

ICT393

Advanced Business Analysis and Design

Topic 5 (Part 1)

Tools and Techniques for Business Process Modelling



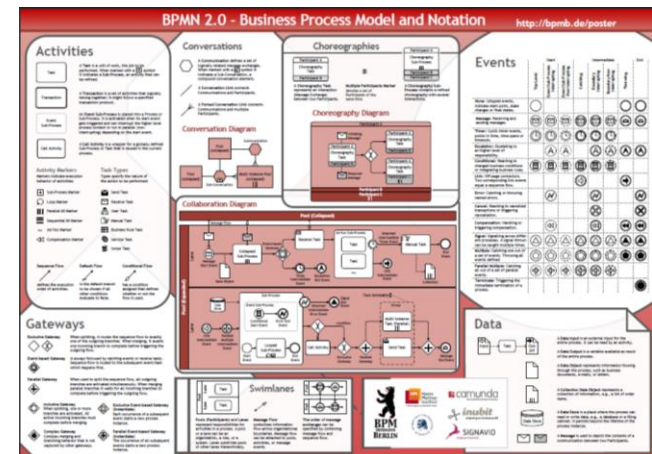
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Readings and Resources



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- Havey, M. (2005) *Essential Business Process Modeling*, O'Reilly Media Inc. Chapters 1 & 4. Electronic copy also available from library
- Berliner BPM-Offensive (2015) *BPMN 2.0 Poster*. Also available from:
<http://www.bpmb.de/index.php/BPMNPoster>



Learning Objectives



After completing this topic you should be able to:

- Read process models created using Business Process Modelling Notation (BPMN)
- Read process models created using UML activity diagrams
- Create process models using BPMN
- Create process models using UML activity diagrams
- Understand the difference between As-Is and To-Be process diagrams

Learning Objectives



After completing this topic you should also be able to:

- Be aware of the variety of software that can be used to support business process modelling/management
- Understand the relationship between diagramming notations and process definition languages such as Business Process Execution Language for Web Services (BPEL4WS)

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Background

- The design of a business process usually involves some sort of flowchart that outlines the steps performed over time as part of the process
- Process modelling can be informal (e.g. example in Exercise 1 from Topic 4) or formal
- Both business and technical people are involved in business process modelling – so notation must be both business-oriented and amenable to implementation using technology



Background ctd.

- A variety of modelling notations exist but Business Process Modelling Notation (BPMN) and UML activity diagrams are the most commonly used
- Most organisations adopt the notation of the business process modelling tool they have available or choose (rather than vice versa)

Types of Model: As-Is versus To-Be Models



- An **As-Is process model** is a model that represents how a business process is currently structured. It is used to establish a **baseline** for subsequent business improvement actions
- A **To-Be process model** is a process model that results from a business process restructuring attempt. The To-Be model shows how the business process will function after the improvement action is implemented

Business Process Modelling Notation



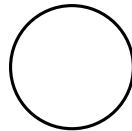
- BPMN is a graphical flowchart language that can be used to represent a business process in an intuitive visual form
- It was released by the Business Process Management Initiative (BPMI) in 2004 and Object Management Group (OMG) is now responsible for it
- The current OMG standard is BPMN 2.0.2 (see <https://www.omg.org/spec/BPMN> for the full 500+ pages)
- It is supported by many software tools - bpmn.org lists over 70

BPMN Symbols

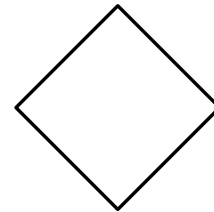
A BPMN process model consists of **four types of core elements**:



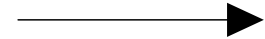
activity



event



gateway



sequence
flow

See the *BPMN 2.0 Poster* for a summary of the notation



Example – Exercise 1

A typical order-to-cash process is triggered by the receipt of a purchase order from a customer. The purchase order has to be checked against the stock for the availability of the item(s) requested.

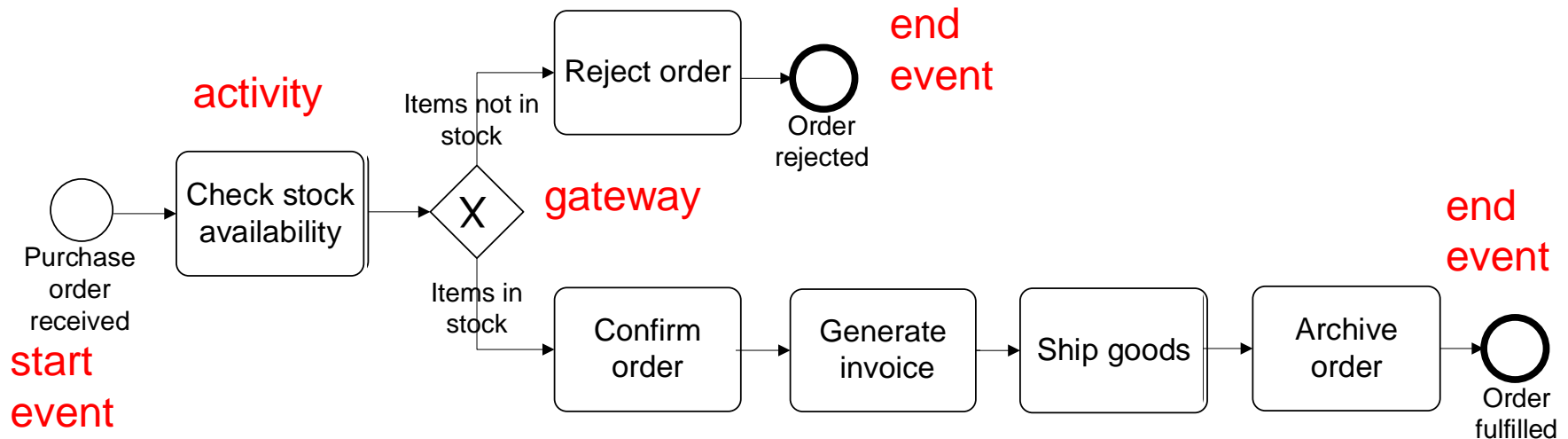
Depending on stock availability the purchase order may be confirmed or rejected.

If the purchase order is confirmed, an invoice is generated and the goods are shipped.

The process completes by archiving the order or if the order is rejected.



BPMN Model for Example



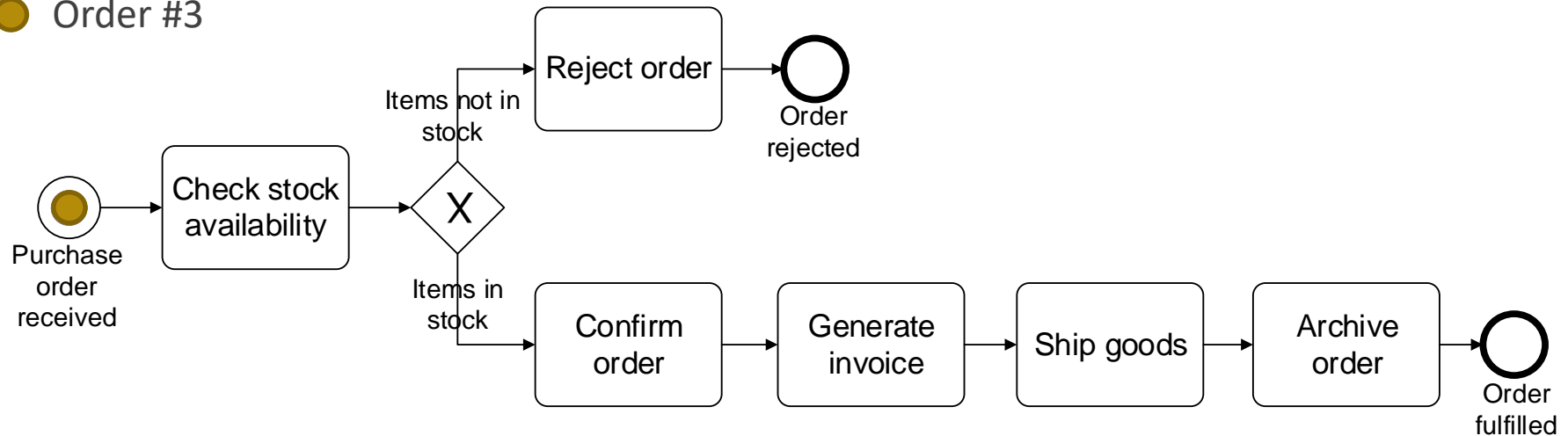
Naming conventions

- Activity: verb + noun (e.g. assess credit risk)
- Event: noun + past tense verb (e.g. insurance claim lodged)

Process Models vs Process Instances



- Order #1
- Order #2
- Order #3

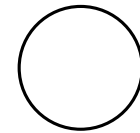


The notion of a token can be used to identify the progress or state of a process instance

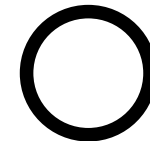


Events...

A **start event** triggers a new process instance by generating a token that traverses the sequence flow



start
event



end
event

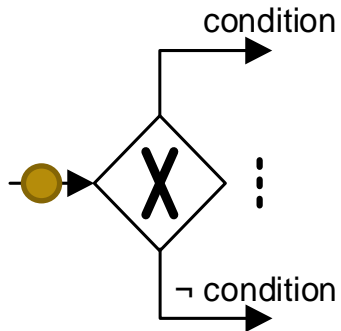
An **end event** signals that a process instance has completed with a given outcome by consuming a token



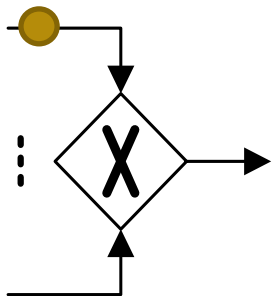
Gateways: XOR Gateway



An **XOR Gateway** captures decision points (XOR-split) and points where alternative flows are merged (XOR-join)



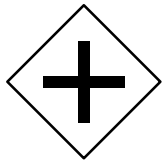
XOR-split → takes **one** outgoing branch



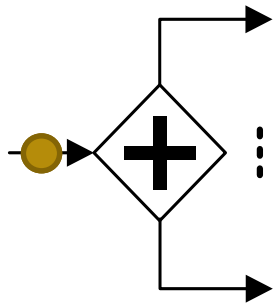
XOR-join → proceeds when **one** incoming branch has completed



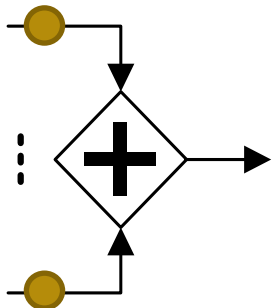
Gateways: AND Gateway



An **AND Gateway** provides a mechanism to create and synchronize “parallel” flows



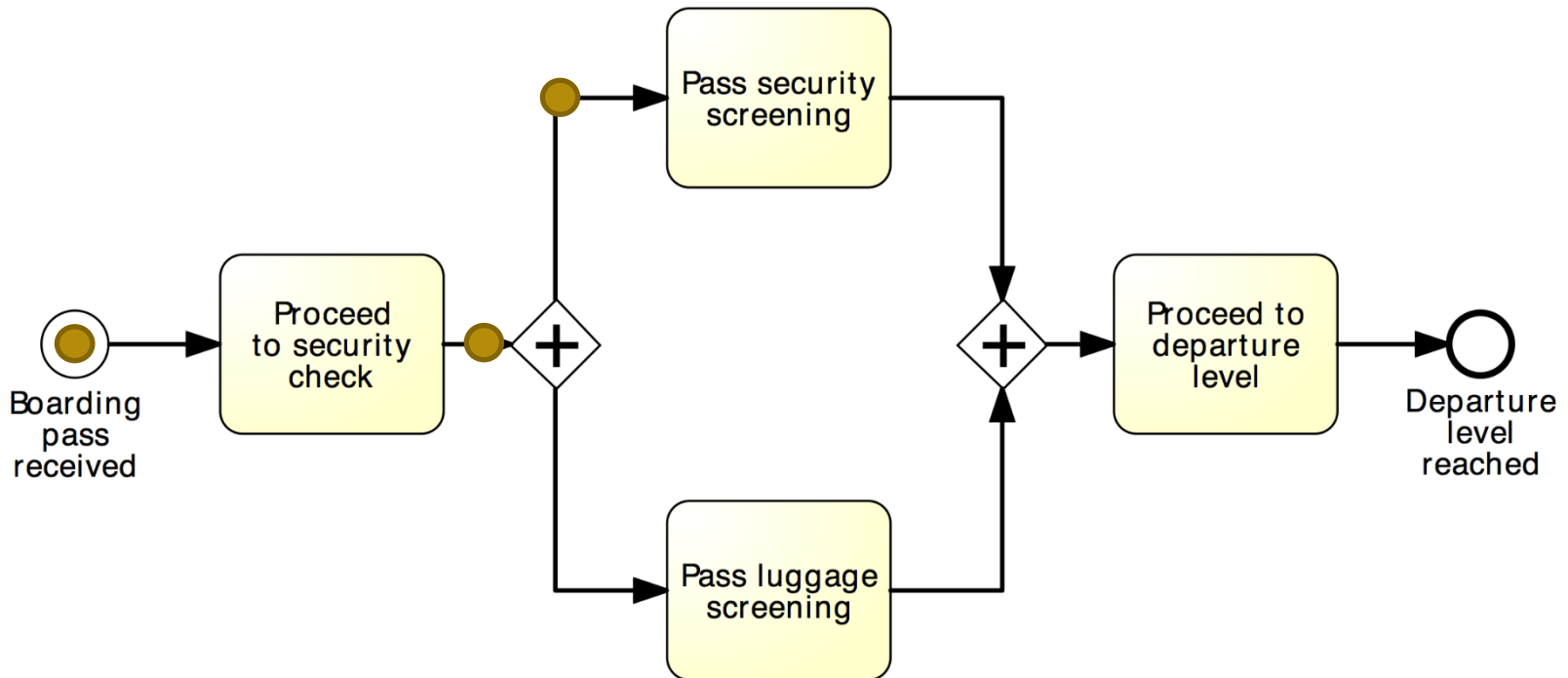
AND-split → takes **all** outgoing branches



