UNIVERSITÄT DES SAARLANDES

30 YEARS DFKI Human Centric AI.

Modeling for Architects II: Business Processes, BPMN 2.0, Object Lifecyles

Architectural Thinking for Intelligent Systems

Winter 2019/2020

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Agenda

- Analyzing business processes with BPMN 2.0
- Basic and advanced language elements
- Style conventions
- Syntactically and semantically correct models
- Pattern and Anti-pattern

- Process model and instance of a process
- Understanding Business Object Lifecycles

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Tutorial Assignment 2

- We practice the usage of BPMN 2.0 with a number of exercises.

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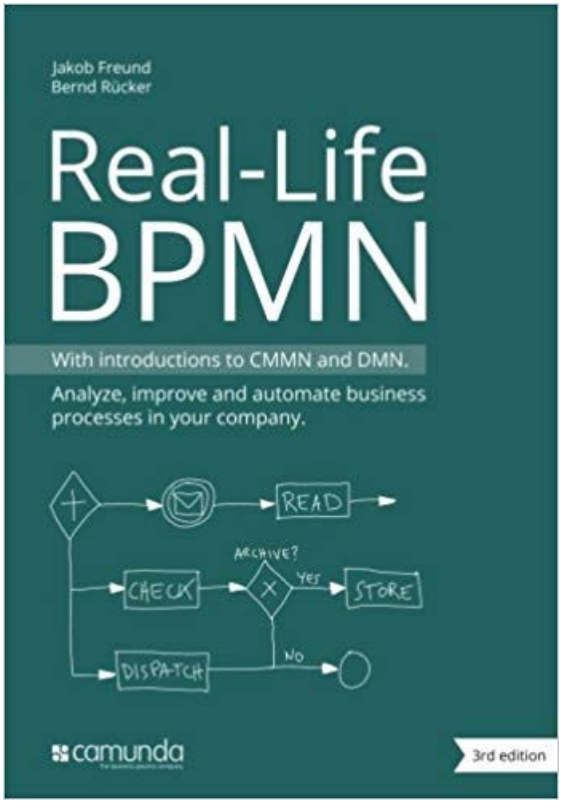
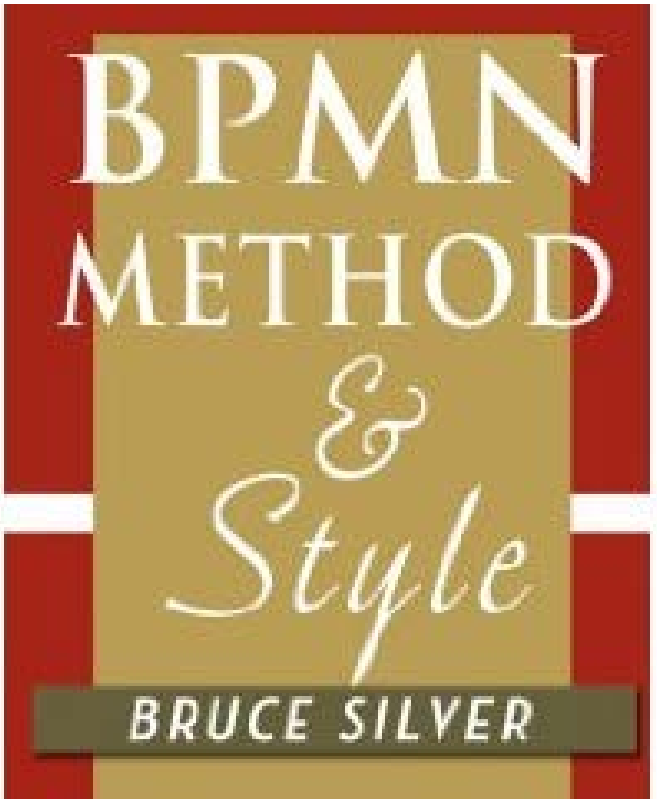
Understanding and Modeling Business Processes





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Why Process Models?

- Understanding the processes in an organization
- Create documentation for audits
- Execution of simulations for process optimization
- Comparison of process variants
- Specification of requirements for changes/automations
- ➢ Service orientation
- ➢ Business capability management

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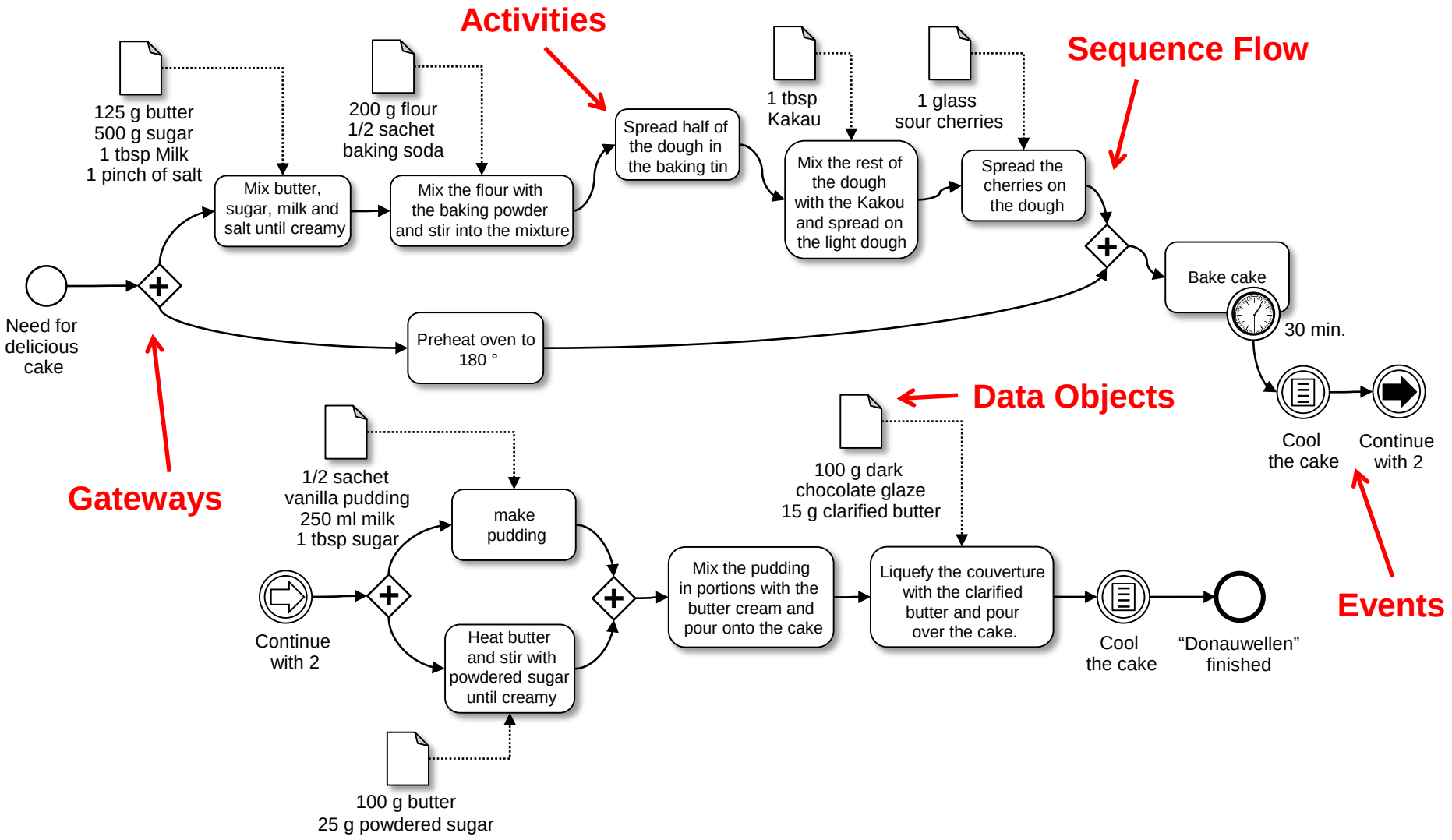
Everything is a Process …



http://blog.frapu.de/index.php?entry=entry090720-212758 Frank Puhlmann (inubit) Blog

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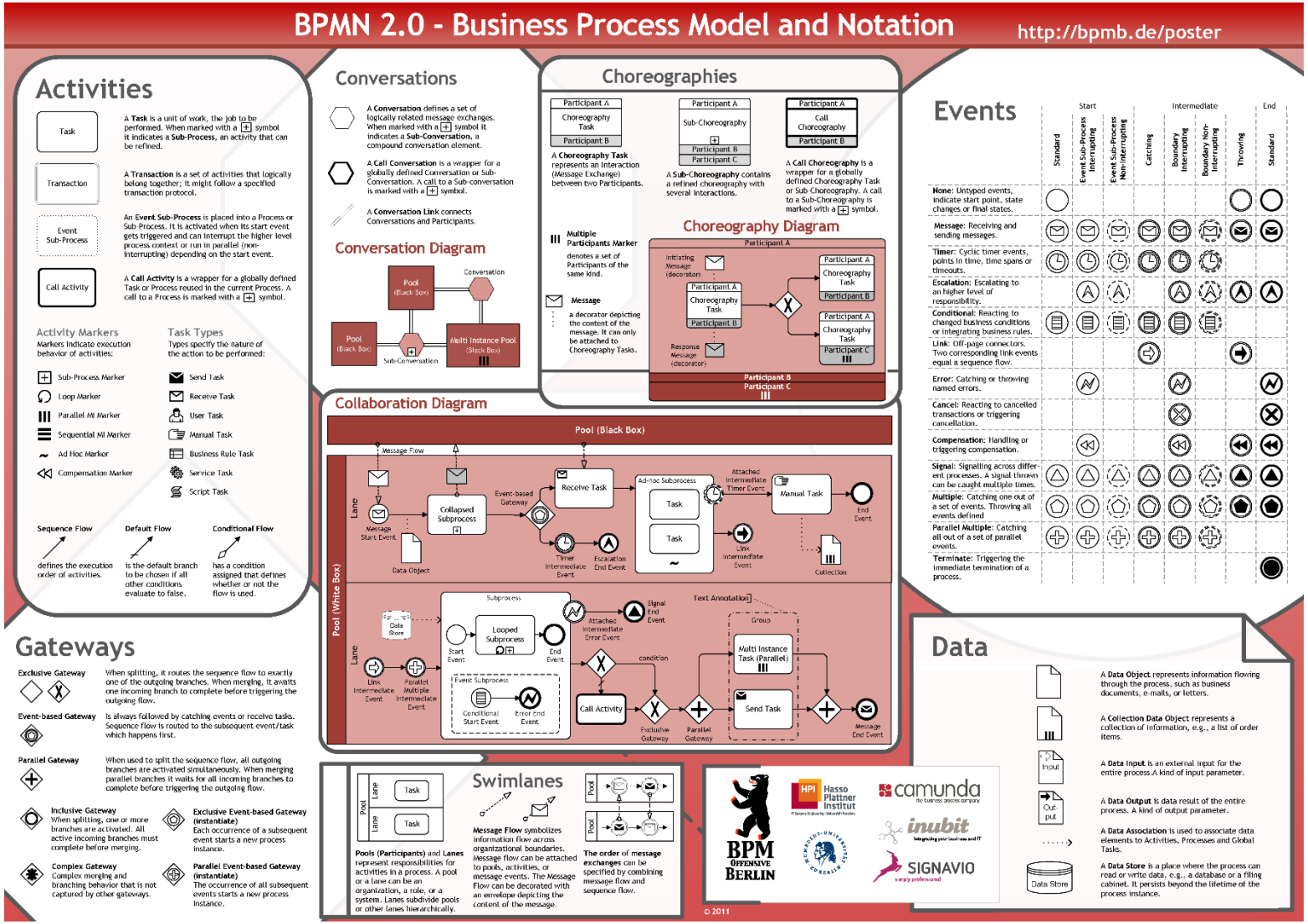
BPMN 2.0 Poster

http://signavio.com/



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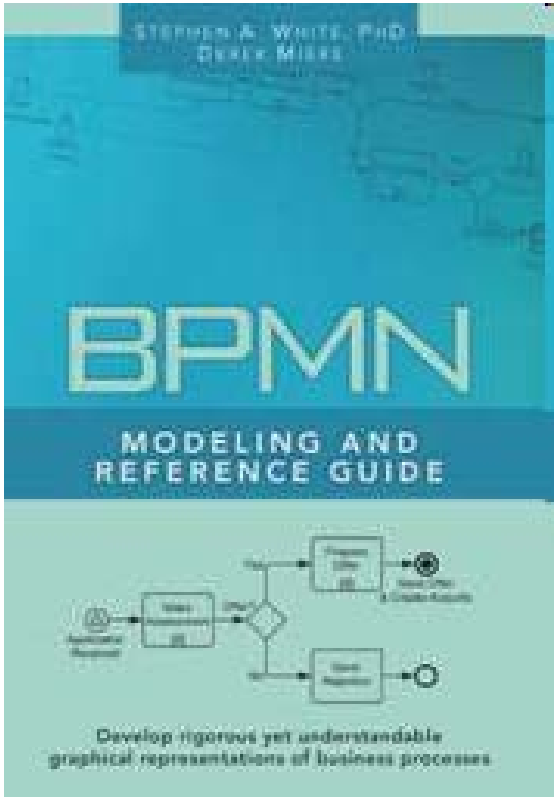
History of BPMN

- First initiative at OMG in September 2000
- Version 1.0 of the standard in May 2004
  - Graphical symbols, informal semantics, many examples, first tools
- Version 1.1 in January 2008, approx. 60 vendors
- Version 1.2 in January 2009
- Version 2.0 Proposal of IBM/SAP/Oracle in June 2009
  - Metamodel, formal semantics, technical attributes
- Adoption of version 2.0 in January 2011
  - http://www.omg.org/spec/BPMN/
- Current version 2.0.2 since 2014



