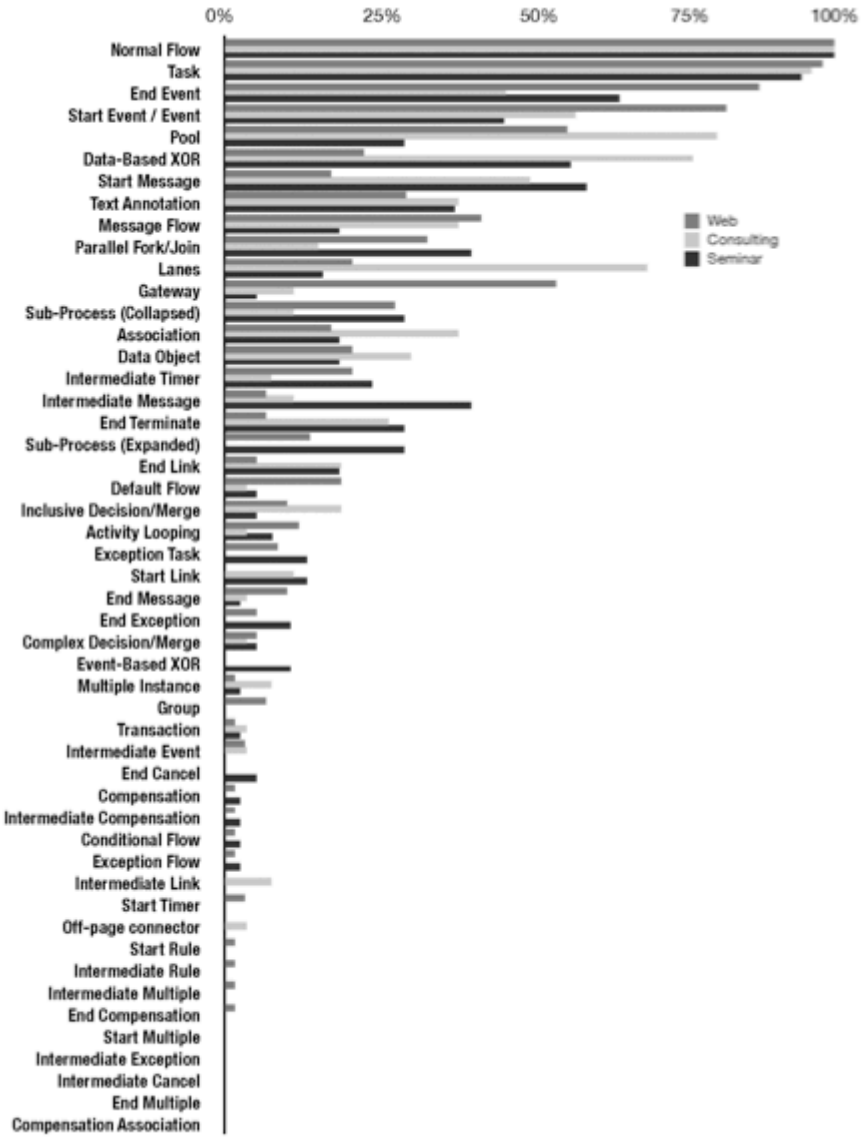
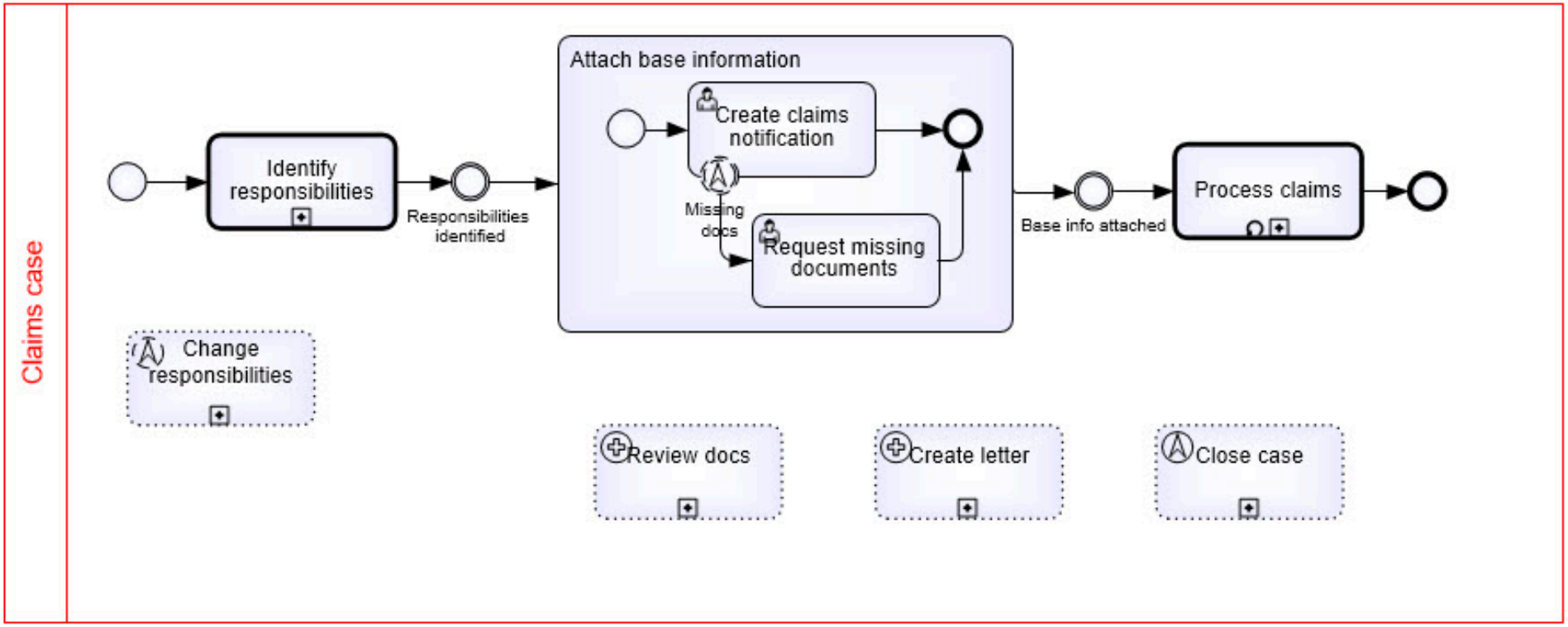


Fig. 1. Occurrence Frequency of BPMN Constructs

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