AND-join → proceeds when **all** incoming branches have completed

Example: AND Gateway

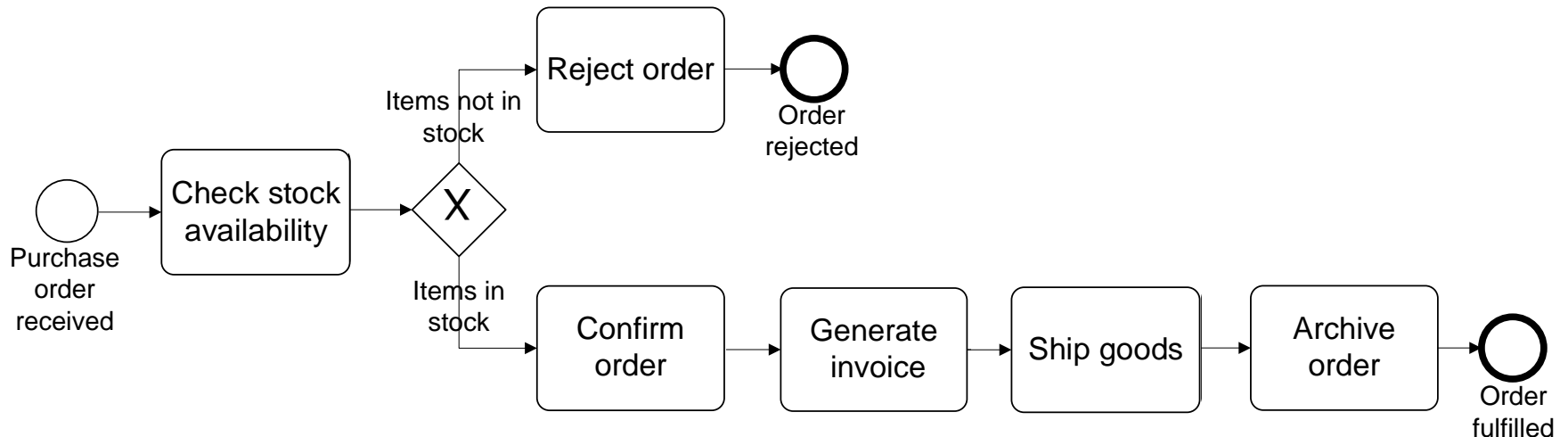
Airport security check



BPMN Model Example

Revisited – Exercise 1b

You discover that sending the invoice and shipping the goods can be done in parallel. Redraw the model to reflect this.



Organizational Elements in BPMN – Pools & Lanes



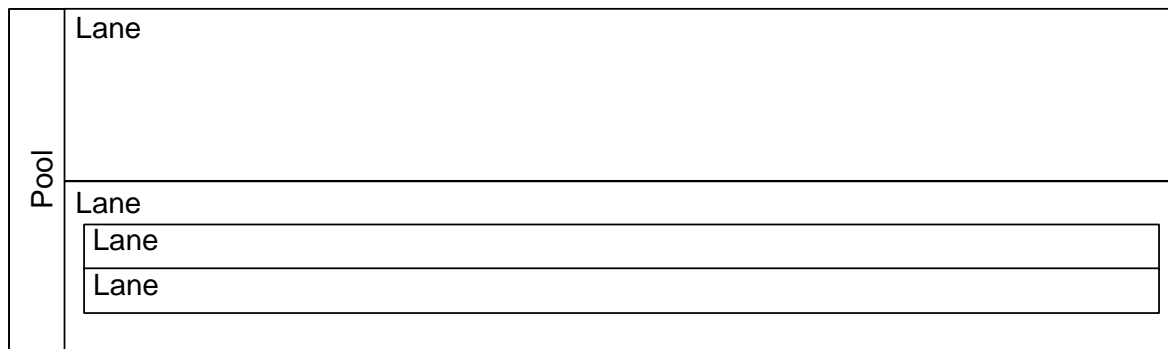
Pool

Captures a resource class. Generally used to model a business (e.g. a whole company)



Lane

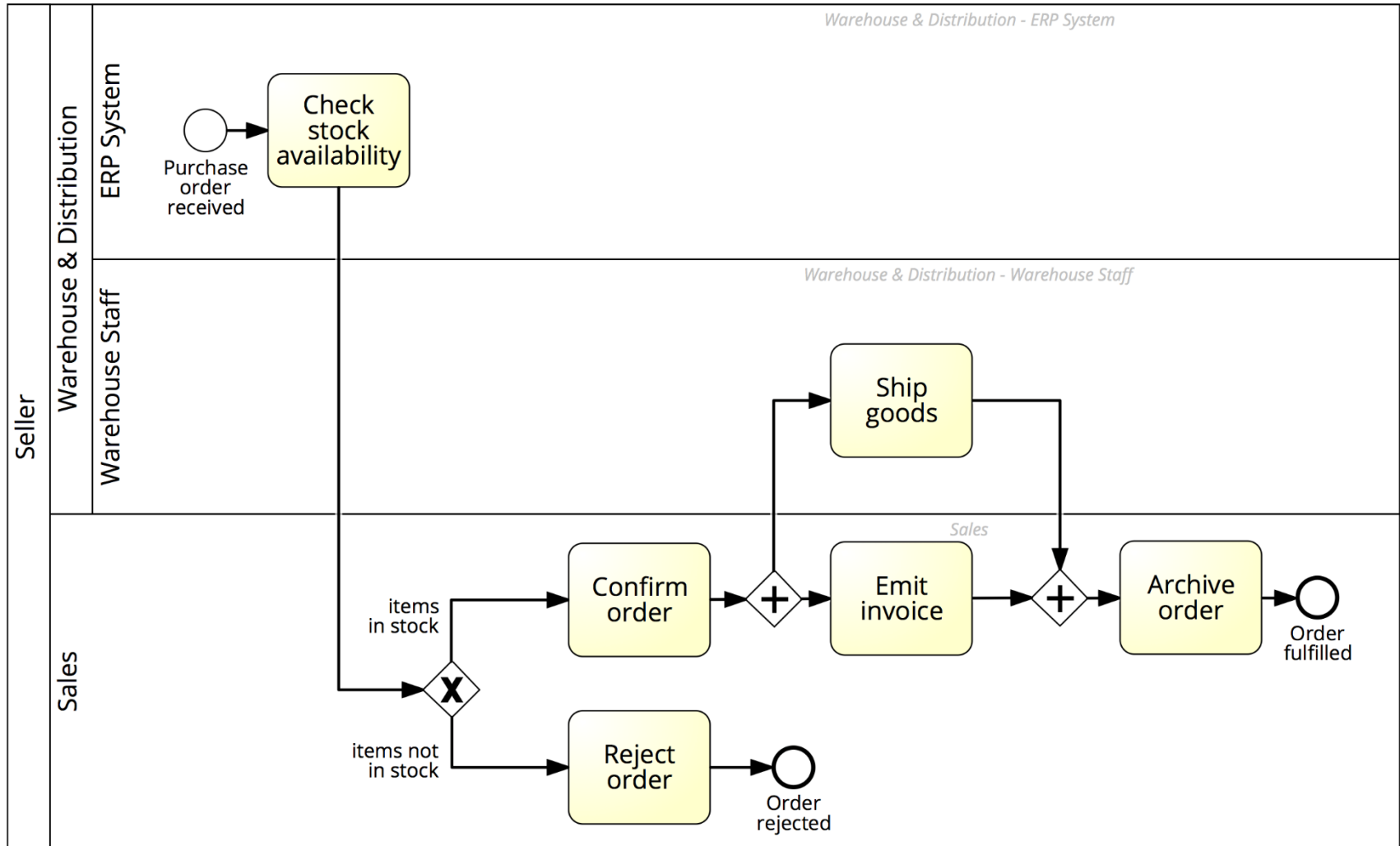
A *resource sub-class* within a pool. Generally used to model departments (e.g. shipping, finance), internal roles (e.g. Manager, Associate), software systems (e.g. ERP, CRM)



Order-to-cash Process with Lanes



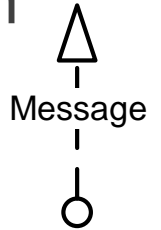
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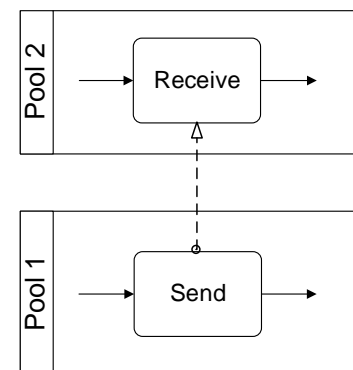
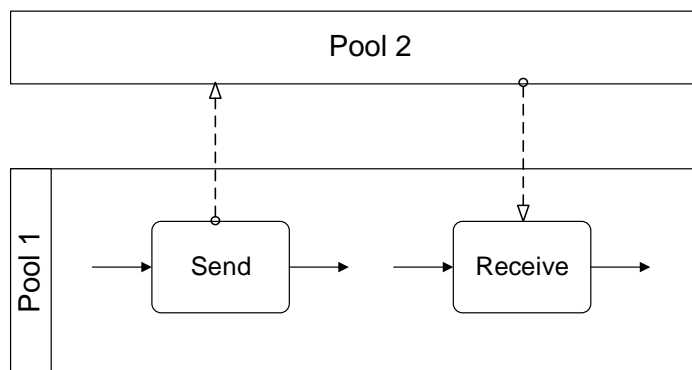
Message Flow