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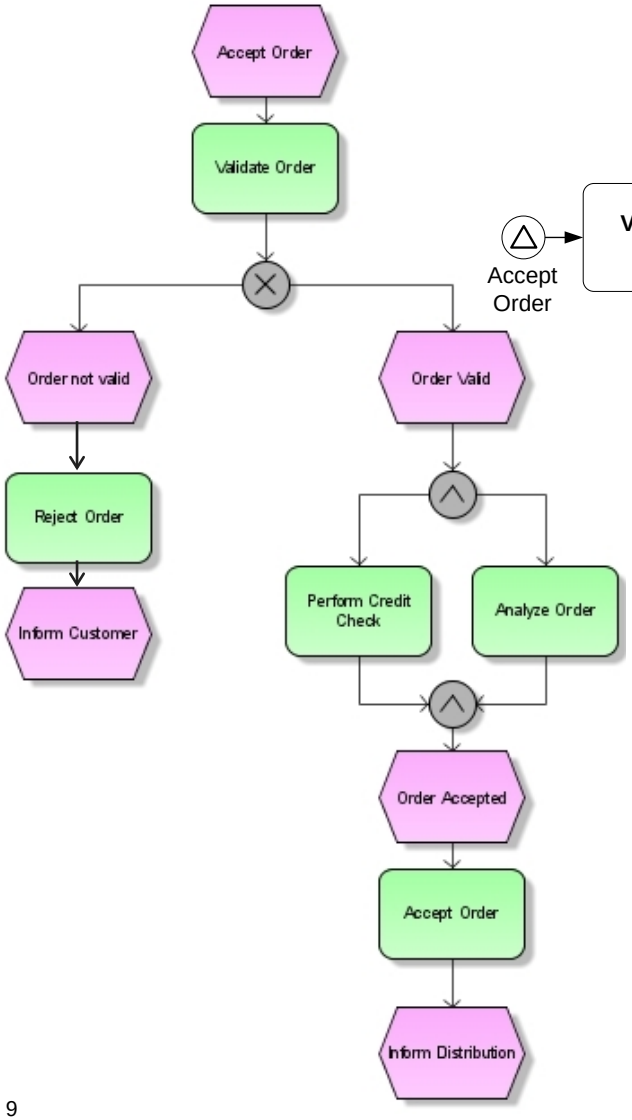
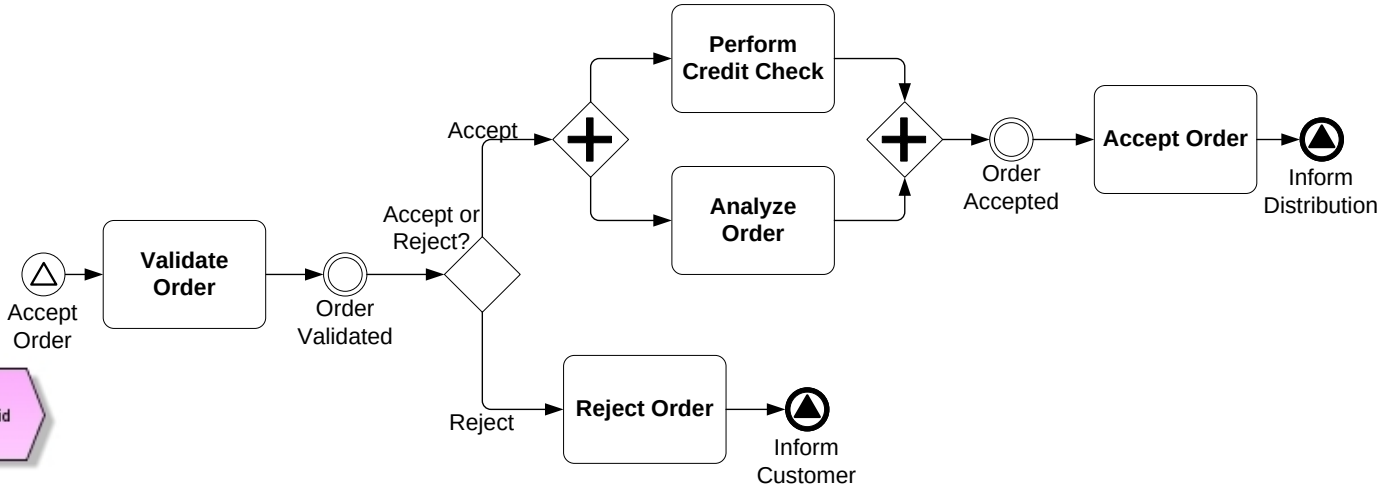
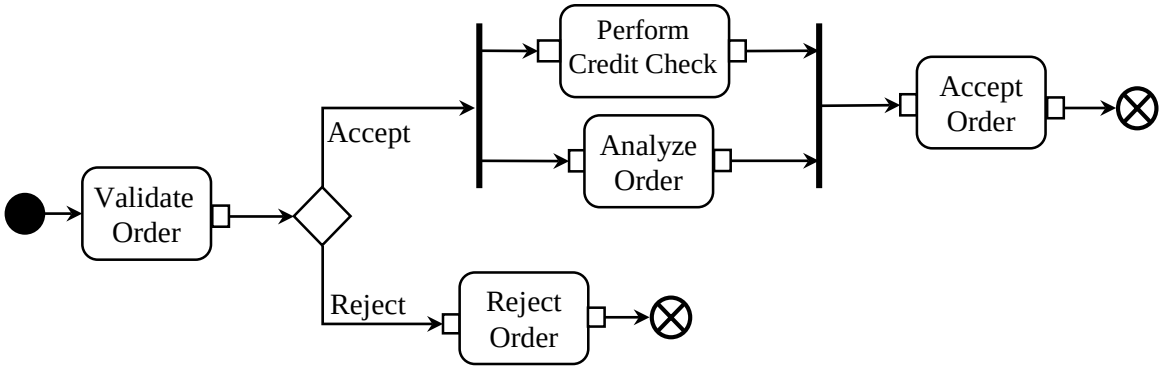
EPK – UML Activity Diagrams – BPMN







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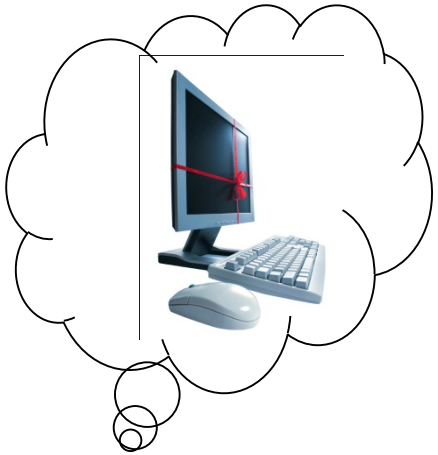
BPMN Focuses on Connected Businesses



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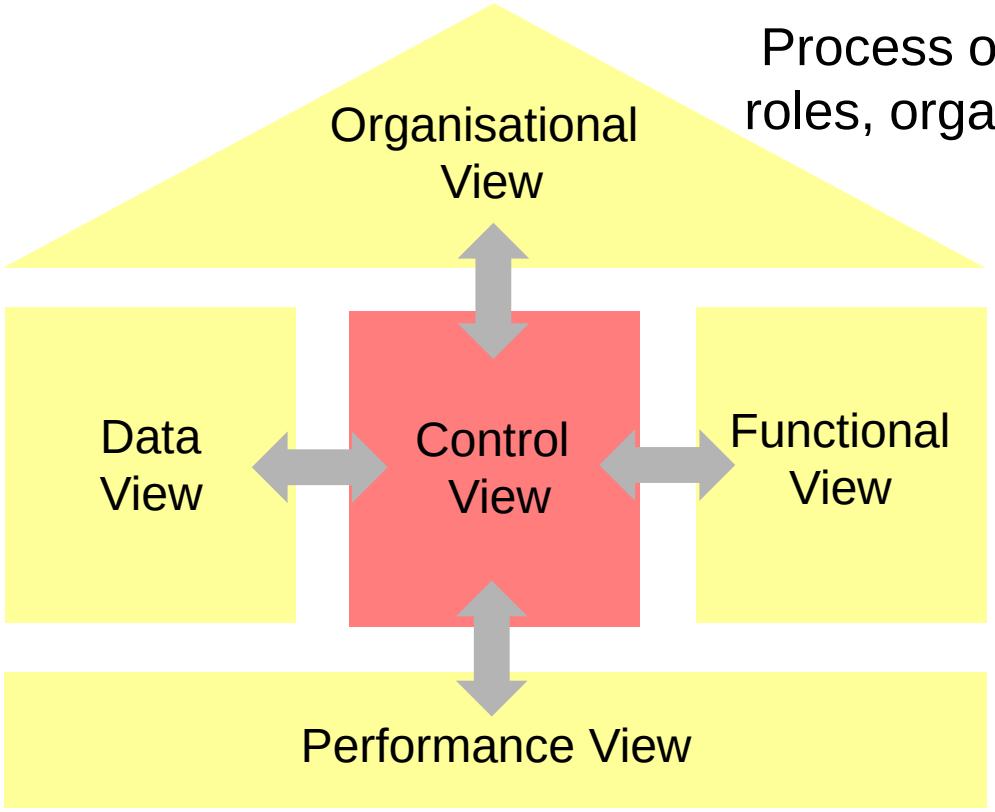
Process Views (Scheer)

- ARIS = Architecture of Integrated Information Systems

Process owners/participants
roles, organizational structure



Data and their states, events

Activities and sub-processes

Products and services of the enterprise, business capabilities
goals and business value of processes

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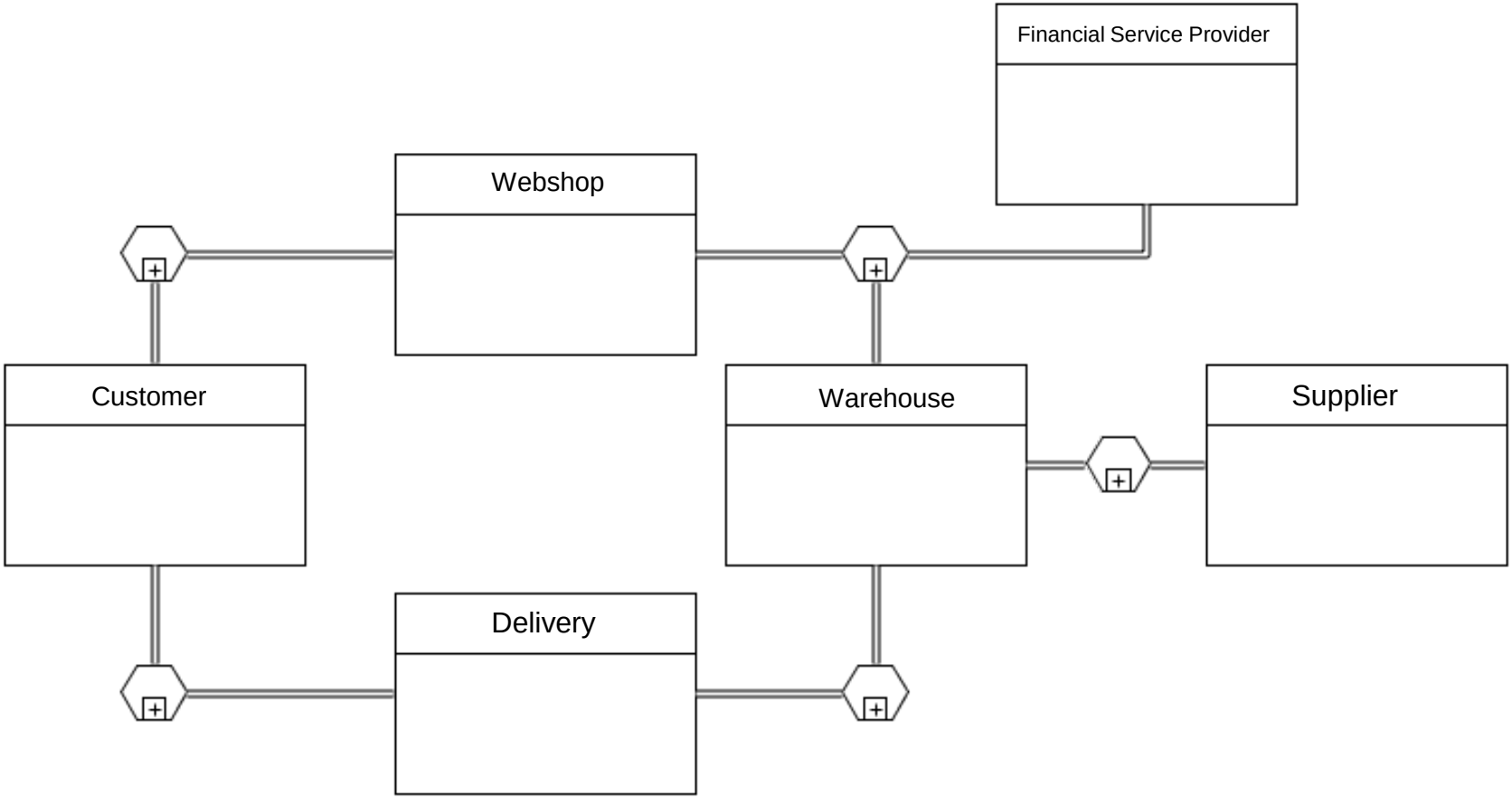
Which Partners Interact? - BPMN Conversation Diagram



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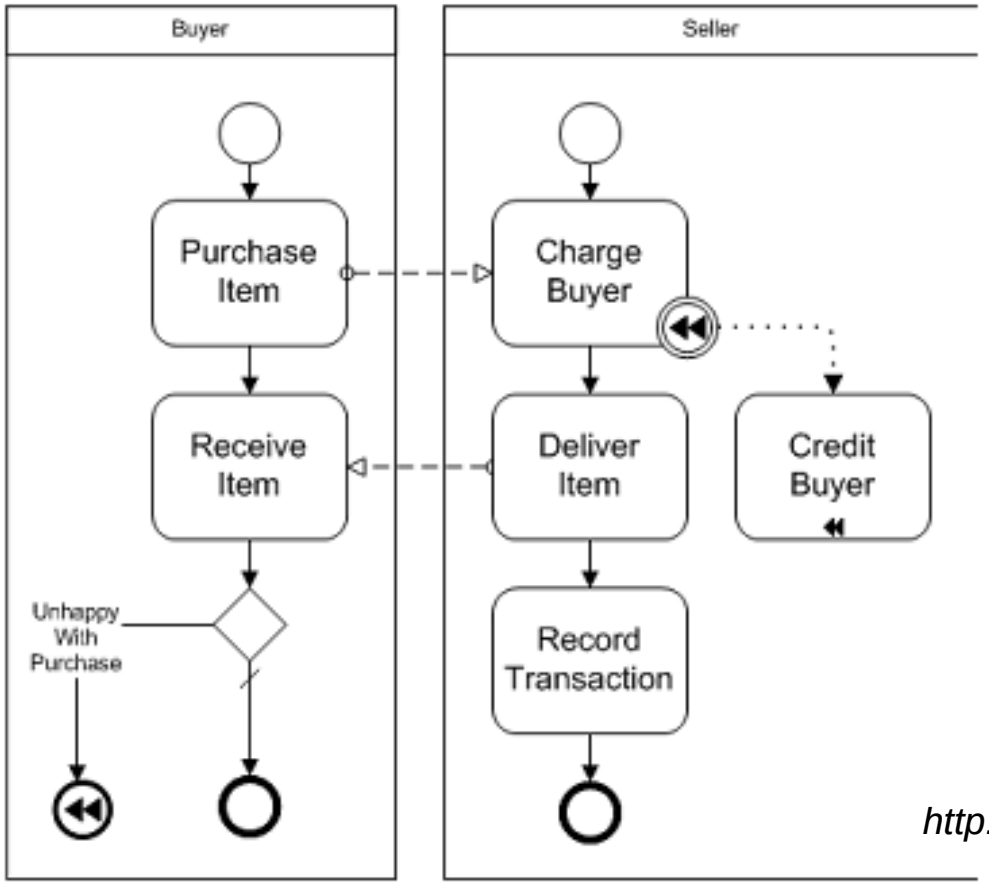
How do Processes of Partners Proceed?
- BPMN Collaboration Diagram (Process Model)



http://www.brsilver.com/wp-content/comp2.gif

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Recommended Modeling Tools

- http://academic.signavio.com/
- Software as a Service cloud solution

- https://camunda.com/download/modeler/
- Download and install local instance on your computer

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Analyze a Process

1. Where are process boundaries? Which start and end events/conditions occur? (Processes)
2. Which individual steps must be executed in the process? (Activities)
3. Which process paths (happy path, exceptions) are described? (Gateways and sequence flow)
4. Which organizations are involved? (Pools)
5. Which essential business objects (data) are exchanged between the participants? (Messages)

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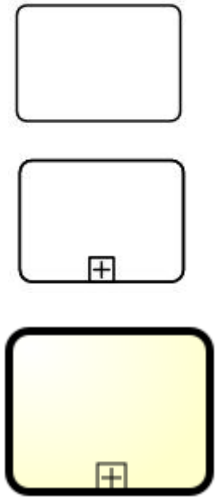
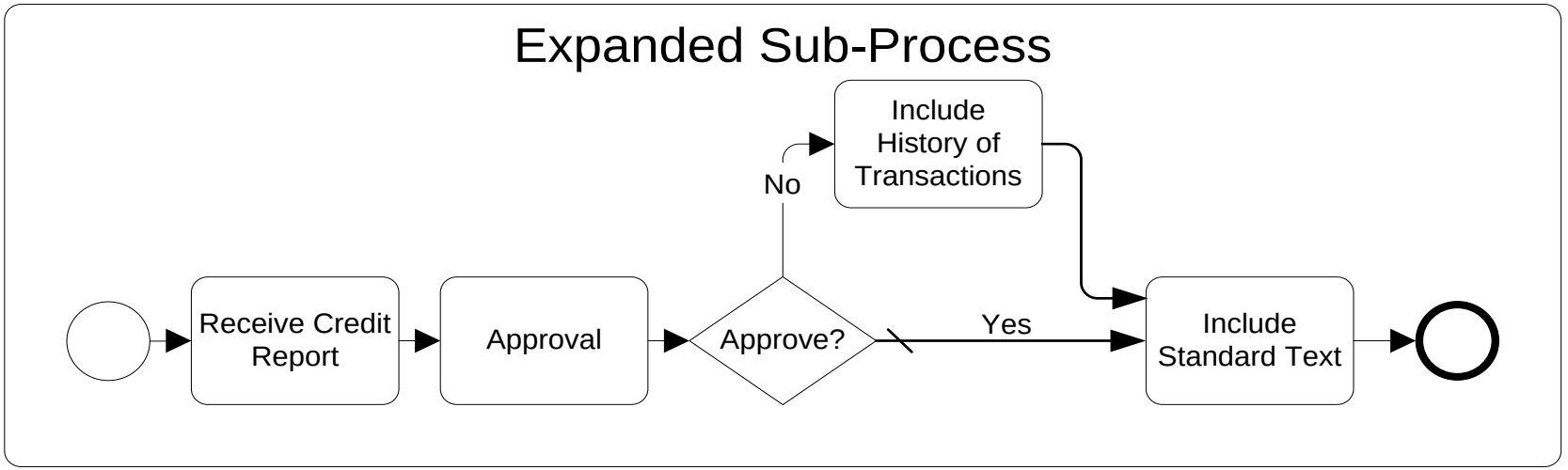
Activities

- A step/a task in the process
  - represents a business function
  - has inputs/outputs

- Task (atomic process step, not further refined)
- Subprocess (refined in further BPMN diagram)



Globally defined Subprocess



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Task Marker and Task Types

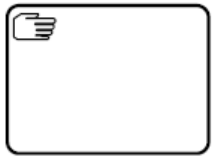
loop task

multi-instance task

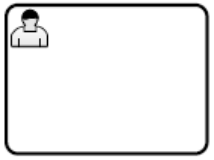
compensation task

service task

send task

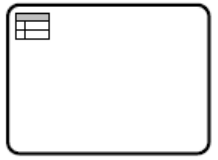


manual (outside BPMS)



user task

receive task



business rules task

script task (code for BPMS)

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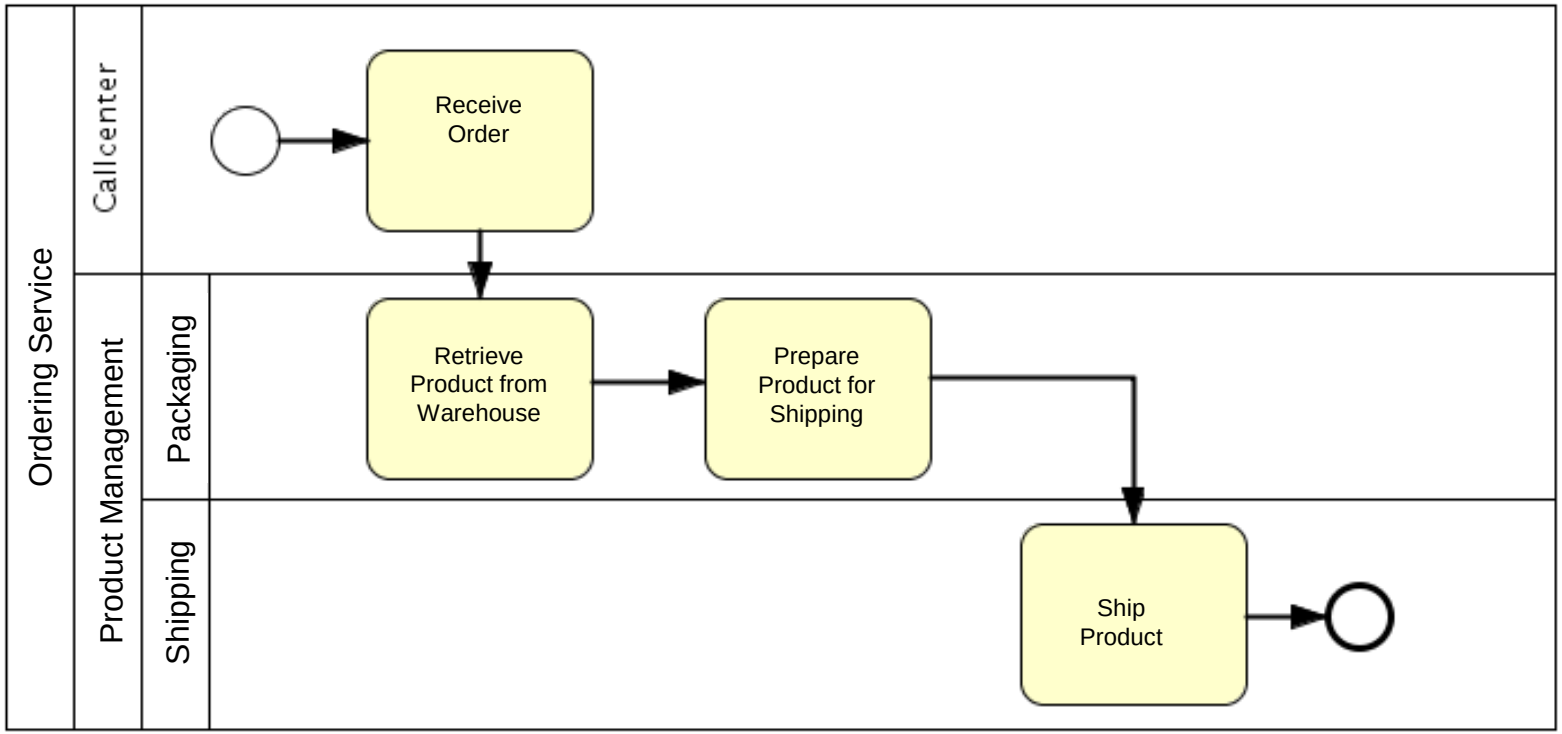
Modeling Process Participants - Lanes



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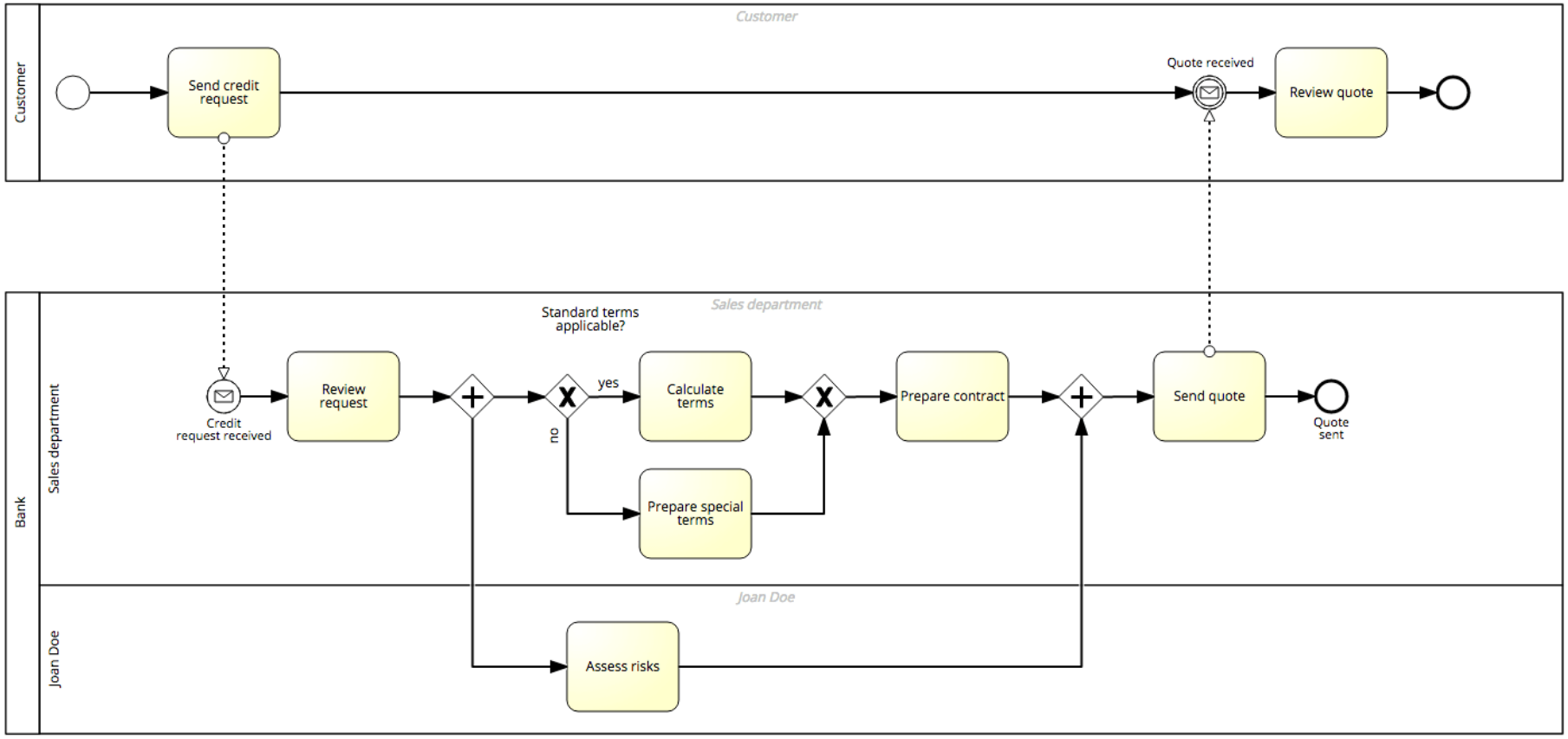
Modeling Cross-Organizational Processes - Pools



https://www.signavio.com/post/bpmn-pools-and-lanes/

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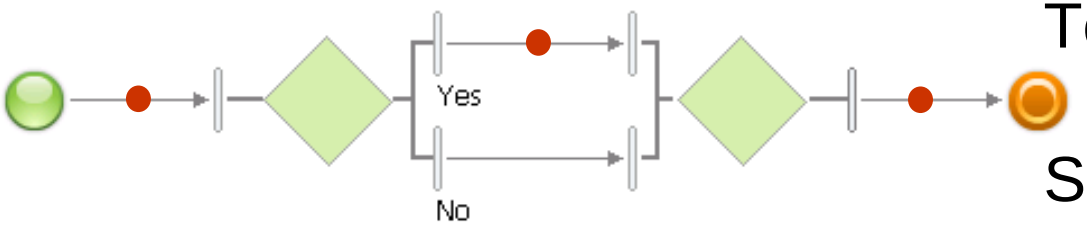
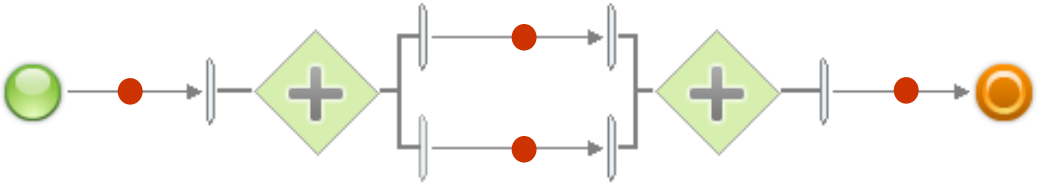
Gateway Semantics

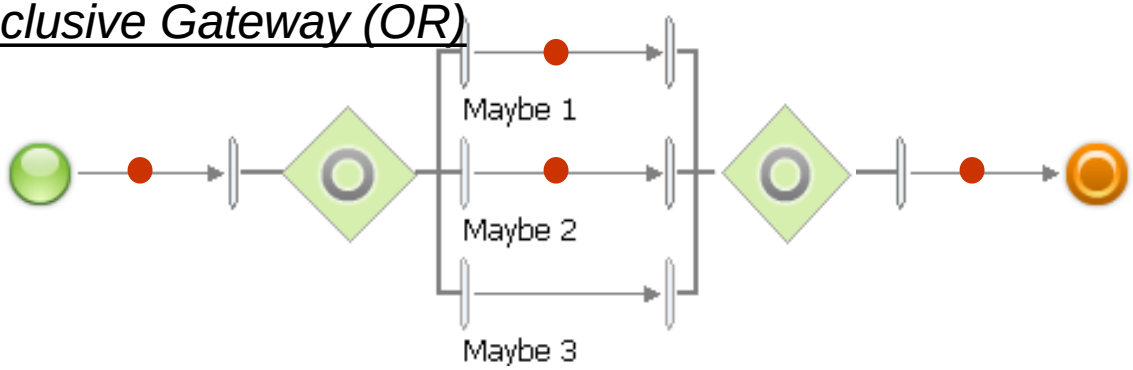
Exclusive Gateway (XOR)



Parallel Gateway (AND)



Inclusive Gateway (OR)



Token flow (Petri nets)

State of a process = Distribution of tokens in the net (marking)

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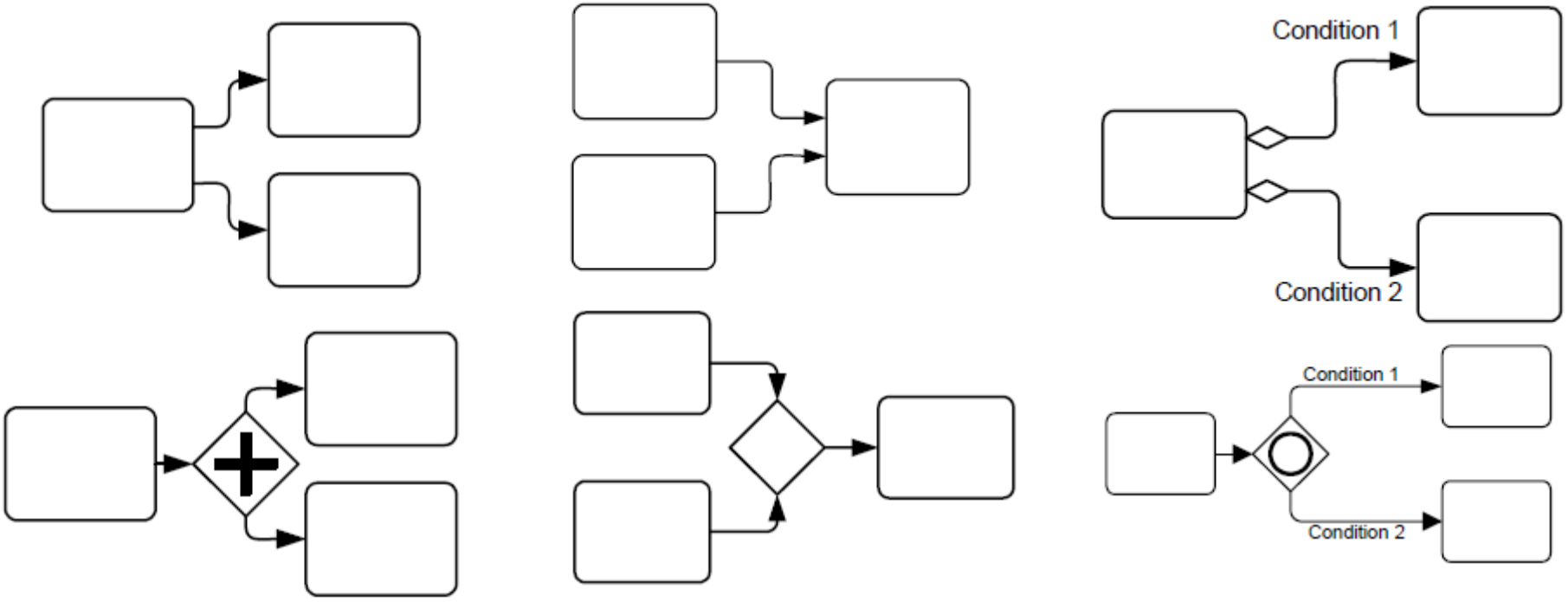
Process paths without gateways



What cannot be modelled without gateways??