A **Message Flow** represents a flow of information between two Pools

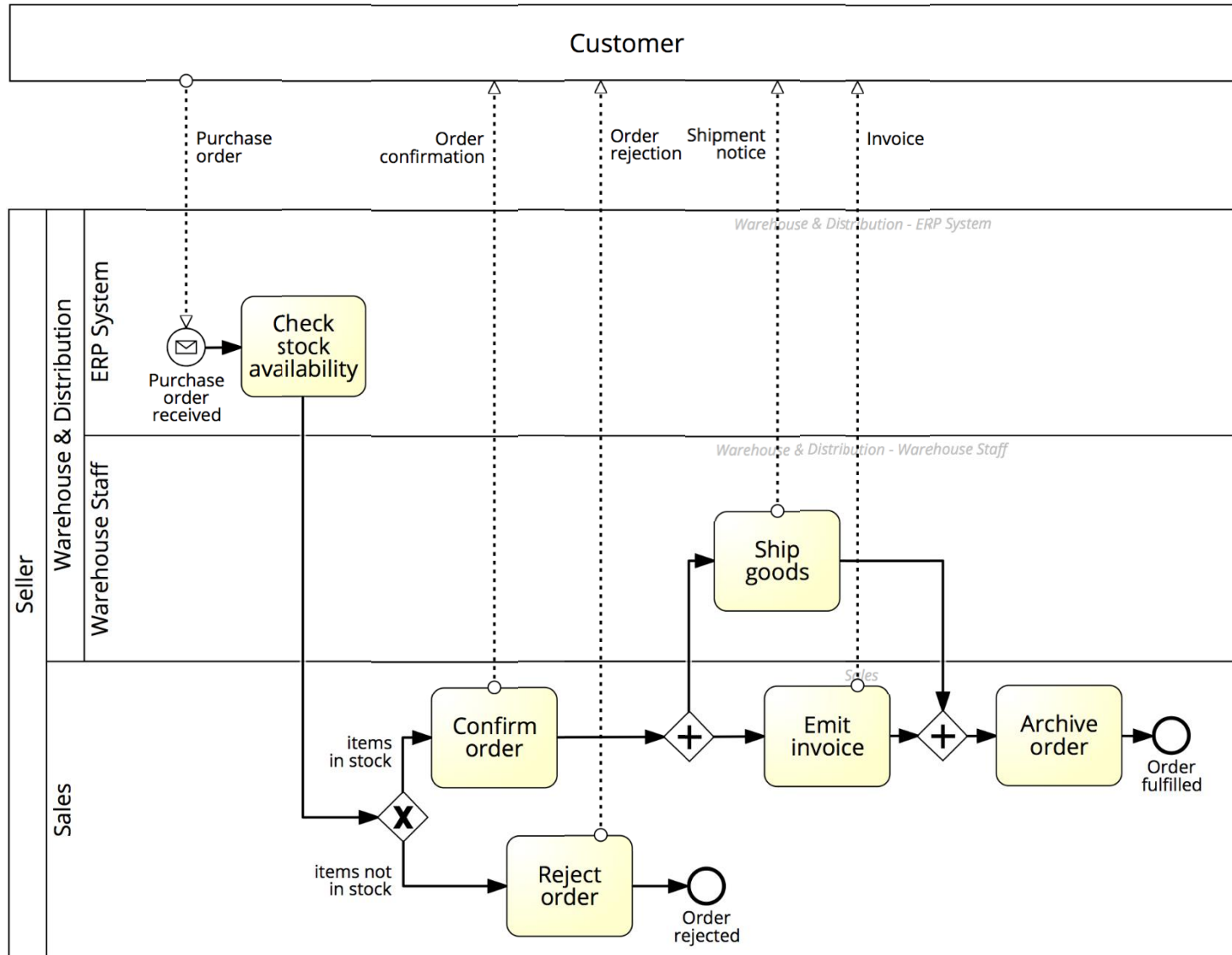


A Message Flow can connect:

- directly to the boundary of a Pool → captures an informative message to/from that organisation
- to a specific activity or event within that Pool → captures a message that triggers a specific activity/event



Order-to-cash process with a black-box customer pool

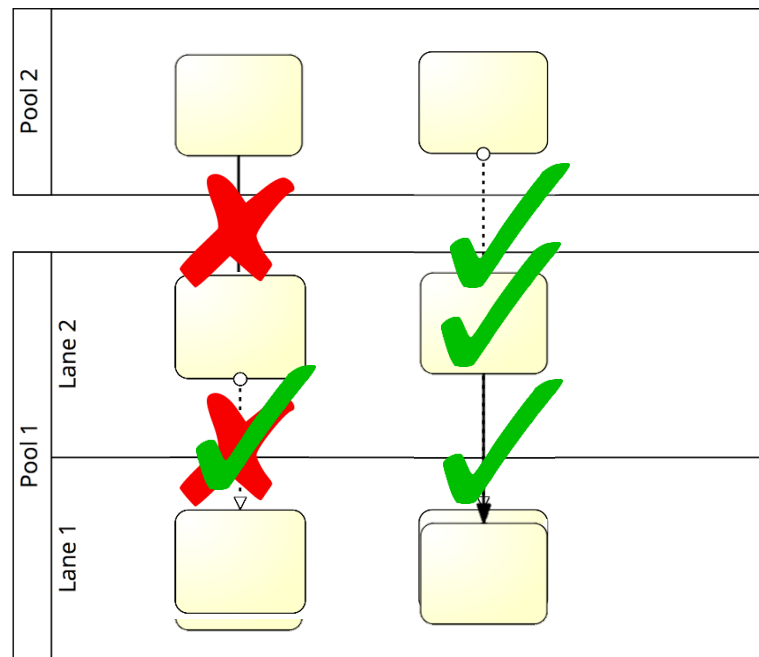


Pools, Lanes and Flows: Rules



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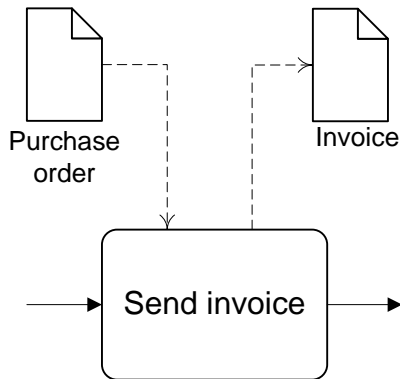
- A Sequence Flow **cannot** cross the boundaries of a Pool
- Both Sequence Flow and Message Flow **can cross** the boundaries of Lanes
- A Message Flow **cannot connect** two flow elements within the same pool



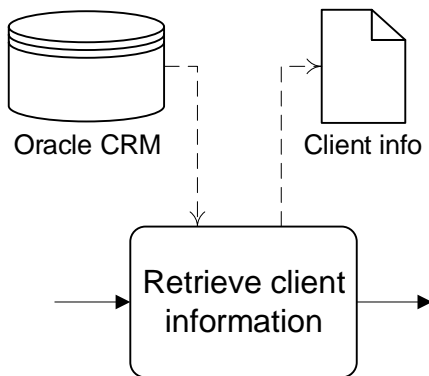
BPMN Information Artifacts



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A **Data Object** captures an artifact required (input) or produced (output) by an activity - can be physical or electronic



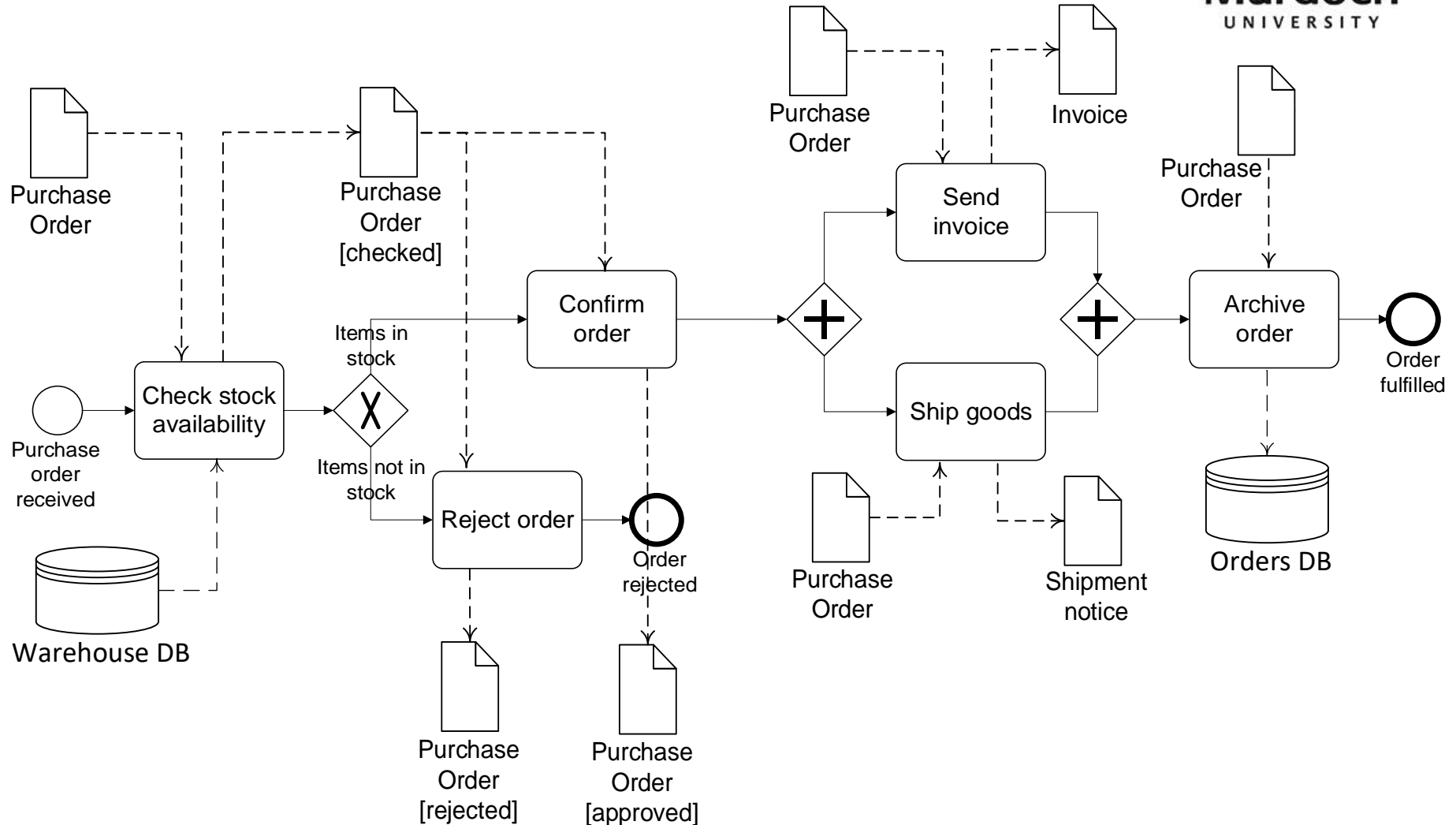
A **Data Store** is a place containing data objects that must persist beyond the duration of a process instance

It is used by an activity to store (as output) or retrieve (as input) data objects

Example with Information Artifacts



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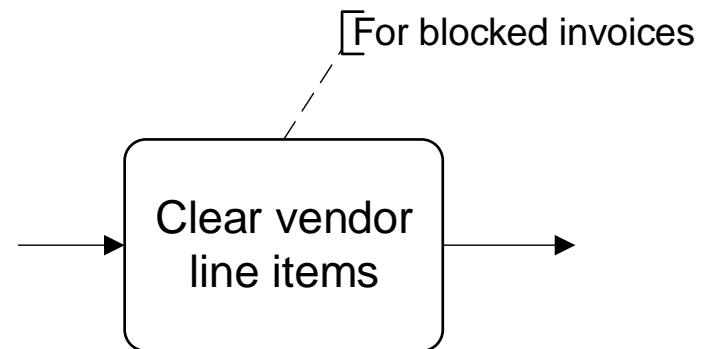
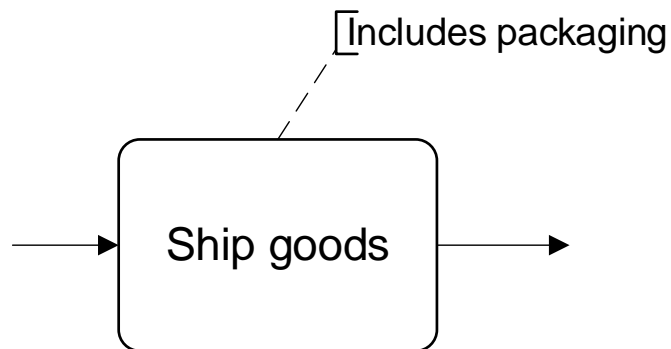
BPMN Text Annotations



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A **Text Annotation** is a mechanism to provide additional text information to the model reader