Synchronizations of parallel paths!!

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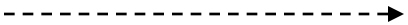
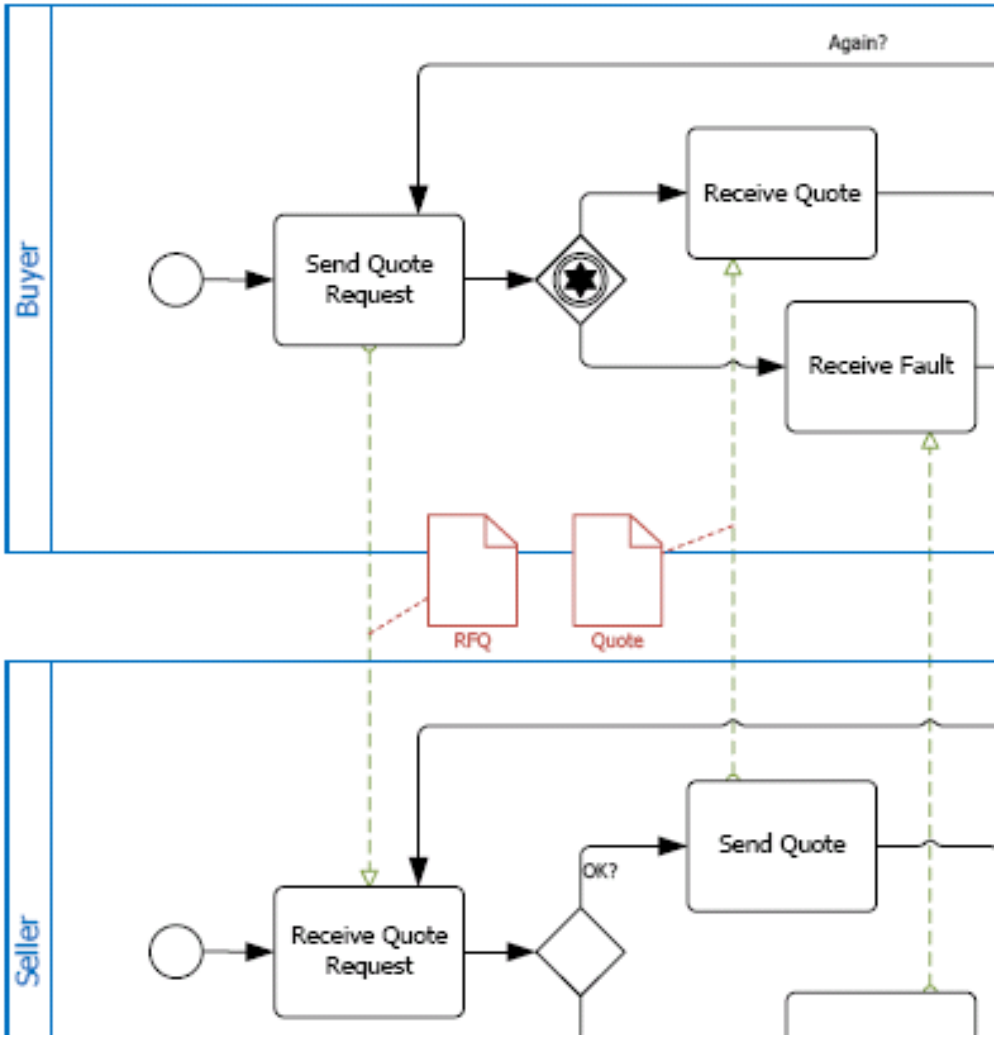
Connectors

- Sequence Flow

- Message Flow



- Association



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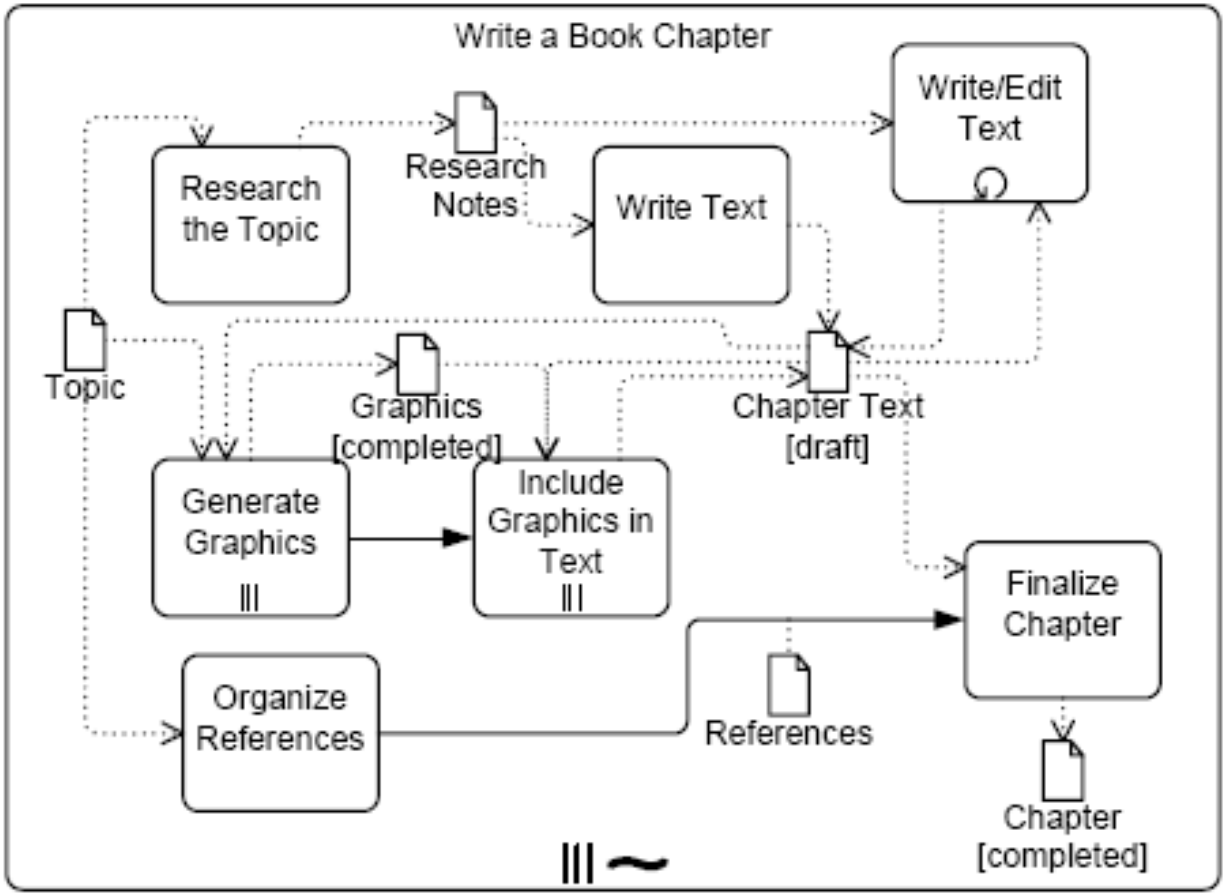
Adhoc Process



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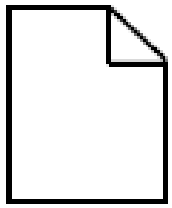
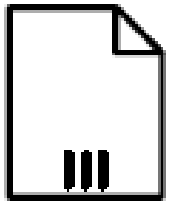
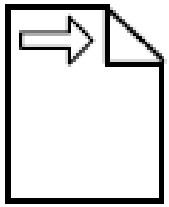
Data Modeling and Data Flow



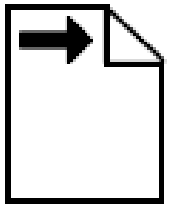
Collection

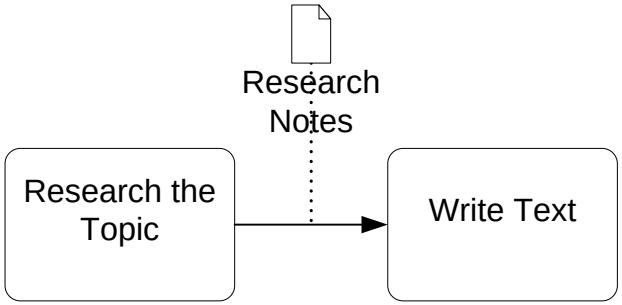


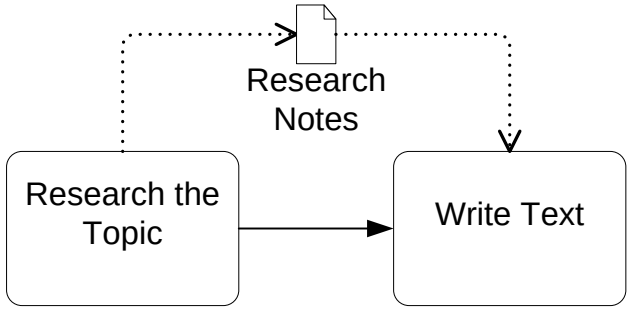
Data Input

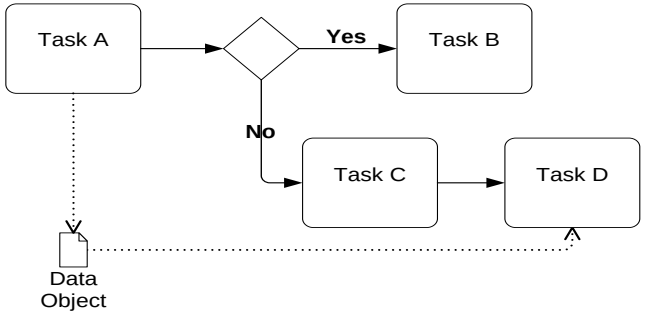


Data Output









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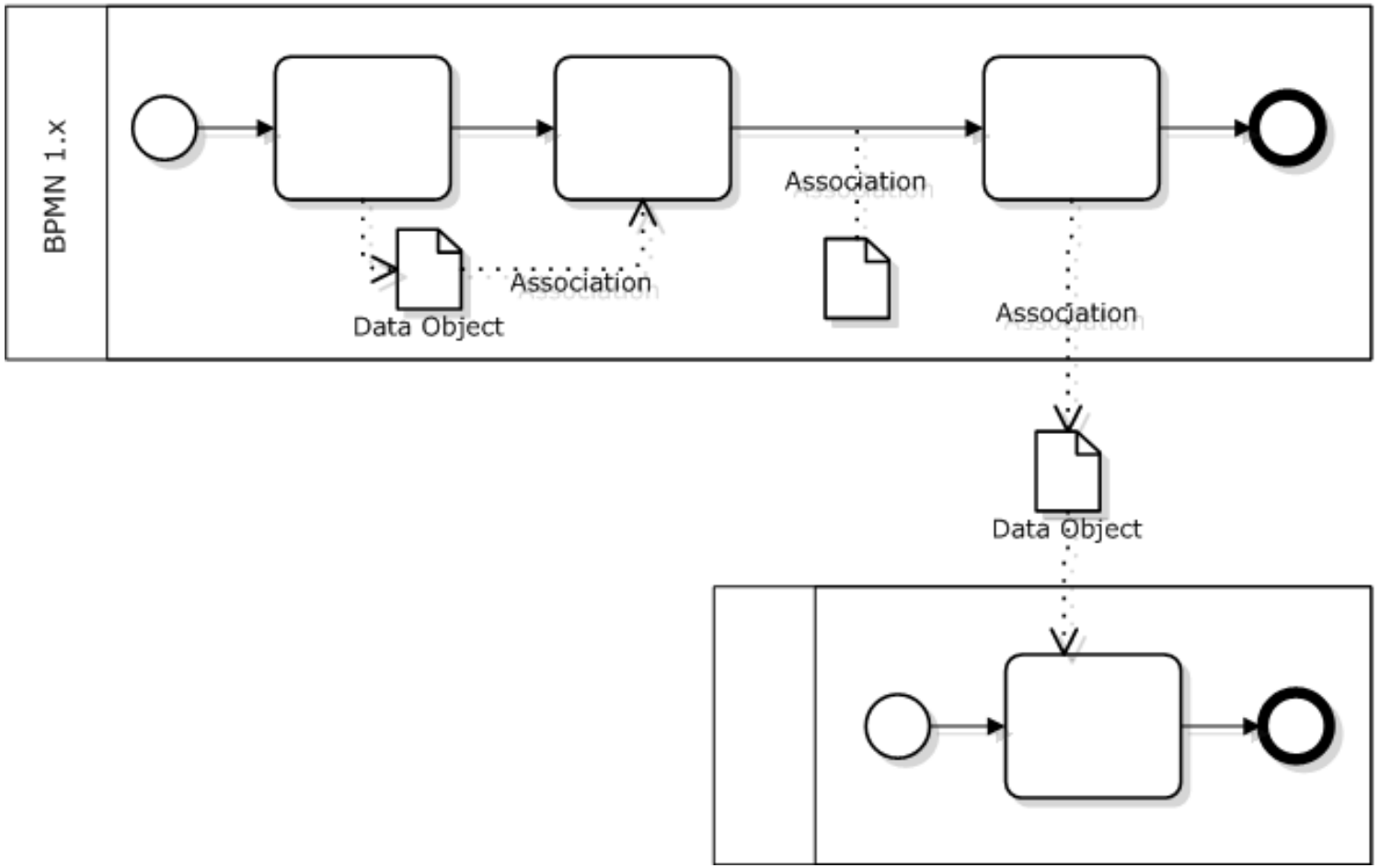
Using Data in Models



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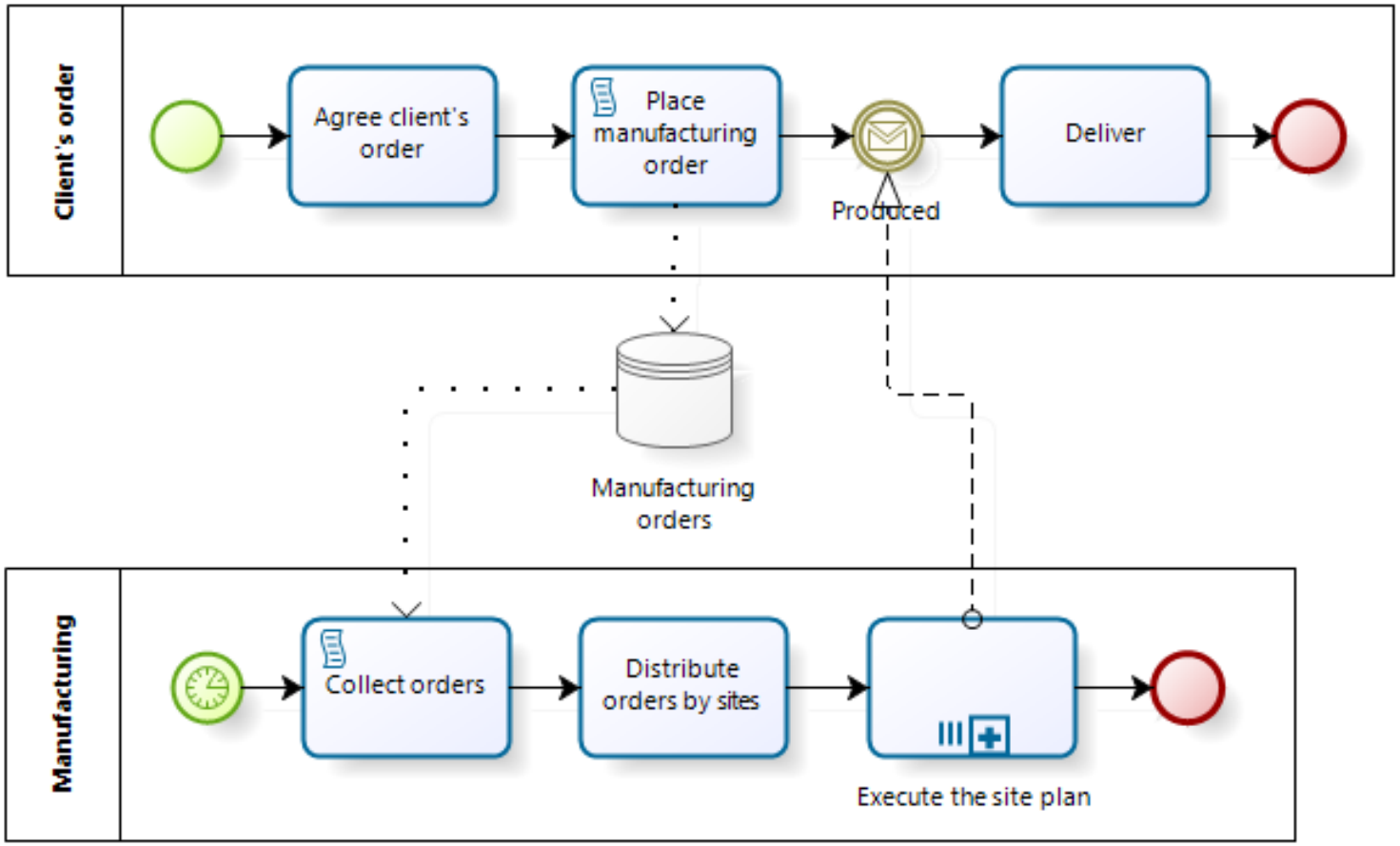
Processes interact with each other via Data Exchange



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Events

- "An Event is something that “happens” during the course of a Process. "

  These Events affect the flow of the Process and usually have a cause or an impact and in general require or allow for a reaction. The term “event” is general enough to cover many things in a Process. The start of an Activity, the end of an Activity, the change of state of a document, a Message that arrives, etc., all could be considered Events." (BPMN 2.0 Spec, p. 233)

- ARIS Method 7.0, 4-98, 10/2006
  - “By an event we understand the fact that an information object has taken on a business-relevant state which is controlling or influencing the further procedure of the business process.”

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The most important Events

Start

End

Intermediate

Wait for a message to arrive/send a message

Wait for a certain period of time or a point in time

Trigger compensation/ error handling

Sequence flow "GOTO"

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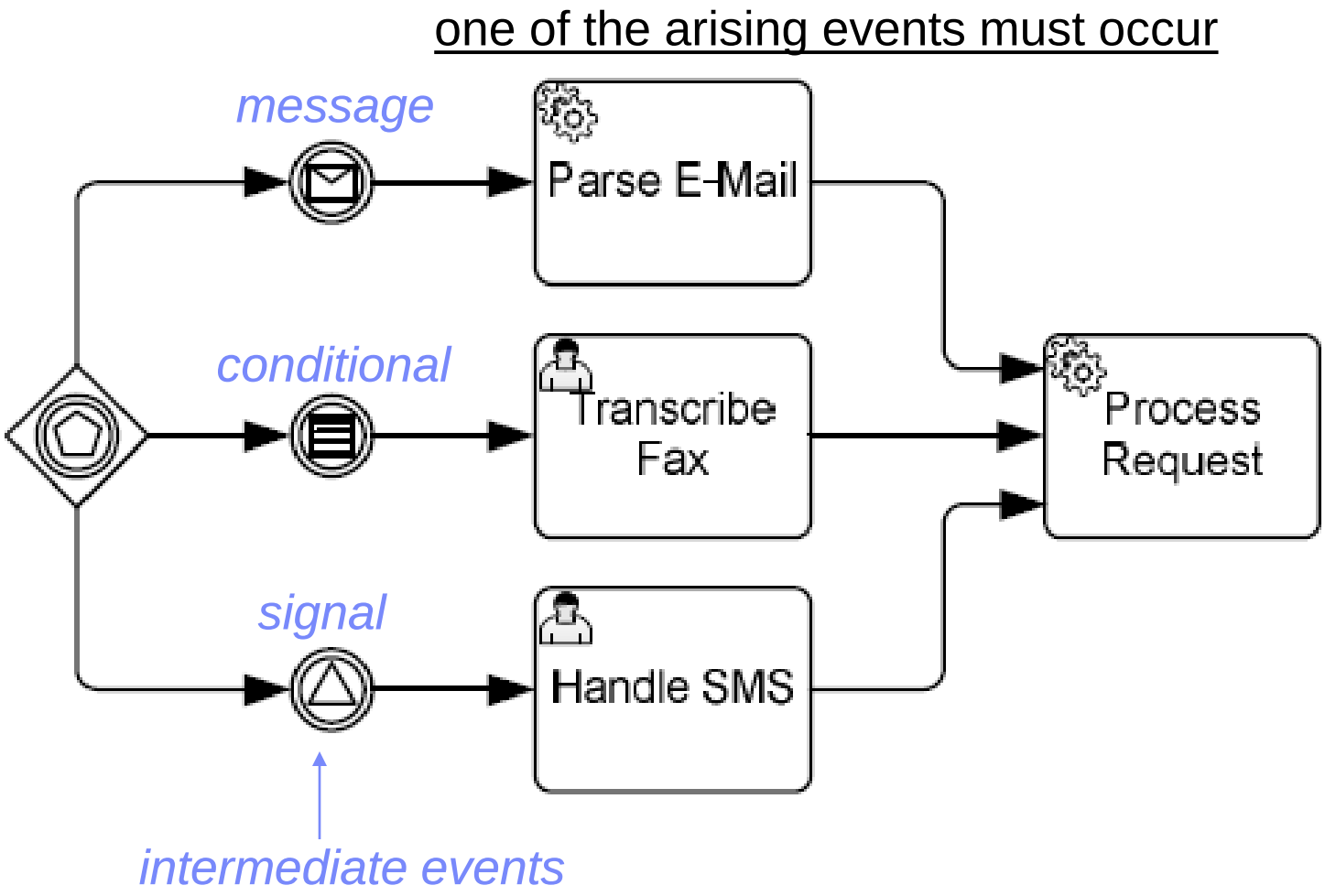
Event-based Gateway



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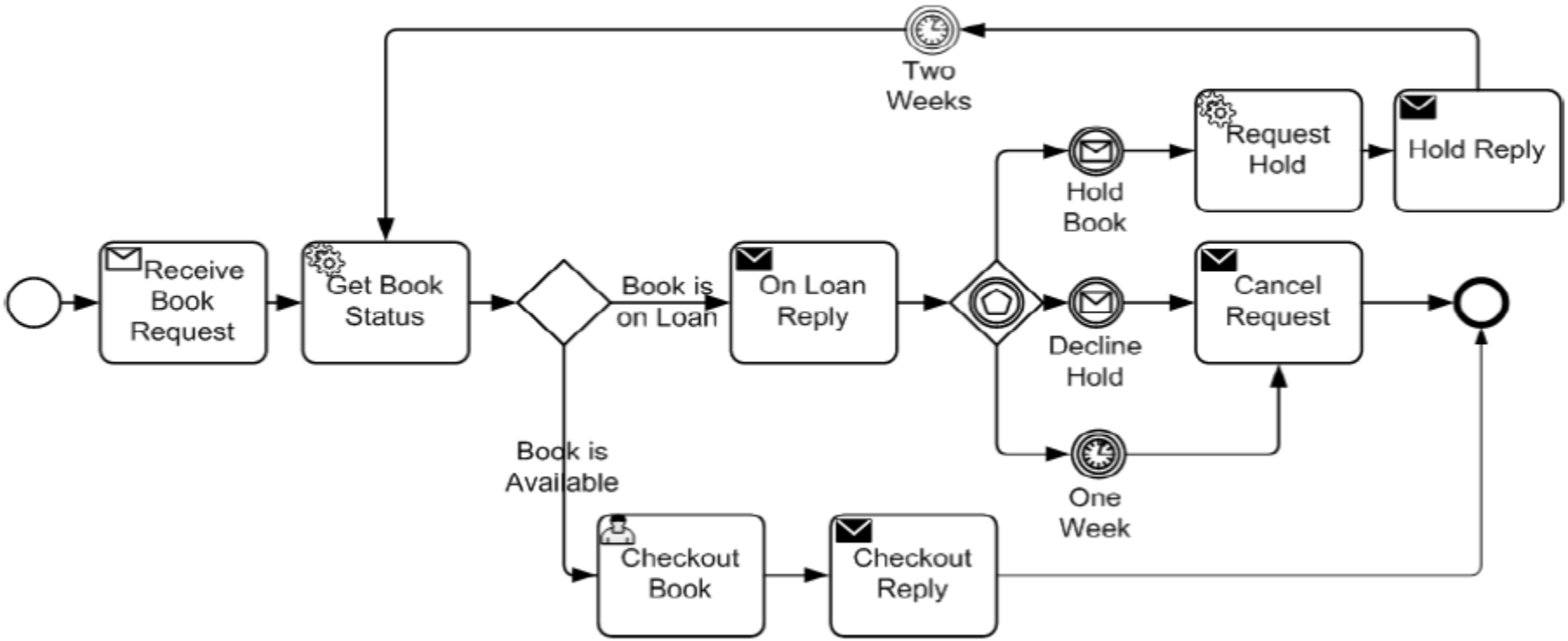
Example



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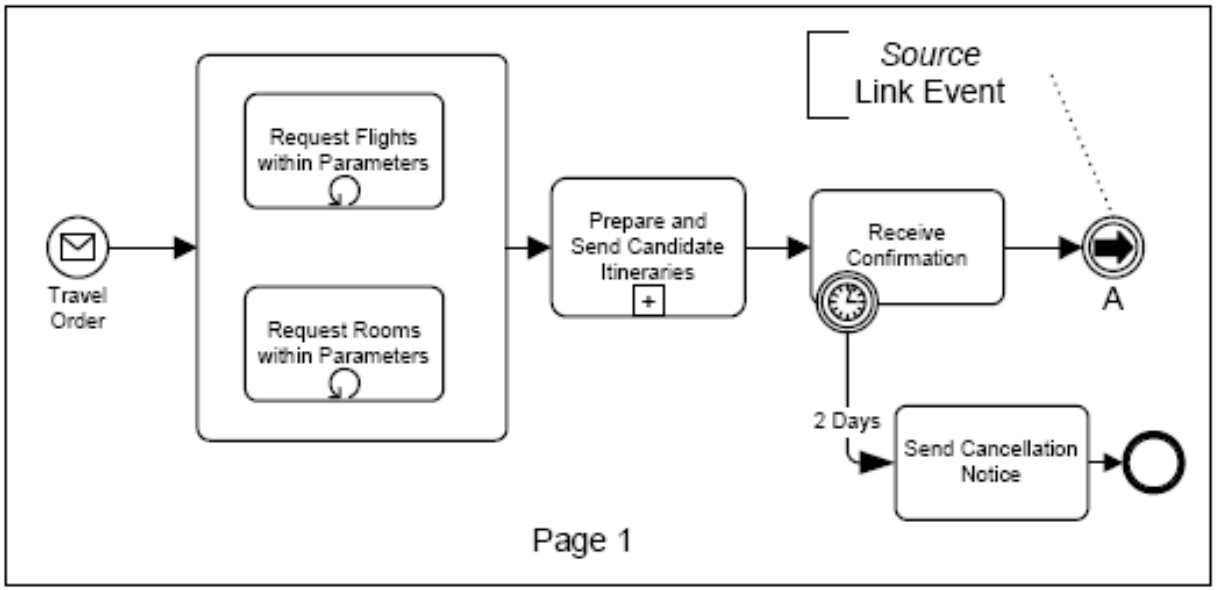
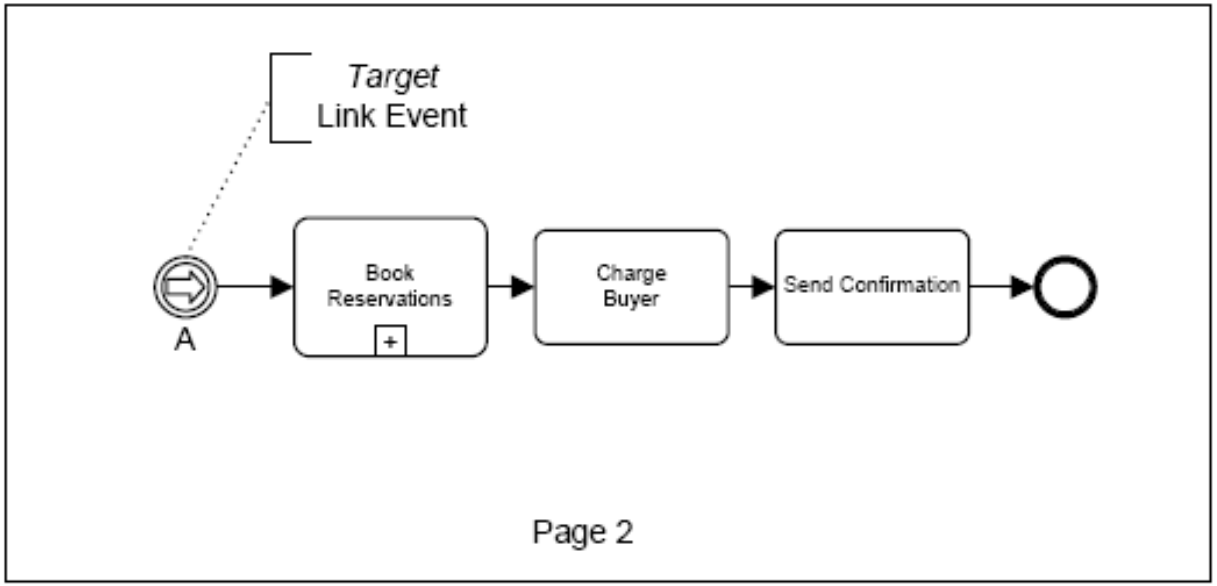
Link Event "Off page" Connector