- Doesn't affect the flow of tokens through the process

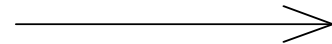


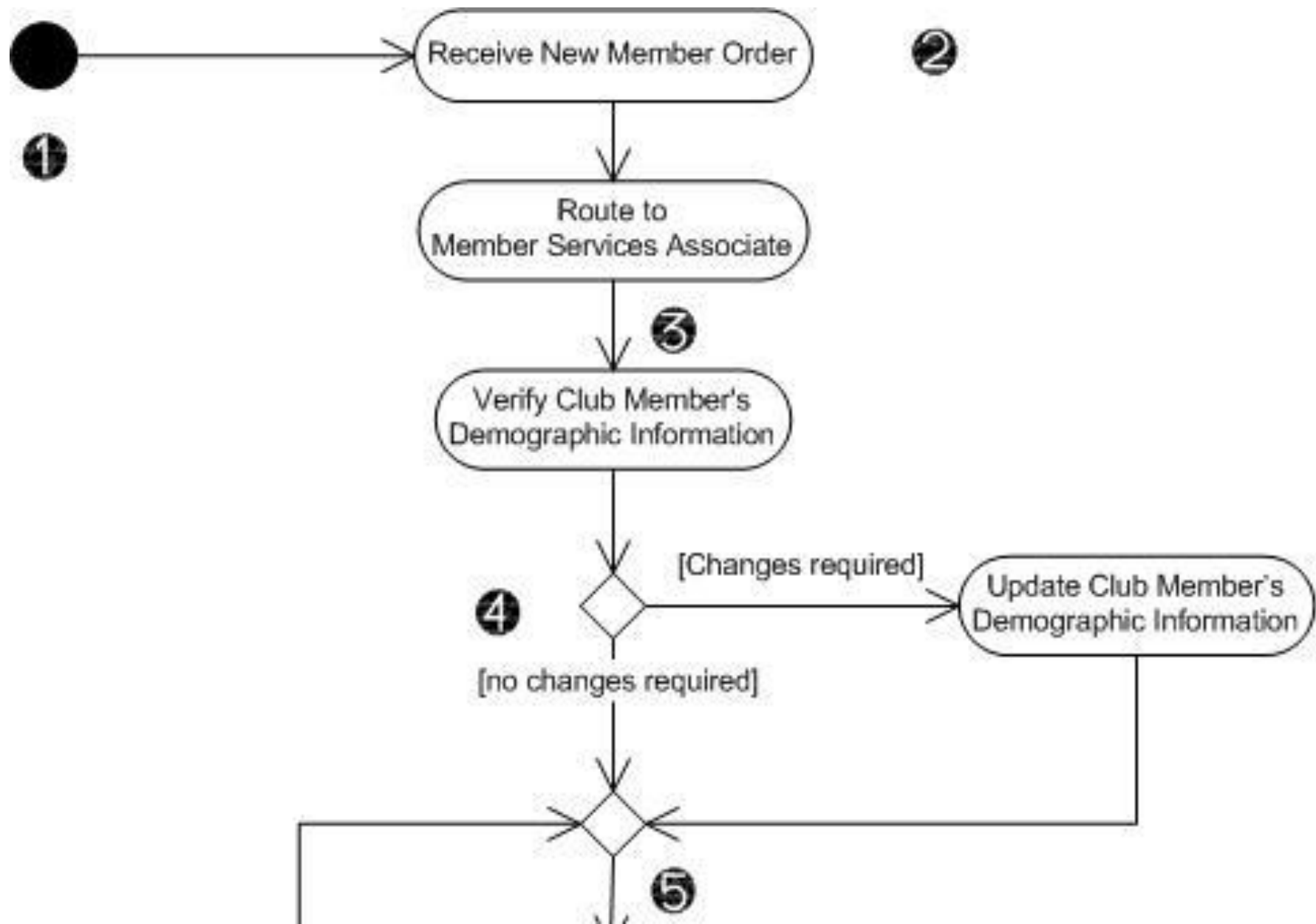
UML Activity Diagram Notation - revision



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- 1. Initial node** - solid circle representing the start of the process
- 2. Actions** - rounded rectangles representing individual steps
- 3. Flow** - arrows on the diagram indicating the progression through the actions - do not need words to identify them unless coming out of decisions
- 4. Decision** - diamond shapes with one flow coming in and two or more flows going out. The flows coming out are marked to indicate the conditions
- 5. Merge** - diamond shapes with multiple flows coming in and one flow going out. This combines flows previously separated by decisions





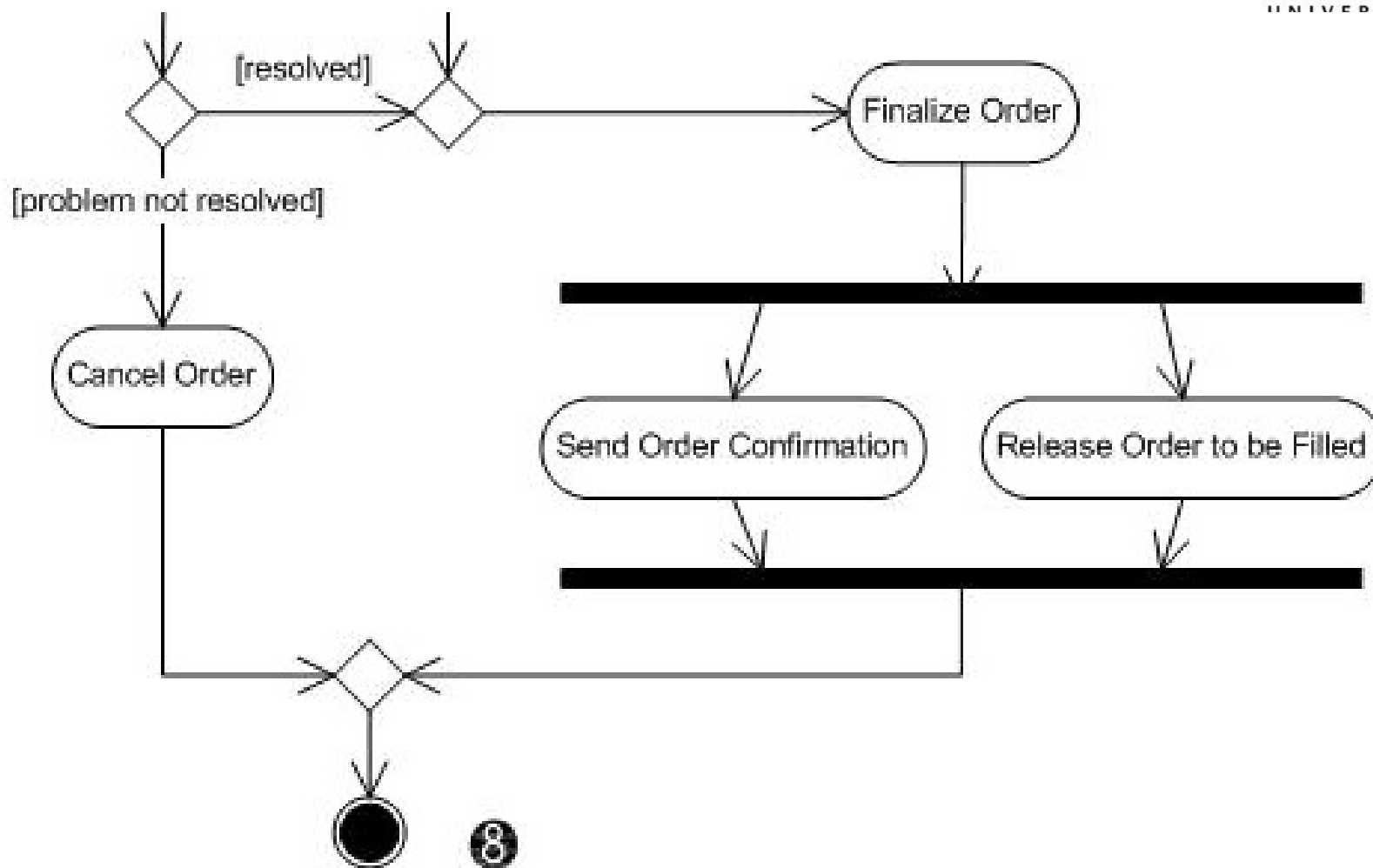
Activity Diagram Notation (ctd)



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6. **Fork** – a black bar with one flow coming in and two or more flows going out. Actions on parallel flows beneath the fork can occur in any order or concurrently
7. **Join** – a black bar with two or more flows coming in and one flow going out, noting the end of concurrent processing. **All actions coming into the join must be completed before processing continues**
8. **Activity final** – the solid circle inside the hollow circle representing the end of the process
9. **Activity partitions** – UML name for swimlanes. No separate pool notation



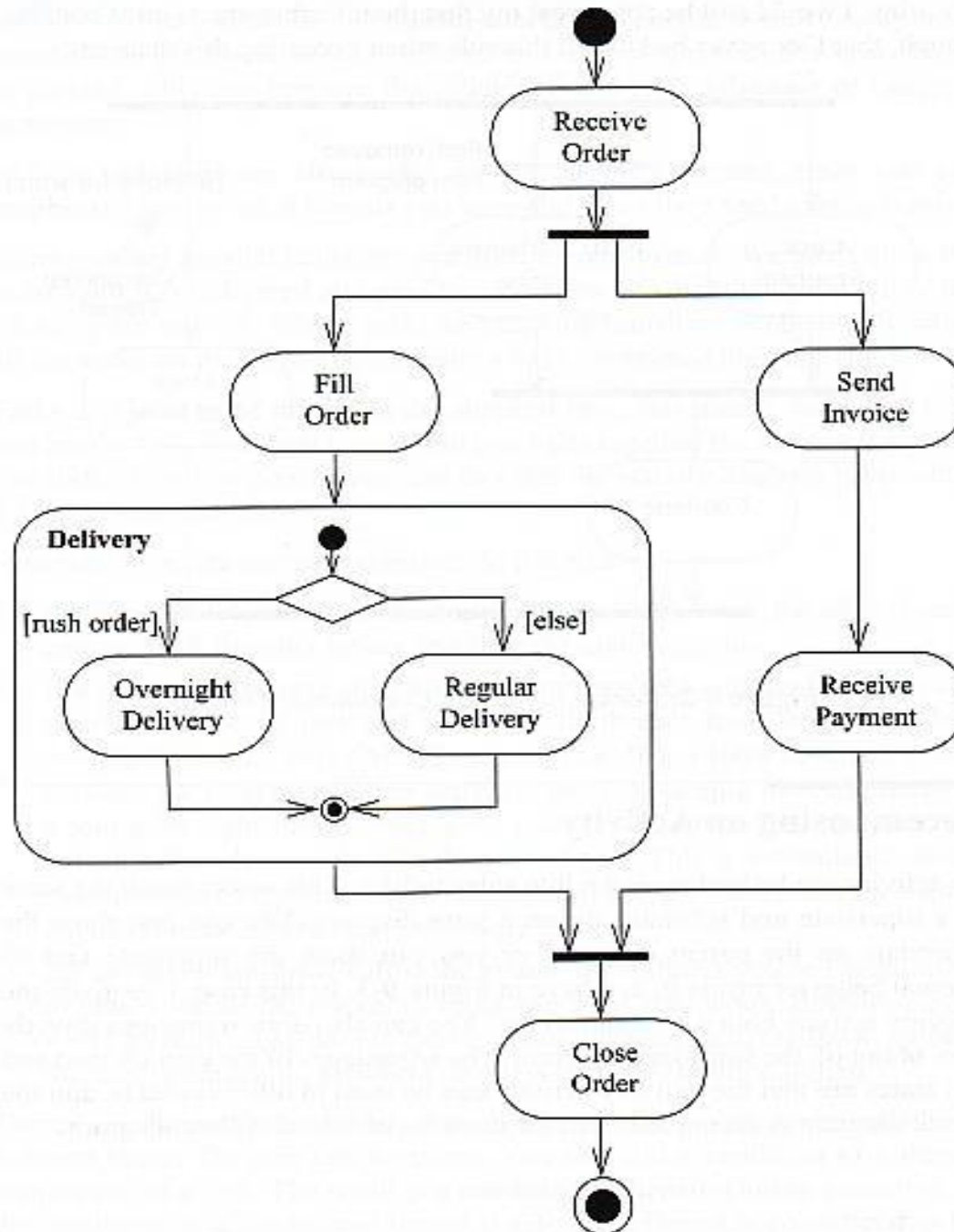


6

7

8

Another Example UML Activity Diagram



BPMN versus UML Activity Diagrams



How do BPMN and UML activity diagrams differ?

See the following article for a detailed comparison:

- Geambasu, C. V. (2012). BPMN vs. UML Activity Diagram for business process modeling. *Accounting and Management Information Systems*, 11(4), 637-651. Available via Murdoch Library

Learning Objectives Revisited



- Can you read and understand BPMN models?
- Can you read and understand UML activity diagrams?
- Can you create process models using BPMN and activity diagrams?
- What is the difference between As-Is and To-Be process diagrams?