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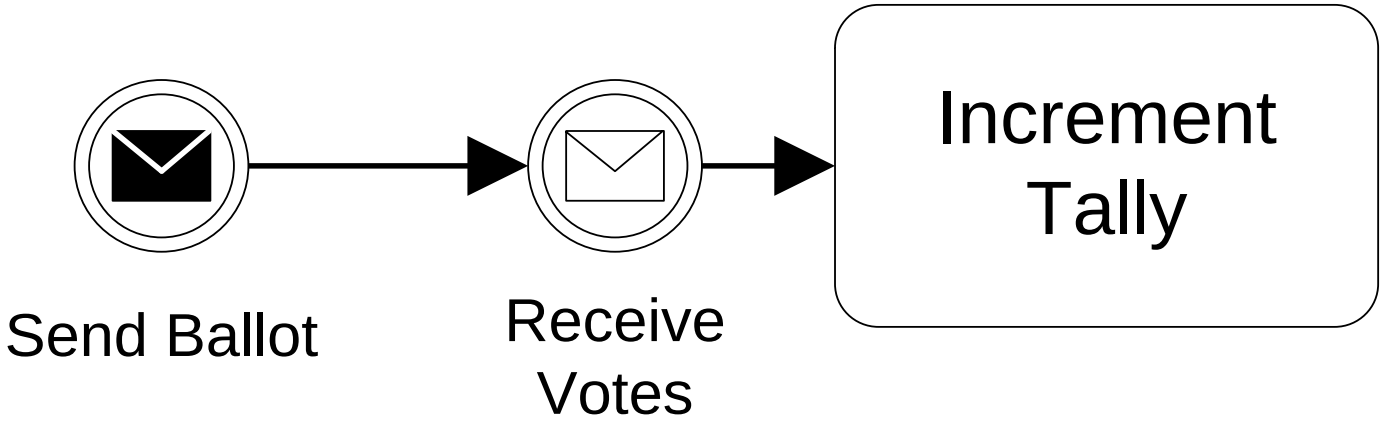
Intermediate Event



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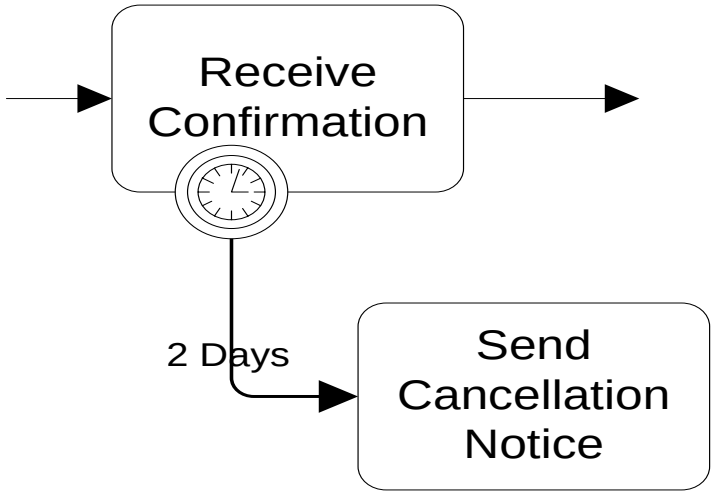
Attached Intermediate Event



intermediate timer, boundary, interrupting

non-interrupting

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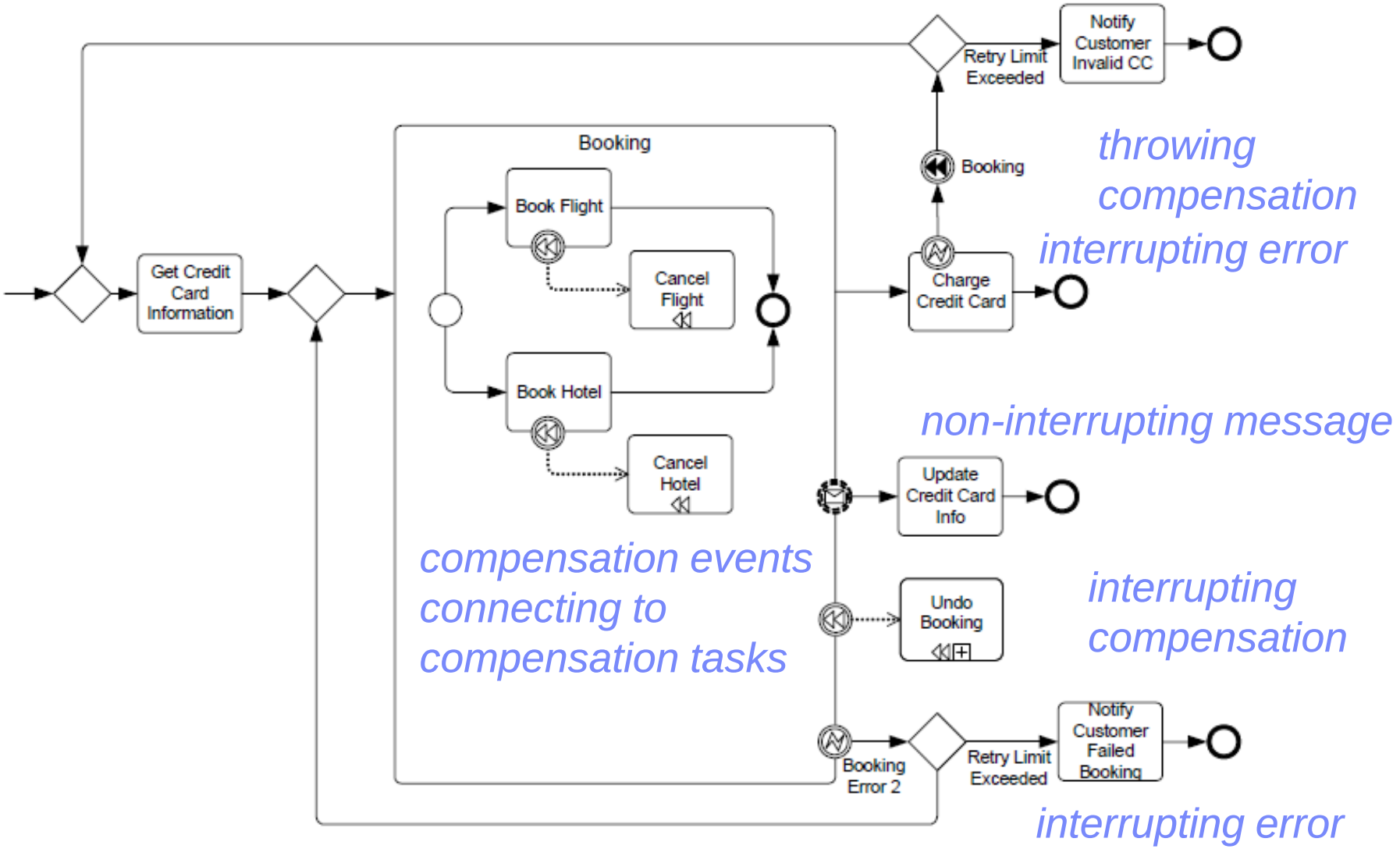
Advanced Modeling with Events



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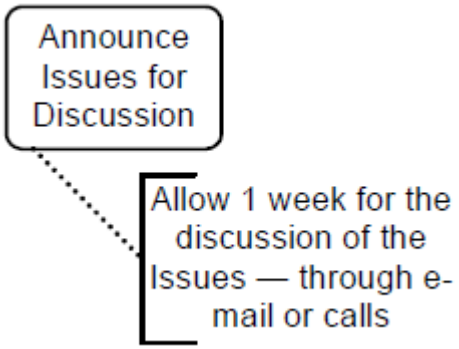
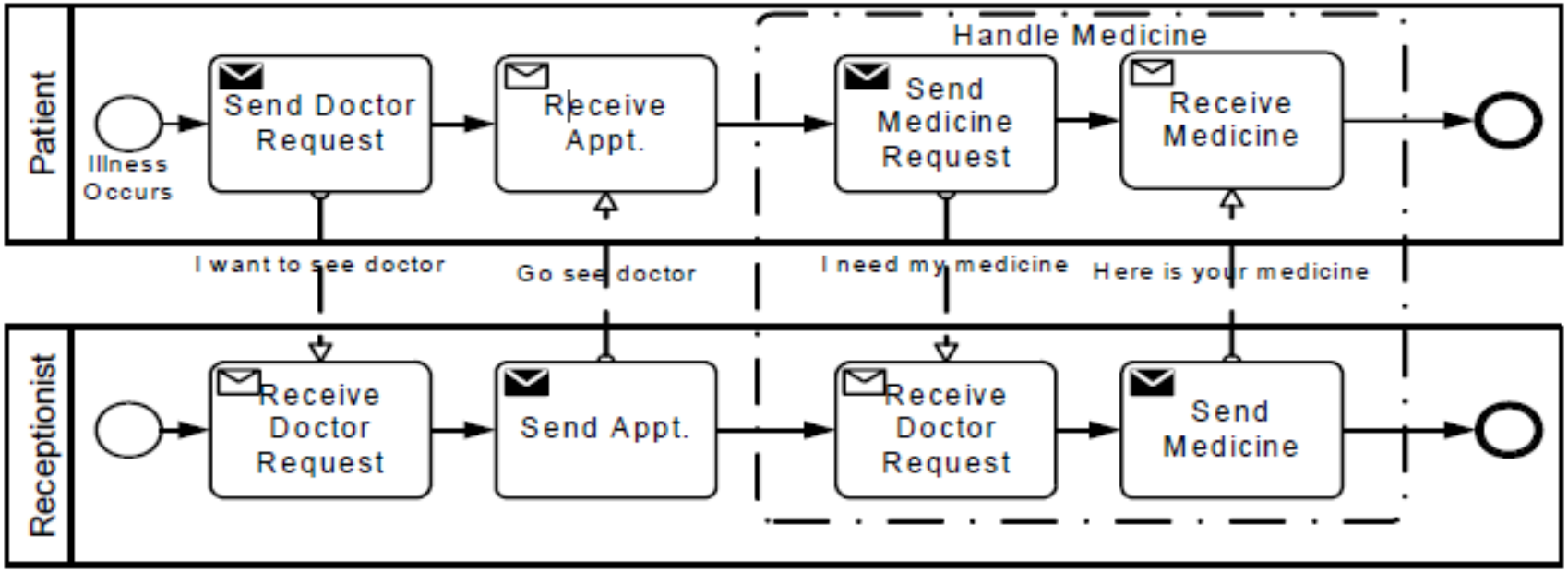
Artifacts





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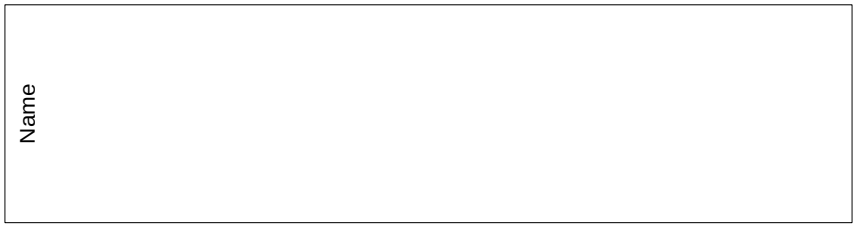
Summary: The most important diagram elements I

Swimlanes

Pool

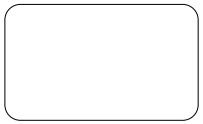


Lanes (within a Pool)

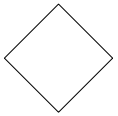
Flow Objects

Events

Activities

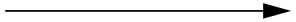


Gateways

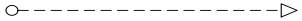


Connectors

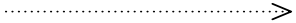
Sequence Flow



Message Flow



Association



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Summary: The most important diagram elements II

Data

Input

Output

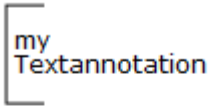
Collection

Data Store

Initiating Message

Response Message

Artifacts



Comments

Groupings of elements

Own elements

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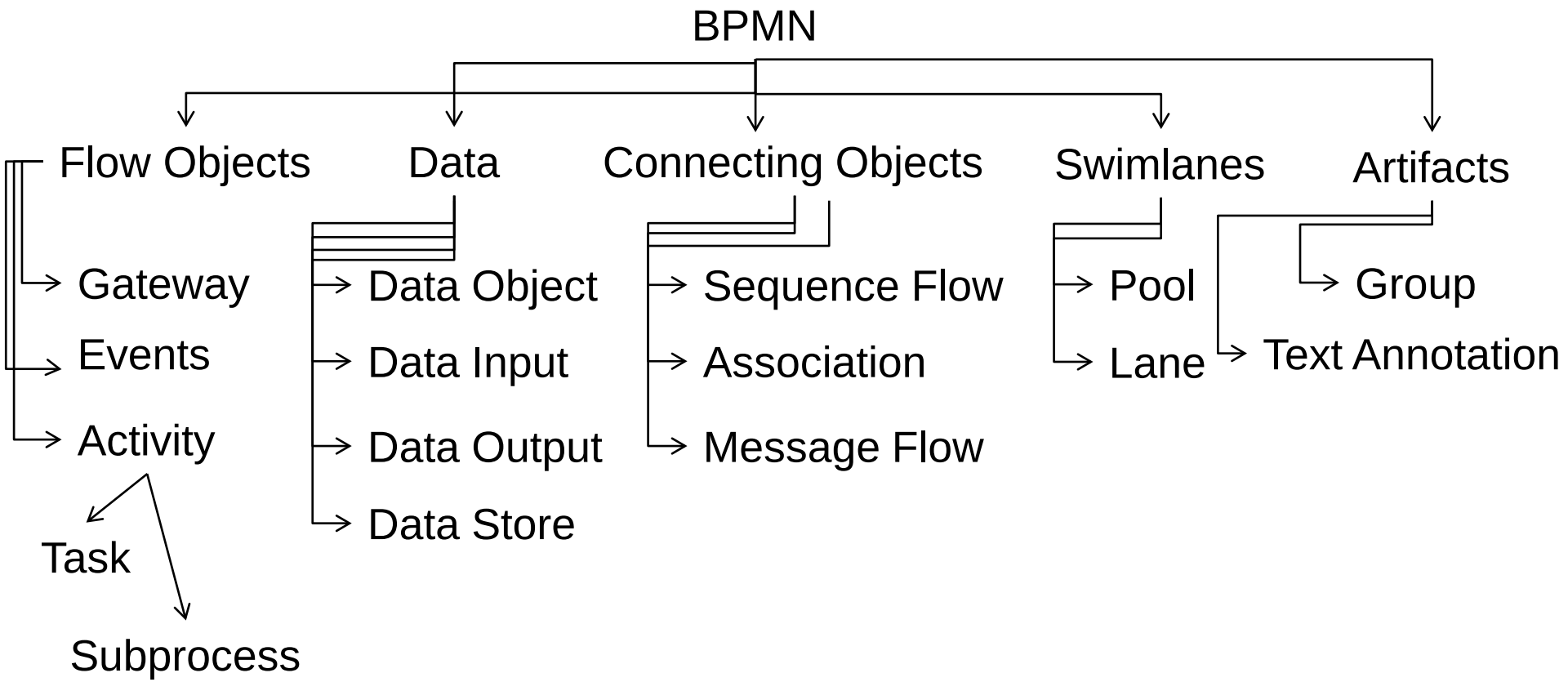
Summary



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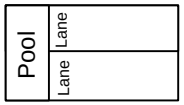
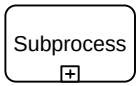
Examen-Relevant BPMN Notation

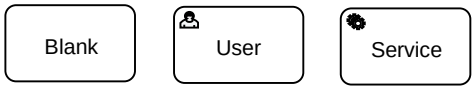
Swimlanes



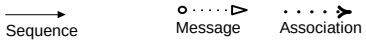
Subprocesses



Tasks Types



Connections



Gateways

Start Events

Intermediate Events

End Events

Artifacts

Data

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BPMN Style (Bruce Silver)