Additional Resources



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- Engels, G., Förster, A., Heckel, R. & Thöne, S. (2005) Process modeling using UML (Chapter 5) in Dumas, M., van der Aalst, W.M. & ter Hofstede, A. H. M. (eds) *Process-Aware Information Systems*. John Wiley and Sons. Available from <http://www.cs.le.ac.uk/people/rh122/papers/2005/EFHT05PAIS.pdf>
- Geambasu, C. V. (2012). BPMN vs. UML Activity Diagram for business process modeling. *Accounting and Management Information Systems*, 11(4), 637-651. Available from http://www.cig.ase.ro/articles/11_4_7.pdf
- Harmon, P. (2007) *Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals* (2nd edition). Morgan Kaufmann Publishers. Chapters 8, 9 & Appendix 1. Electronic copy available in library
- Object Management Group (2013) *Business Process Model and Notation (BPMN) Version 2.0.2* Available from: <https://www.omg.org/spec/BPMN/2.0.2/> (note this is the full specification of >500 pages)



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Advanced Business Analysis and Design

Topic 5 (Part 2)

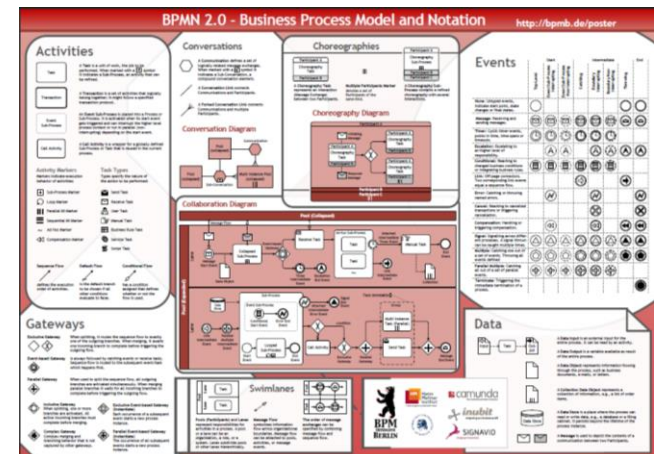
Tools and Techniques for Business Process Modelling

Readings and Resources



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- Havey, M. (2005) *Essential Business Process Modeling*, O'Reilly Media Inc. Chapters 1 & 4. Electronic copy also available from library
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Software for business process modelling/management

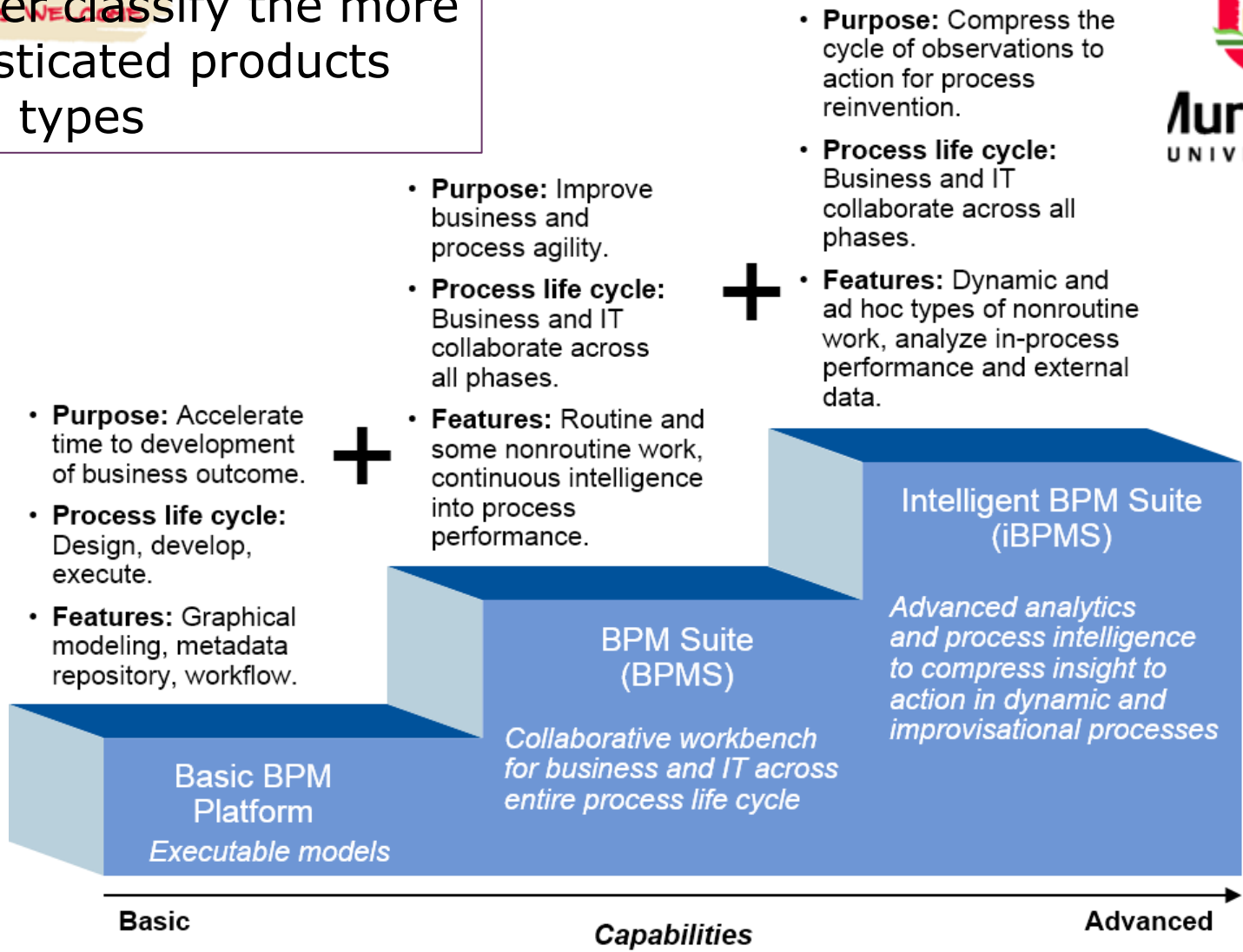
Supporting Business Process Modelling and Management



A wide variety of tools can be used to support business process modelling and business process management. Categories of tools include:

- **Business process modelling tools** – aid in the analysis, modelling and redesign of business processes
- **BPM platform and suite** products - allow analysts to model processes and then automate the execution of the processes at run-time – **more in Topic 7**

Gartner classify the more sophisticated products into 3 types



Ref: Dunie, R. & Cantara, M. (2015) Market Guide to Business Process Management Platforms. Gartner Report: ID Number G00262755

Tools to Support BPM

A study of 528 BPMN users by Recker (2012) identified the most popular modelling tools as:

Microsoft Visio	18.2%
itp-Commerce Process Modeler	7.7%
Sparx Systems Enterprise Architect	6.8%
Visual Paradigm Visual Architect	6.1%
Telelogic System Architect (now IBM)	5.9%
Intalio BPMS	4.9%
ILOG Jviews	3.8%
IDS Scheer ARIS	3.3%
Casewise Corporate Modeler	3.3%
Holocentric Modeler	2.8%

Ref: Recker, J. C. (2012) Modelling with tools is easier, believe me”: the effects of tool functionality on modeling grammar usage beliefs. *Information Systems*, 37(3), 213-226.



Tools to Support BPM (ctd)

- **itp-Commerce Process Modeler** - a Visio plug-in that extended the modelling capacities of Visio - <https://www.itp-commerce.com/> - now replaced with Vizi BPM Suite
- **Sparx Systems Enterprise Architect** – Australian product. BPM capabilities include generating executable BPEL scripts from BPMN models and validation of model correctness <https://sparxsystems.com/products/ea/>
- **Visual Paradigm Visual Architect** – Now broader Visual Paradigm product <https://www.visual-paradigm.com/>
- **IBM Rational System Architect** – was Telelogic. Powerful CASE tool https://www.ibm.com/support/knowledgecenter/en/SS6R BX/sa_family_welcome.html

Tool Functionality



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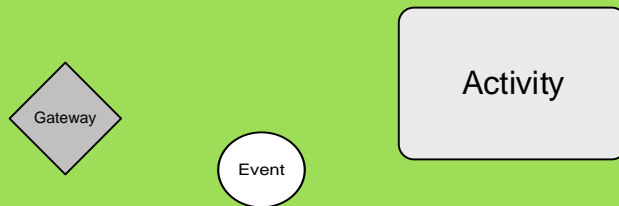
The Recker (2012) study also reported on the most popular tool functionality:

Integrated repository for all process models	46.2%
Navigation between process models on different levels	56.1%
Additional attribute fields for symbols	42.4%
Access to other notations and modelling techniques	31.4%
Access to new symbols in addition to BPMN symbols	26.1%
Access or hyperlinks to other documentation from within the process models	41.7%
Method filter for restricting and specifying the set of symbols to be used	21.2%

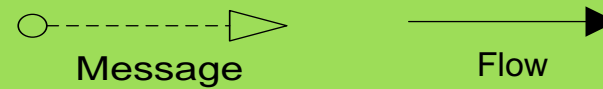


BPMN Main Elements - Recap

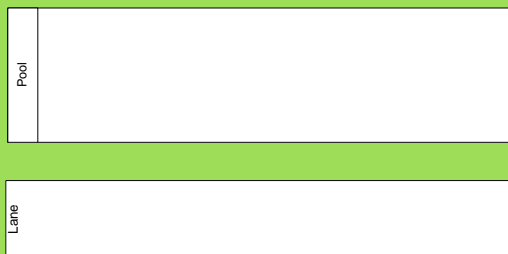
Flow Objects



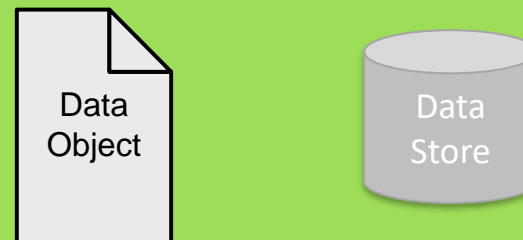
Connections



Pools & lanes



Artifacts





BPMN Gateways - recap

Exclusive (XOR)

- Exclusive decision
take one branch
- Exclusive merge
Proceed when one
branch has
completed

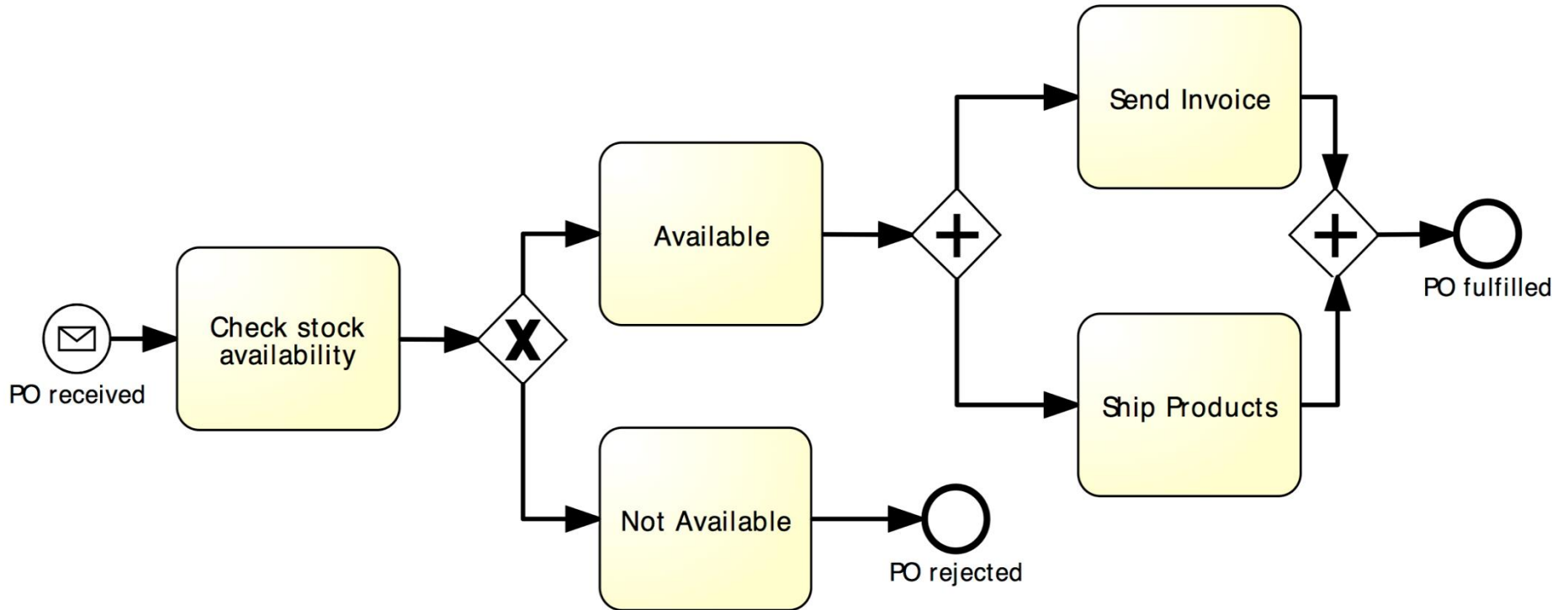
Parallel (AND)

- Parallel split
take all branches
- Parallel join
proceed when all
incoming branches
have completed

What is wrong with this model?

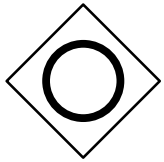


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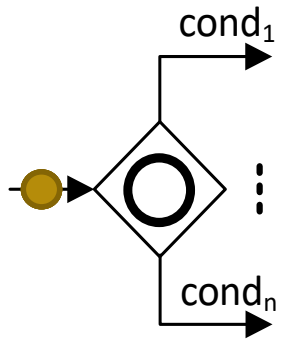




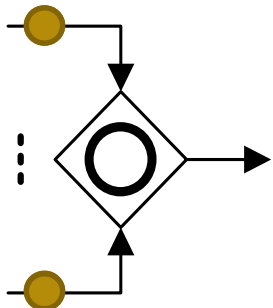
OR Gateway



An OR Gateway provides a mechanism to create and synchronize n out of m parallel flows



OR-split → takes one or more branches depending on conditions



OR-join → proceeds when all active incoming branches have completed

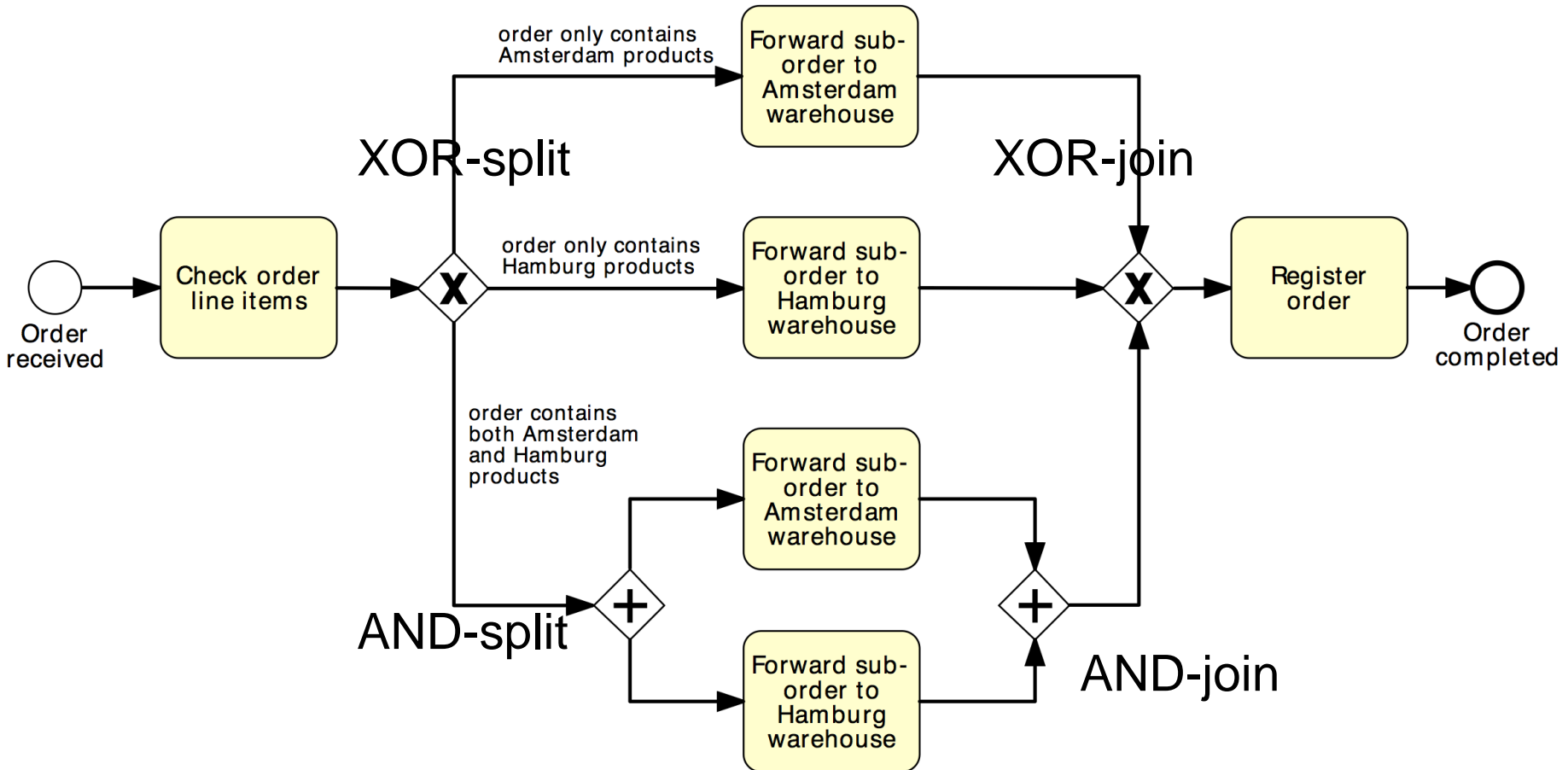
OR Gateway Example



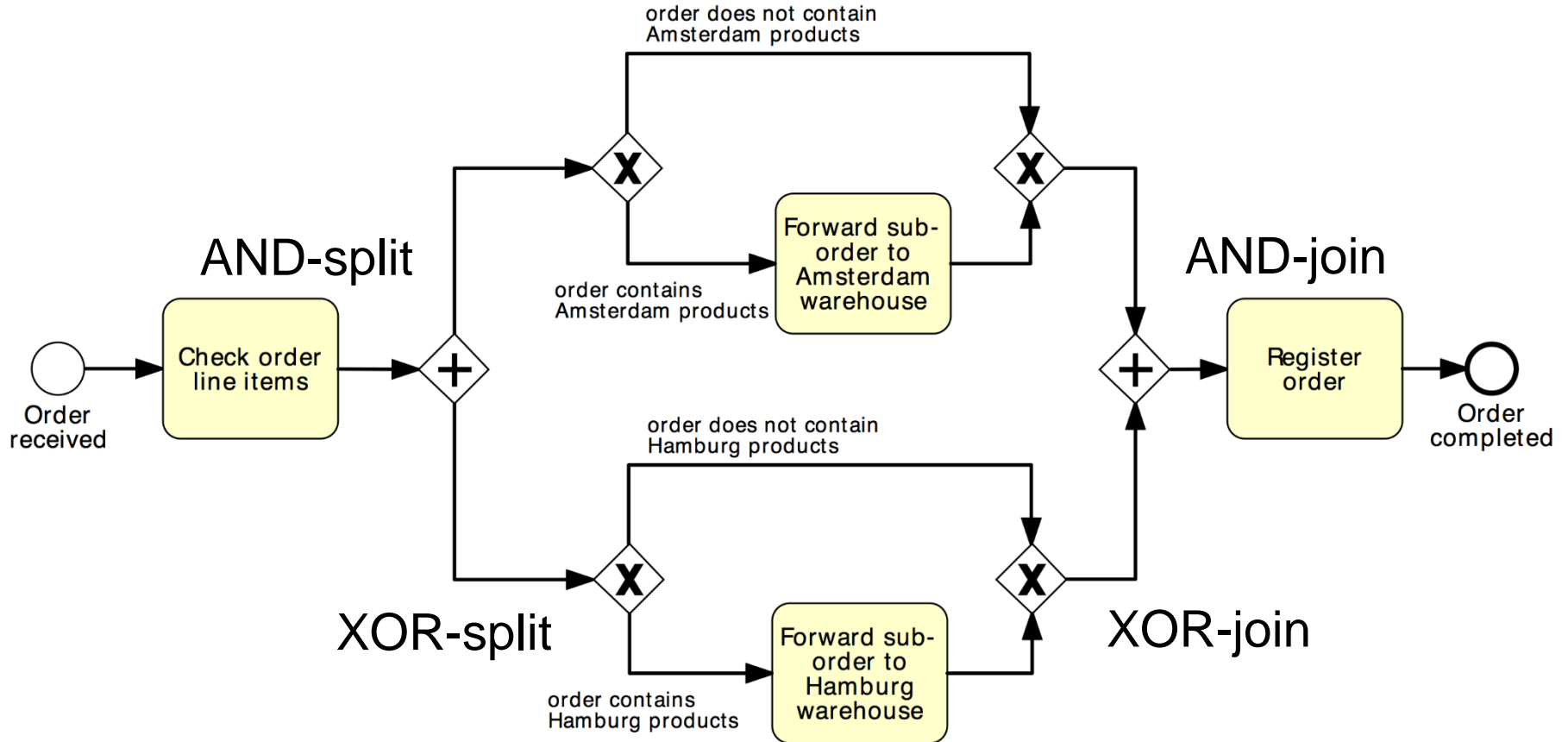
Order distribution process

A company has two warehouses that store different products: Amsterdam and Hamburg. When an order is received, it is distributed across these warehouses: if some of the relevant products are maintained in Amsterdam, a sub-order is sent there; likewise, if some relevant products are maintained in Hamburg, a sub-order is sent there. Afterwards, the order is registered and the process completes.

Solution 1 without OR Gateway



Solution 2 without OR gateway

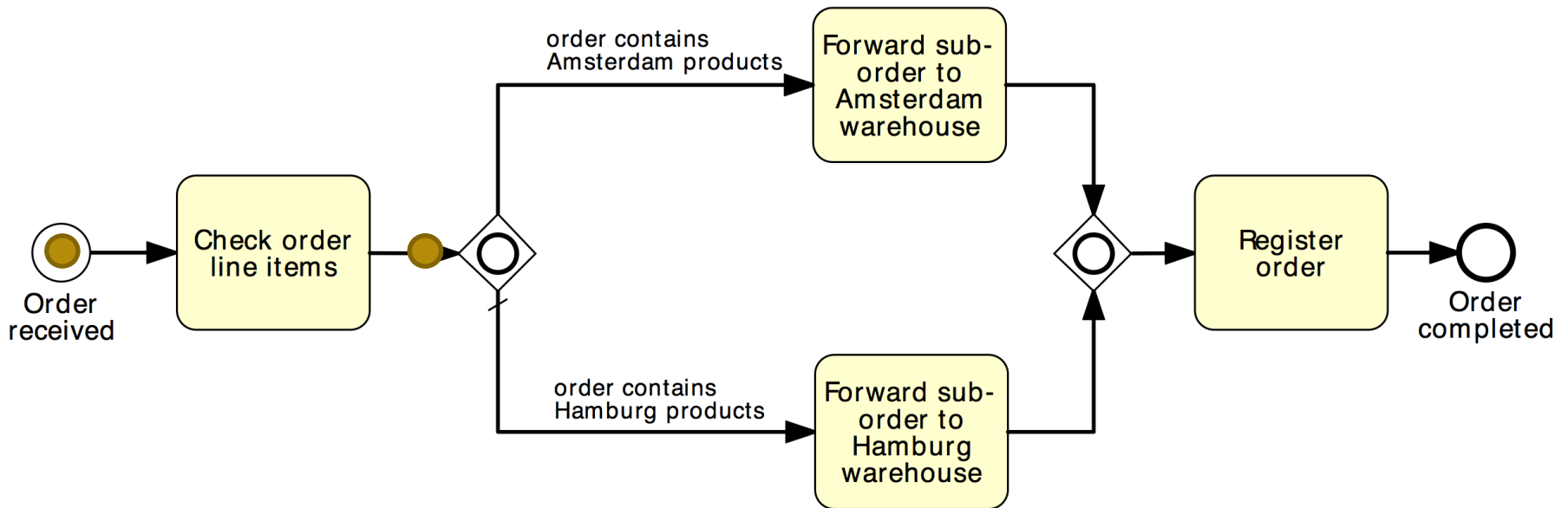




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Can you draw the order distribution process model to use an OR gateway?

Solution using OR Gateway



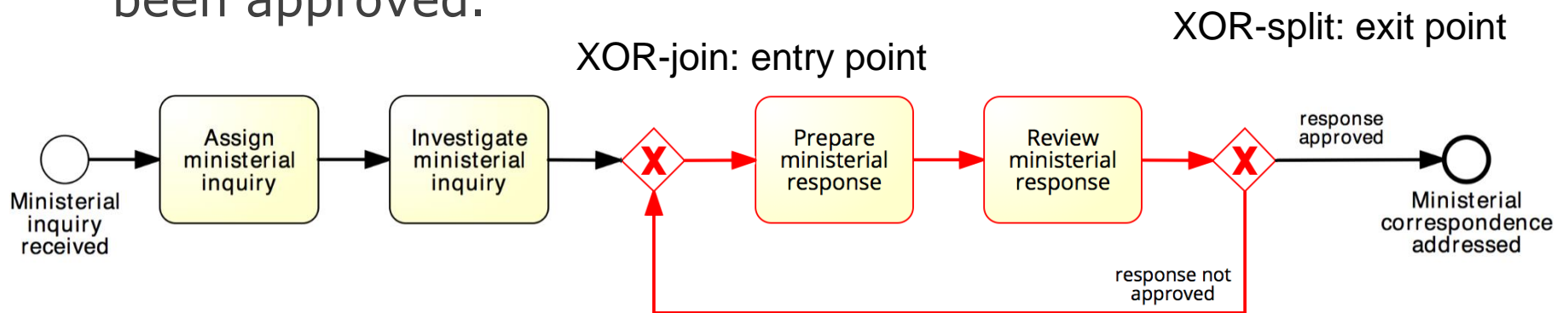
Repetition - Example



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In the Minister of Social Security's office, when a ministerial inquiry has been received, it is registered into the system. Then the inquiry is investigated so that a ministerial response can be prepared.