- Process logic must be reflected in the diagram
- Introduce hierarchies, a process model fits on 1 page
- Present external participants through abstract pools
- Customer-oriented processes start with a message from the customer
- Annotate XOR gateways with Yes/No or condition
- Message start events begin with "Receive X"
- Explicitly name end states, distinguish success/failure
- Identify message flows with the name of the message object

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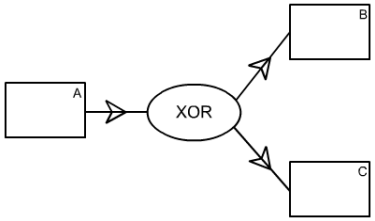
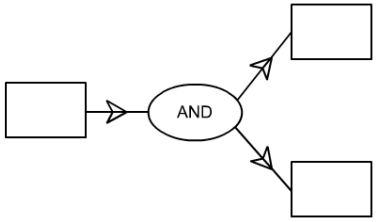
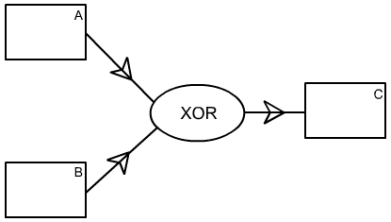
Workflow Pattern (Aalst et al)



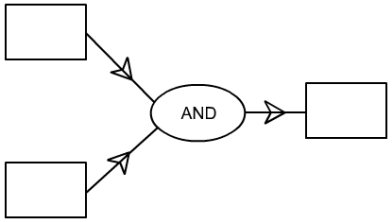
a) Exclusive Choice



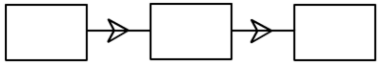
b) Parallel Split



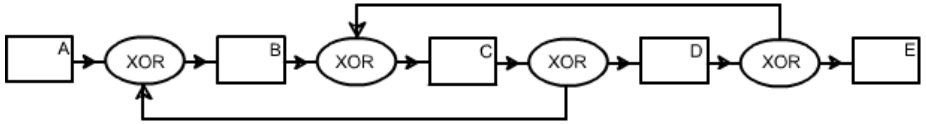
c) Simple Merge



d) Synchronization



e) Sequence



f) Arbitrary Cycles

- More at workflowpatterns.com

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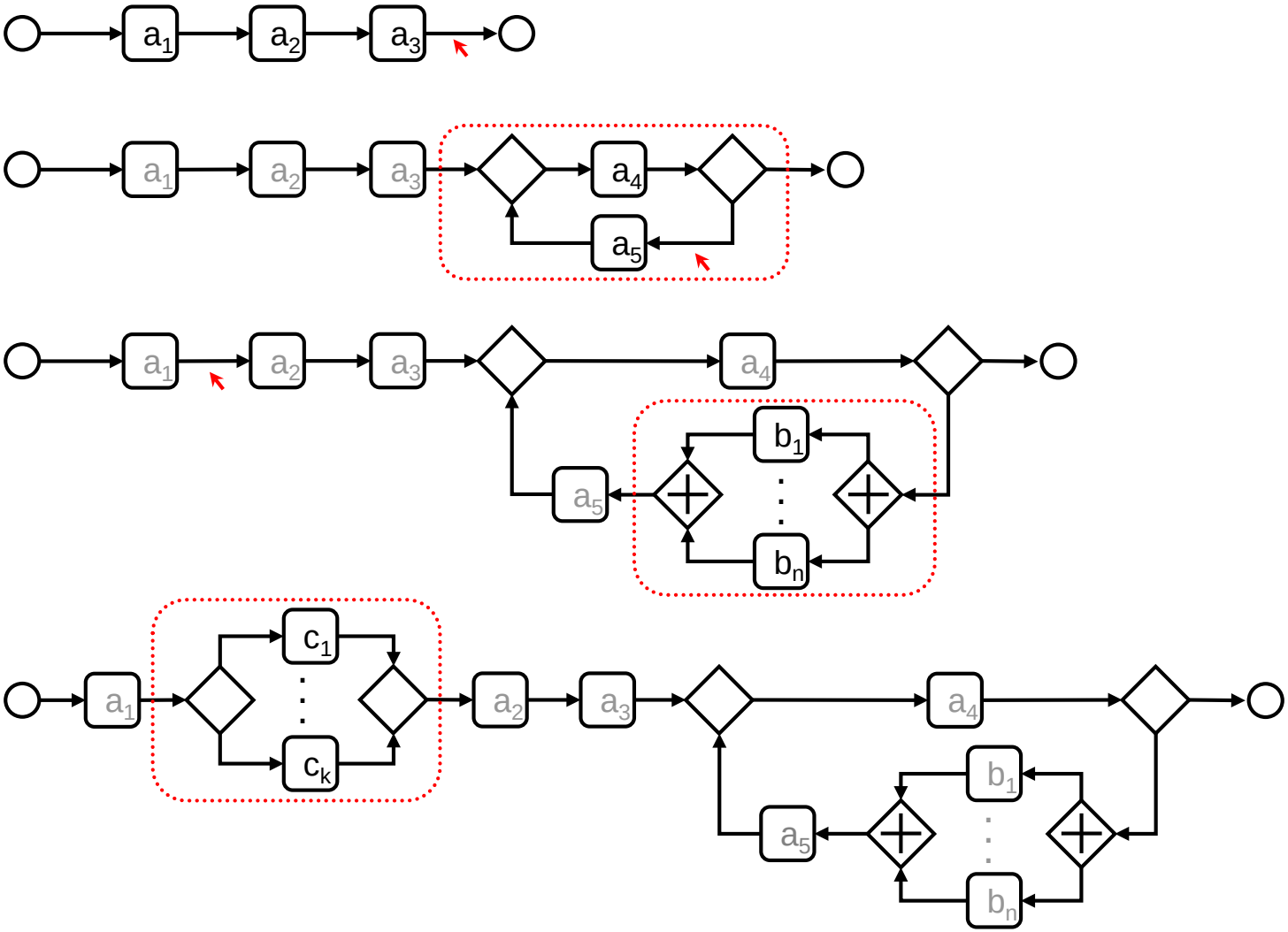
Modeling with Structured Fragments



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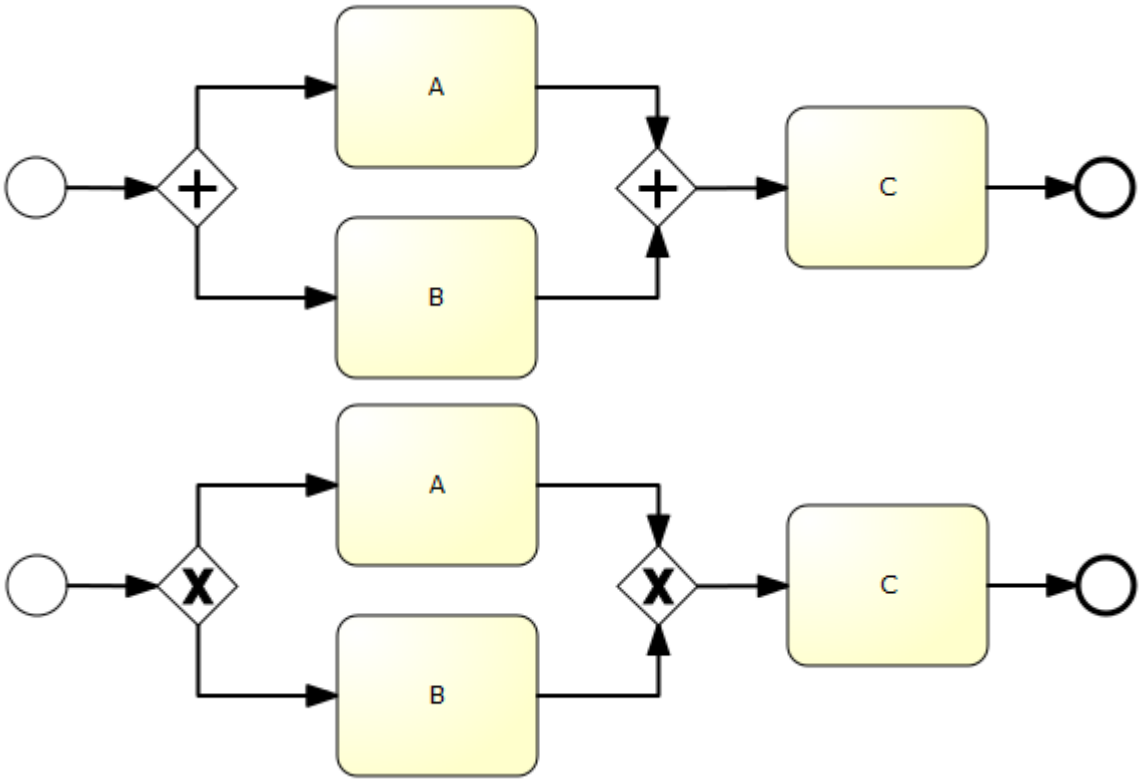
Model versus Instance

- Model describes the basic process flow of a process with all essential paths
- Exactly one path is traversed in an instance



A-B-C
B-A-C

A-C
B-C

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Errors in Process Models

- Process model leads to more execution paths than intended
  - Additional instances of a task
  - Cause : *lack of synchronization*
  - *Livelock:* Infinite iteration of a process without the possibility of progression

- Process model leads to fewer execution paths than intended
  - Some tasks are not executed in some or all instances
  - Cause: *deadlock*

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A process model is sound if it does not contain a deadlock and no lack of synchronization.

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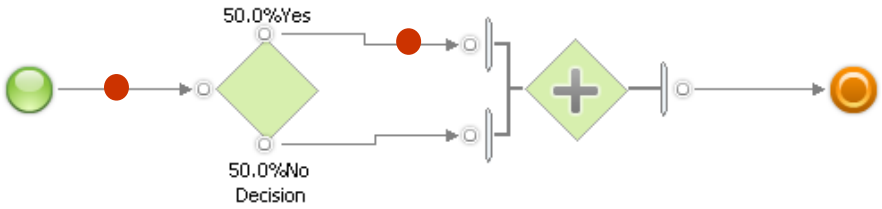
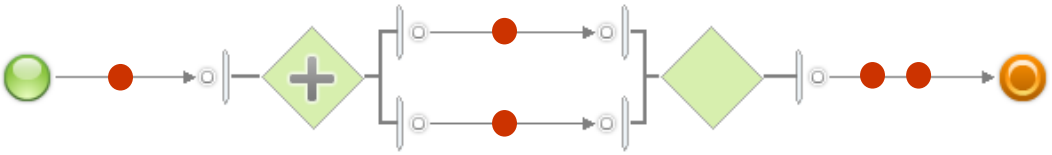
Deadlock vs. Lack of Synchronization

- ***Deadlock***
  - Process is blocked
  - Some activities are never performed
  - Token remains stuck in the process without reaching final state



- ***Lack of Synchronization (LoS)***
  - Some paths/activities are unexpectedly traversed multiple times
  - Risk of uncontrolled data access due to multiple execution of activities
  - Multiple tokens on one edge



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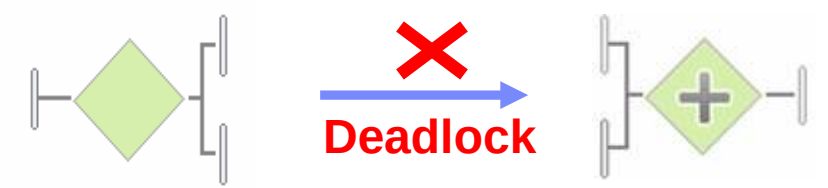
Sequential Antipattern

- Lack of Synchronization due to AND-XOR

- Potential Lack of Synchronization due to IOR-XOR

- Deadlock due to XOR-AND



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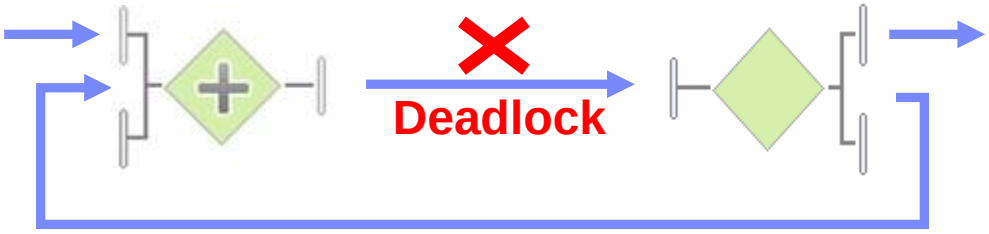
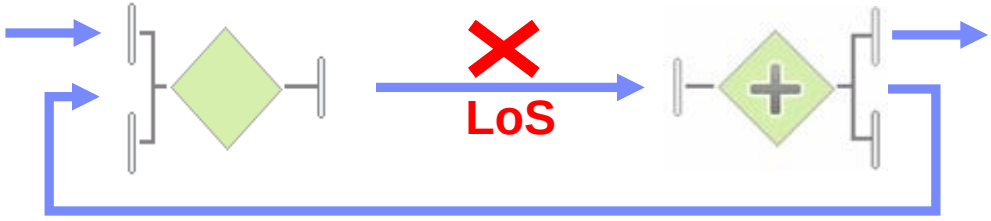
Cyclic Antipattern

- Cyclic Deadlock due to AND-AND and AND-XOR

- Cyclic Lack of Synchronization due to XOR-AND



- Potential Lack of Synchronization due to XOR-IOR



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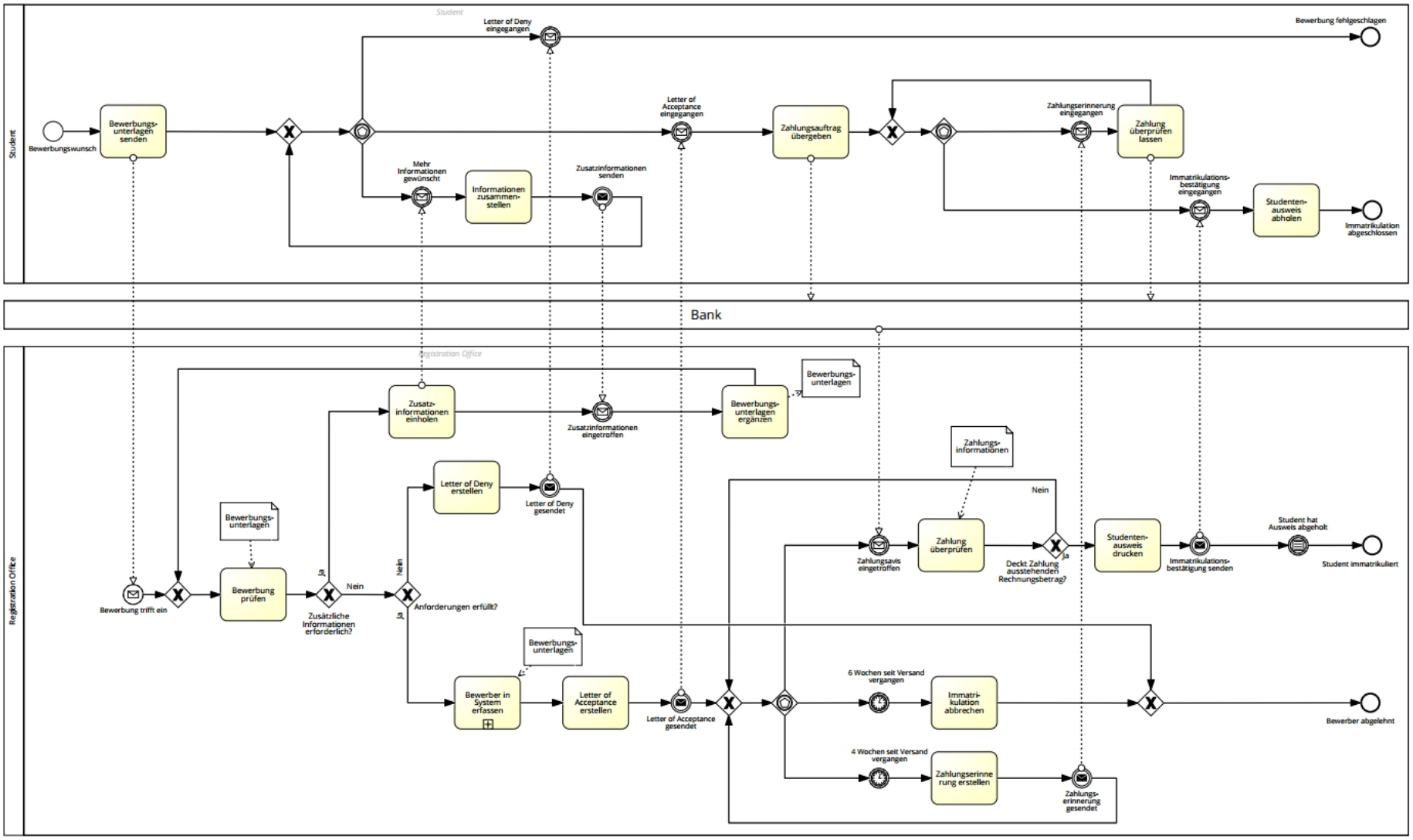
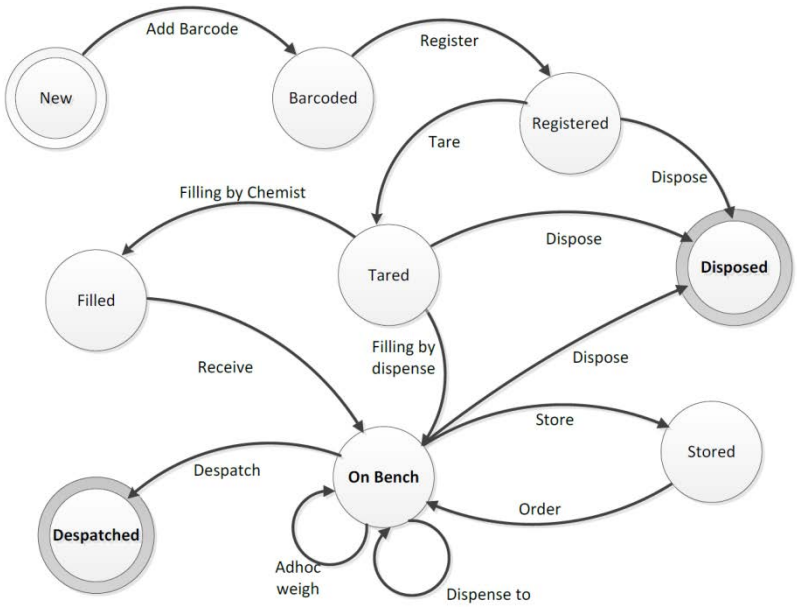
Modeling in the Real World



Data, Data, Data ... and their Lifecycles

- Data (business objects) exist in different states
- Processes change these states
- Process goals can be described by the (final) states of business objects



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Basic Questions

- Which business objects do the processes work with?
- Who has access to which business objects?
- Which states of the business objects do the process actors know?
- How do the business objects interact through their states?

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Enrollment Process

- Business properties
  - Application dossier
    - submit
    - check formally
    - check in detail
    - make a decision
  - Invoice
    - create and send
    - monitor incoming payments
  - Student legitimation
    - create
    - send

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Processes and Object Lifecycles

- Processes change data
  - driven and controlled by events and rules

- Event as "*business-relevant state of an information object which is controlling or influencing the further procedure of the business process*" [ARIS]
  - Which state of one or more objects triggers a process?
  - Which states are successful final states of objects (= process objectives)?
  - Which states require error handling?
  - In which states do which rules control the admissibility of actors' activities?

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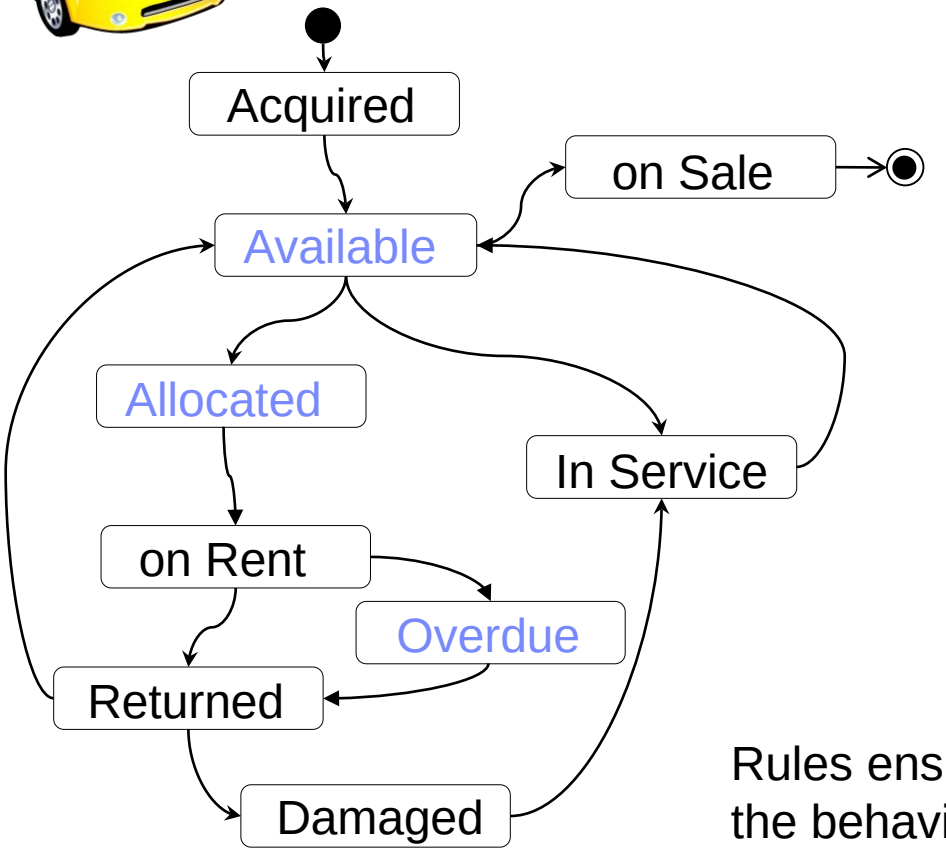
Business Rules and Object Lifecycles



"A car from another branch may be allocated, if there is a suitable car available and there is time to transfer it to the pick-up branch."

"If a car is three days overdue and the customer has not arranged an extension, insurance cover lapses and the police must be informed."

Rules ensure the integrity of data and regulate the behavior of actors

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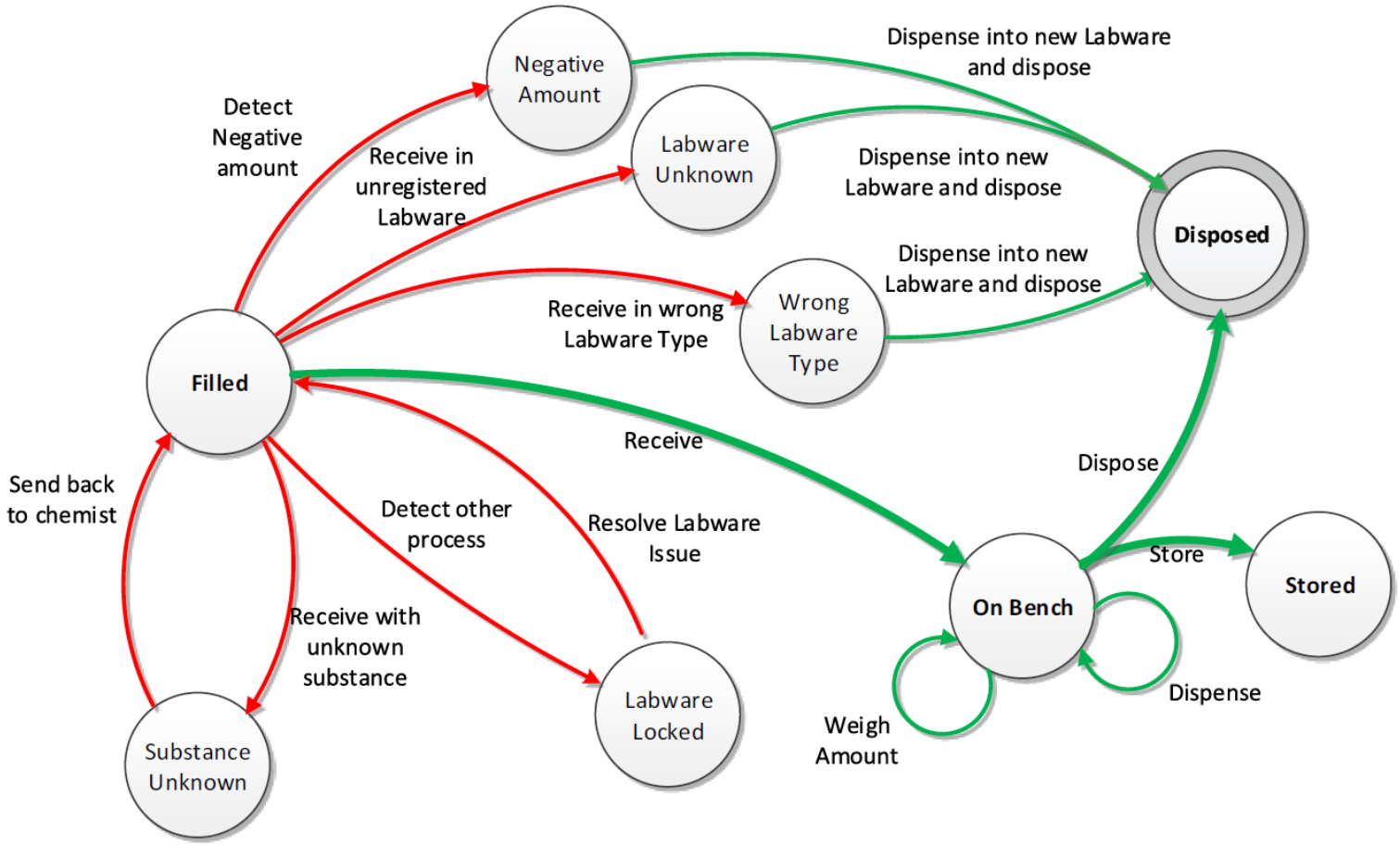
Error States in Lifecycle



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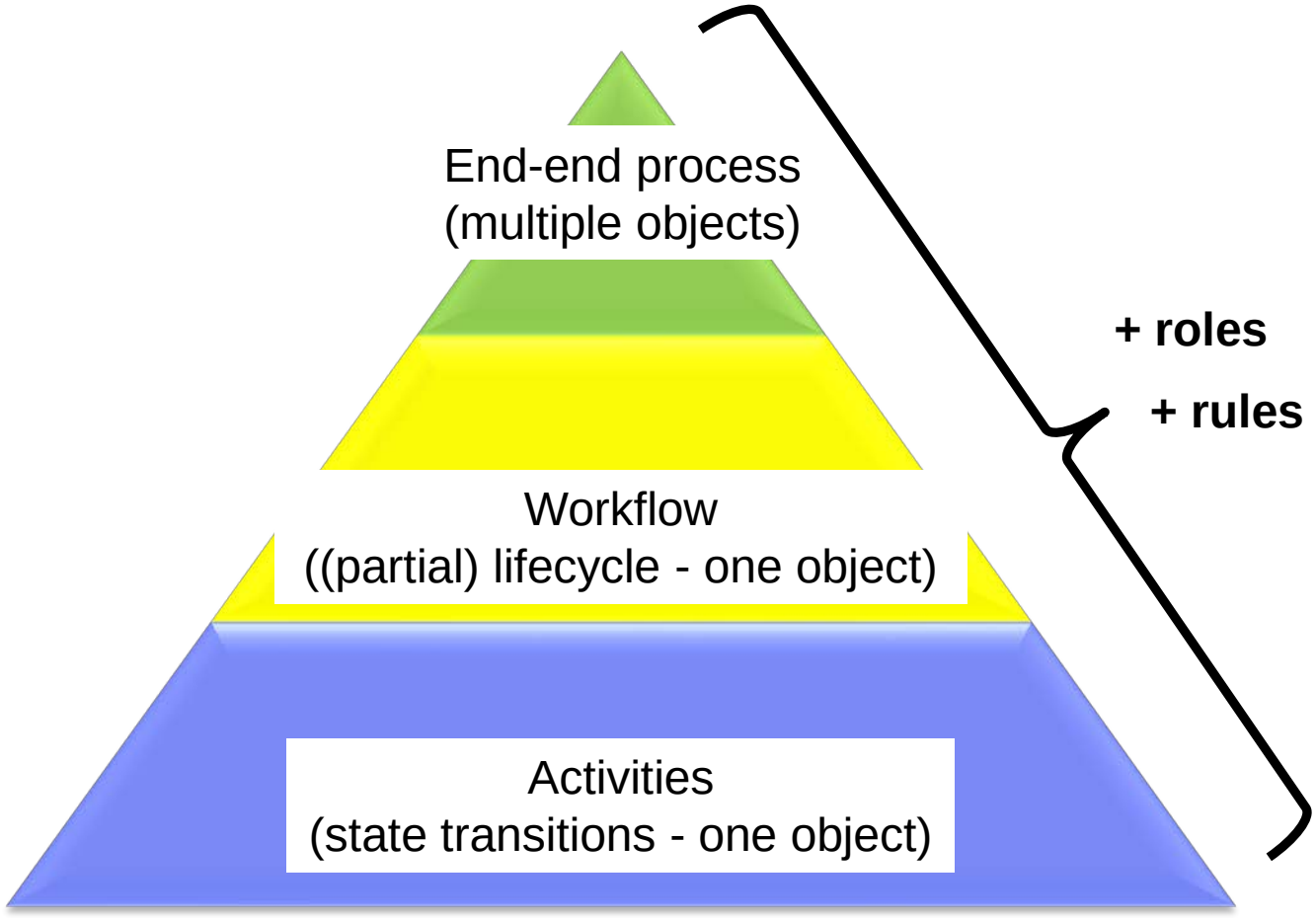
Levels of Process Modeling



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Summary

- BPMN 2.0 is an accepted standard for business process modeling
- High-quality models are important for correct analysis and simulations and facilitate implementation in IT
- Approx. 60-90 % of all non-trivial process models (at least one cyclic path or 2 different gateways) are semantically incorrect, i.e. cannot be executed
- Style conventions improve model comprehensibility, the use of structured model fragments avoids execution errors
- Modeling in a more data-oriented way with business object life cycles works often better in practice than pure activity flows

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Working Questions:

1. What was the motivation behind BPMN?
2. Which BPMN diagrams exist and what are they used for?
3. What basic groups of elements are included in the notation and how are they used correctly in the model?
4. What is the semantics of AND, XOR and OR Gateways?
5. What are the most important style conventions for BPMN?
6. What is the difference between a model and an instance of that model?
7. What are Deadlock and Lack of Synchronization errors? Give examples of gateway combinations in BPMN models leading to these errors.

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