The finalisation of a response includes the preparation of the response itself by one staff member and the review of the response by a more senior staffer. If the response is not approved, it needs to be prepared again and re-reviewed. The process finishes only once the response has been approved.

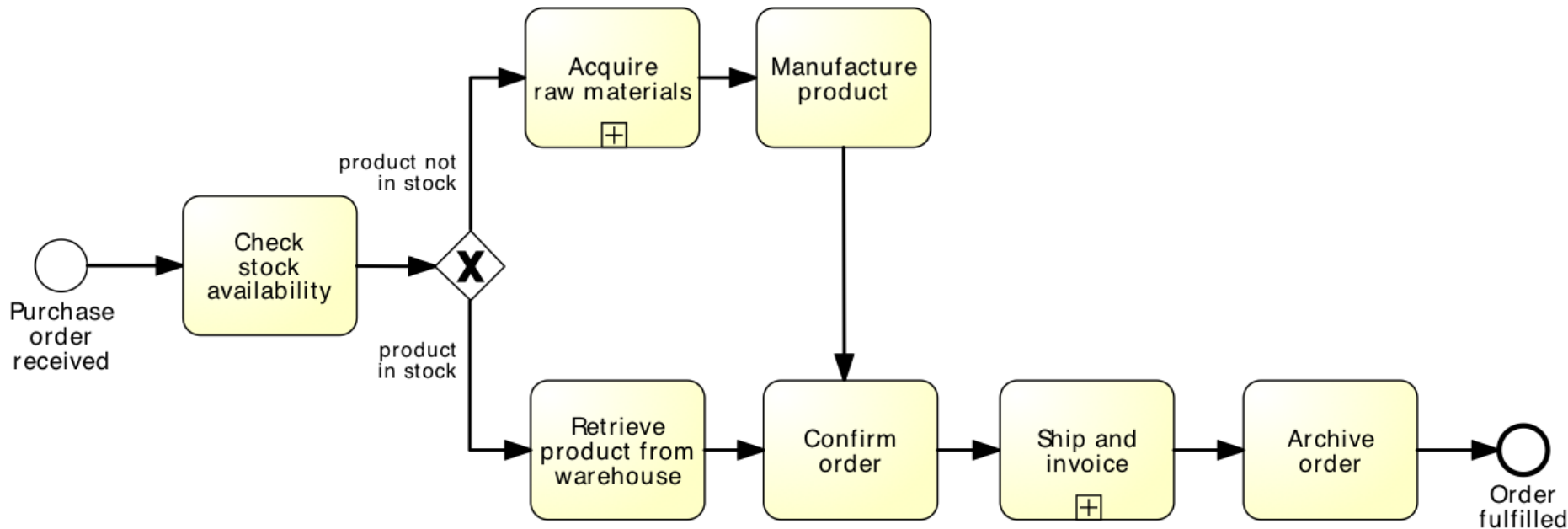


Sub-processes



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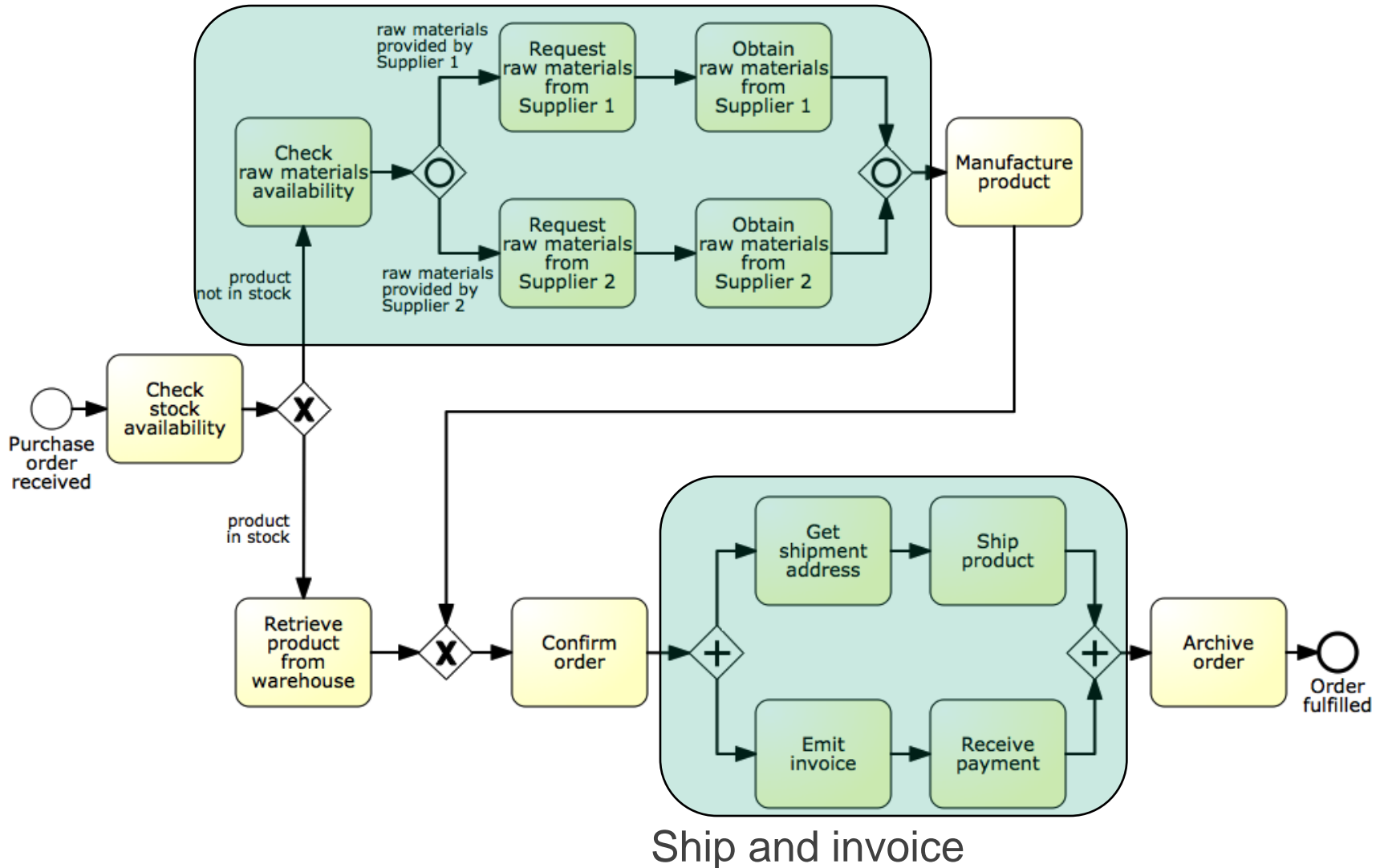
An activity in a process can invoke a separate sub-process. Use this to decompose large models into smaller ones, making them easier to understand and maintain - e.g. Acquire raw materials



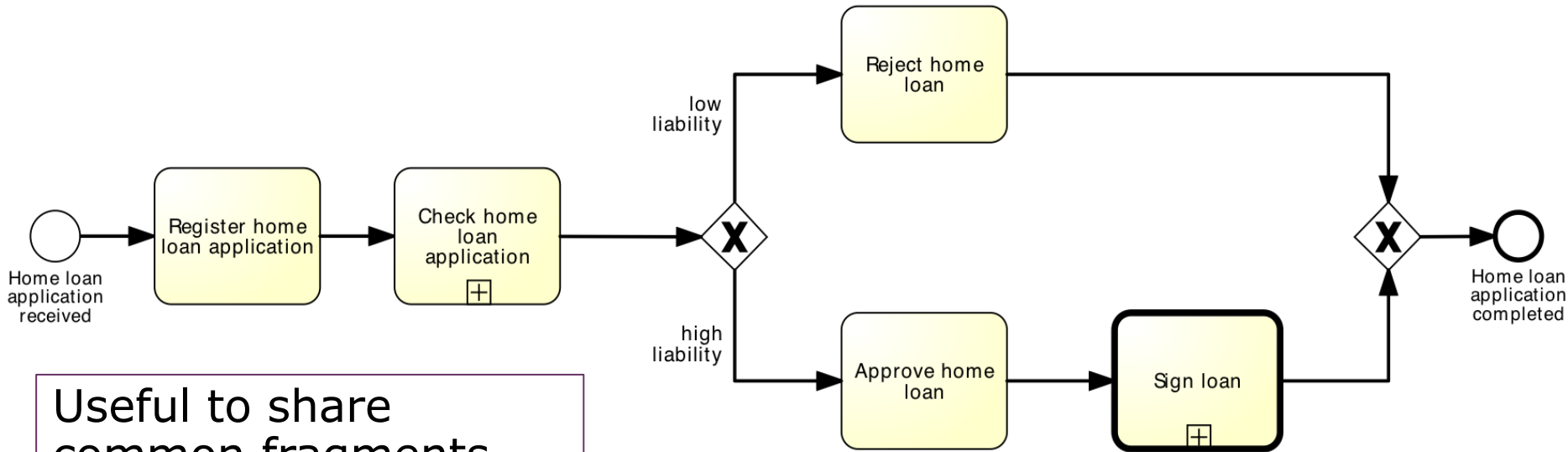
Sub-processes



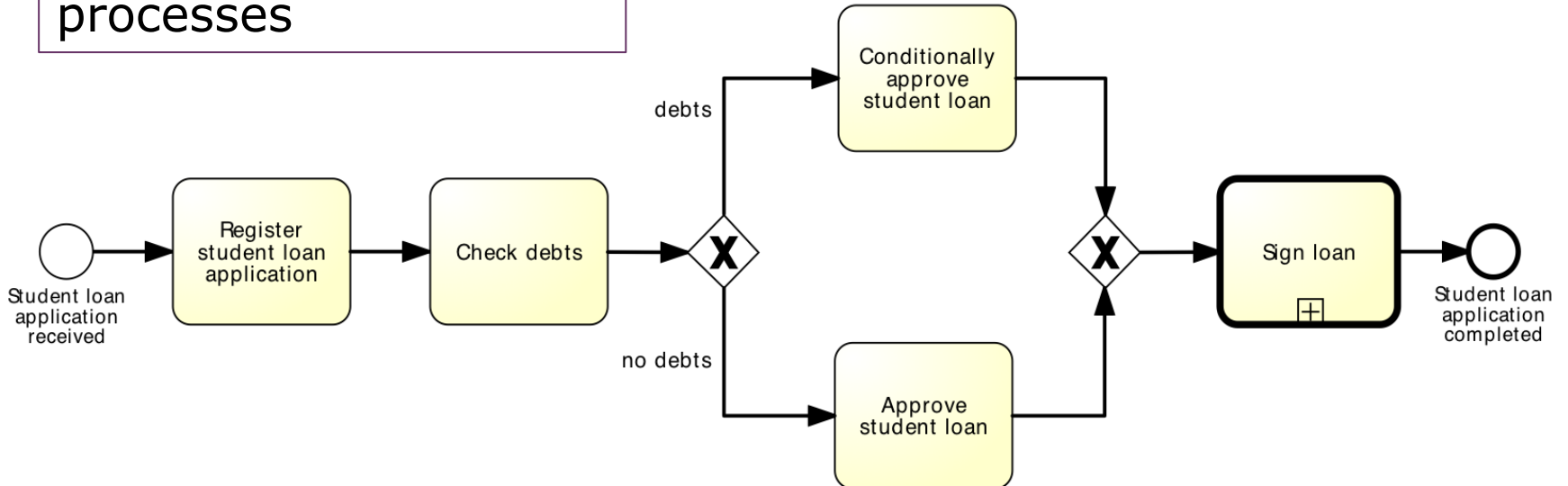
Acquire raw materials



Shared sub-processes



Useful to share common fragments across multiple processes




Block-structured repetition: Activity loop



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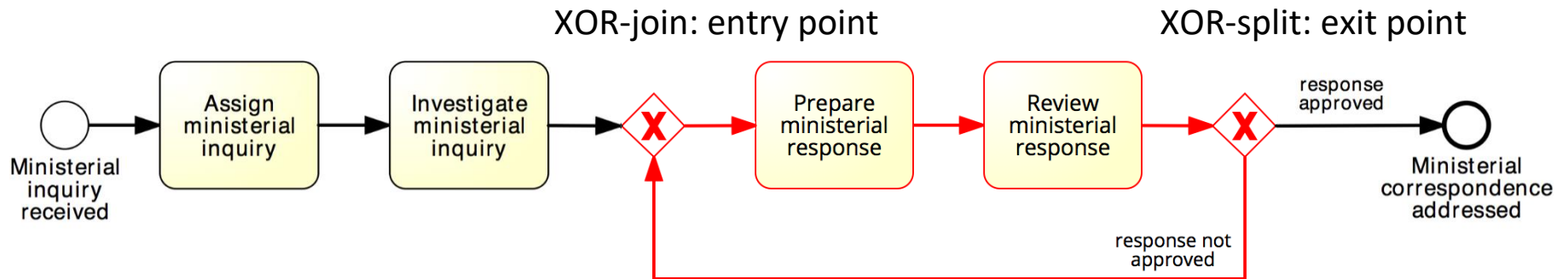
Activity loop markers allow us to state that a task or a sub-process may be repeated multiple times

Task
Loop


Sub-process
Loop




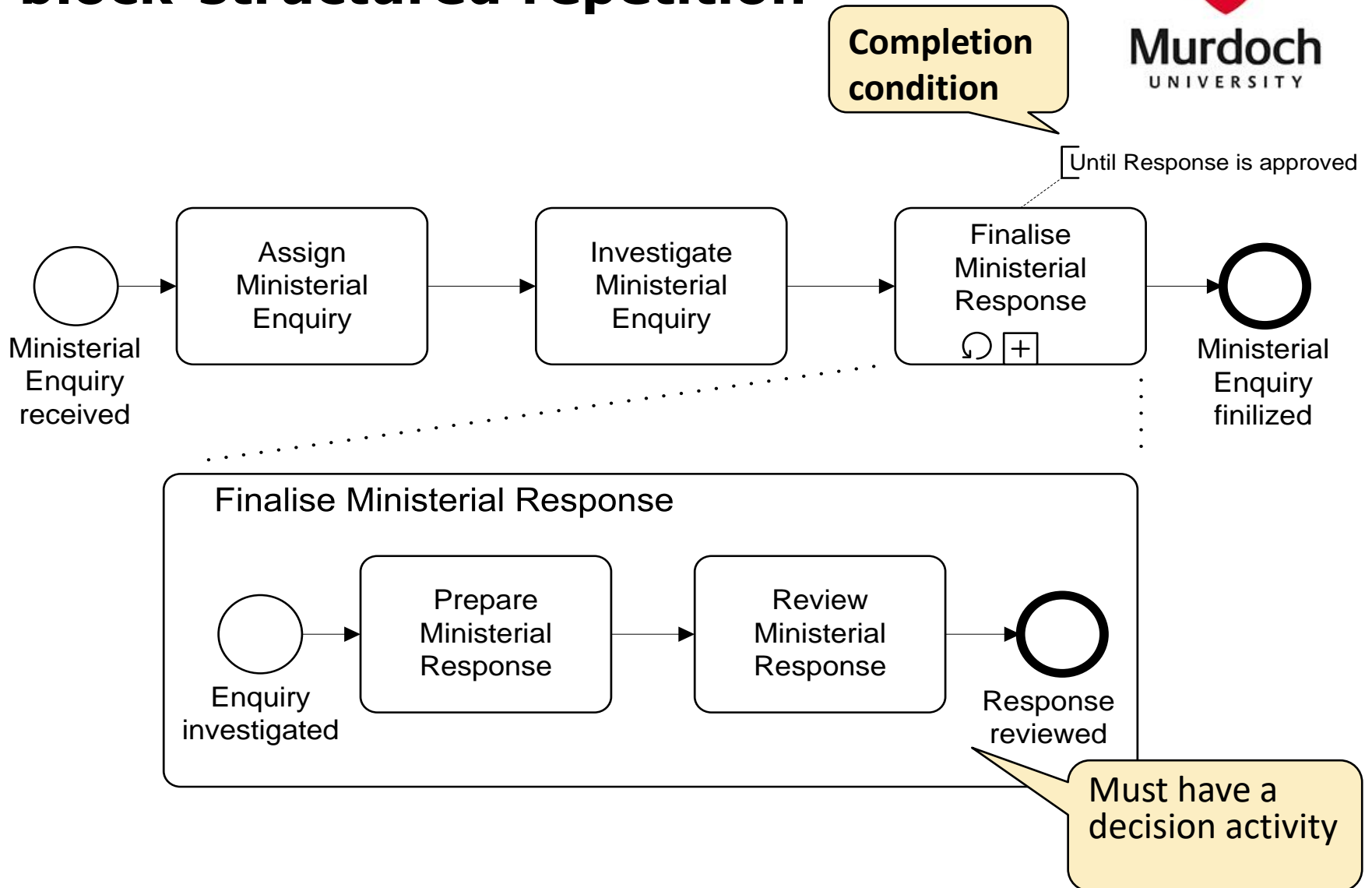
Remember this method of showing repetition?



It can also be shown like this - using block-structured repetition



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Parallel repetition: multi-instance activity

The multi-instance activity provides a mechanism to indicate that an activity is executed **multiple times concurrently**

Multi-Instance
Task



Multi-Instance
Sub-process



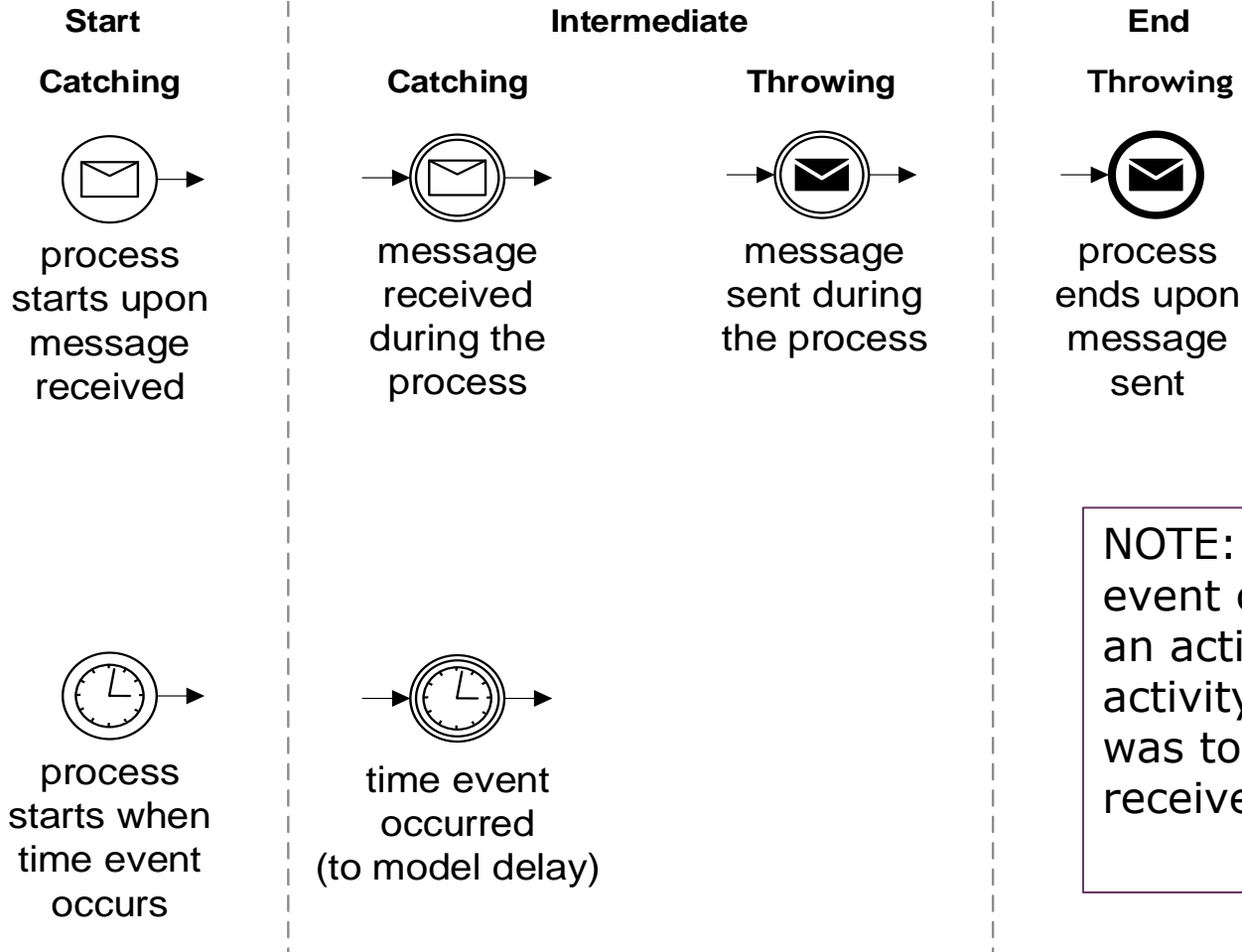
Useful when the same activity needs to be executed for multiple entities or data items, such as:

- Request quotes from multiple suppliers
- Check the availability for each line item in an order separately

Message and Timer events



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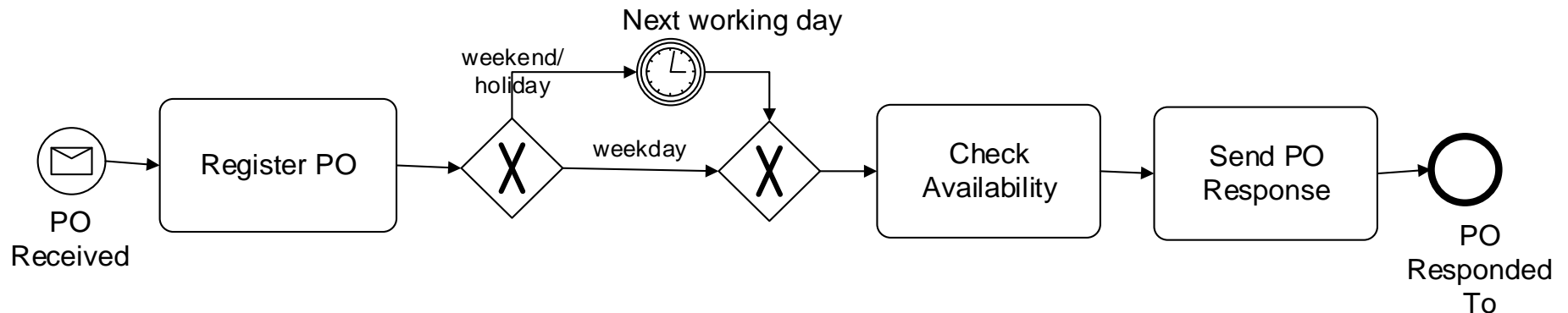
NOTE: A message event can replace an activity if all the activity was doing was to send or receive a message

Timer Event Example



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A Purchase Order (PO) handling process starts when a PO is received. The PO is first registered. If the current date is not a working day, the process waits until the following working day before proceeding. Otherwise, an availability check is performed and a PO response is sent back to the customer.





Event-based decisions

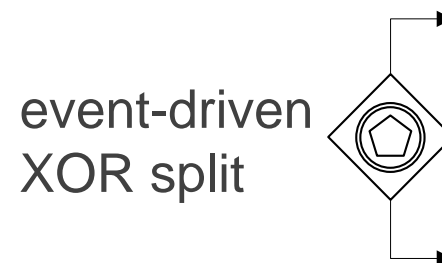
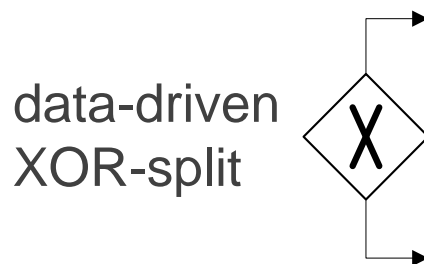
With the XOR-split gateway, a branch is chosen based on conditions evaluated using available data

→ The choice can be made immediately after the token arrives from the incoming flow

Sometimes the choice must be delayed until an event happens

→ The choice is based on a “race” among events

There are therefore 2 types of XOR split:



Choices outside our control – event-driven example

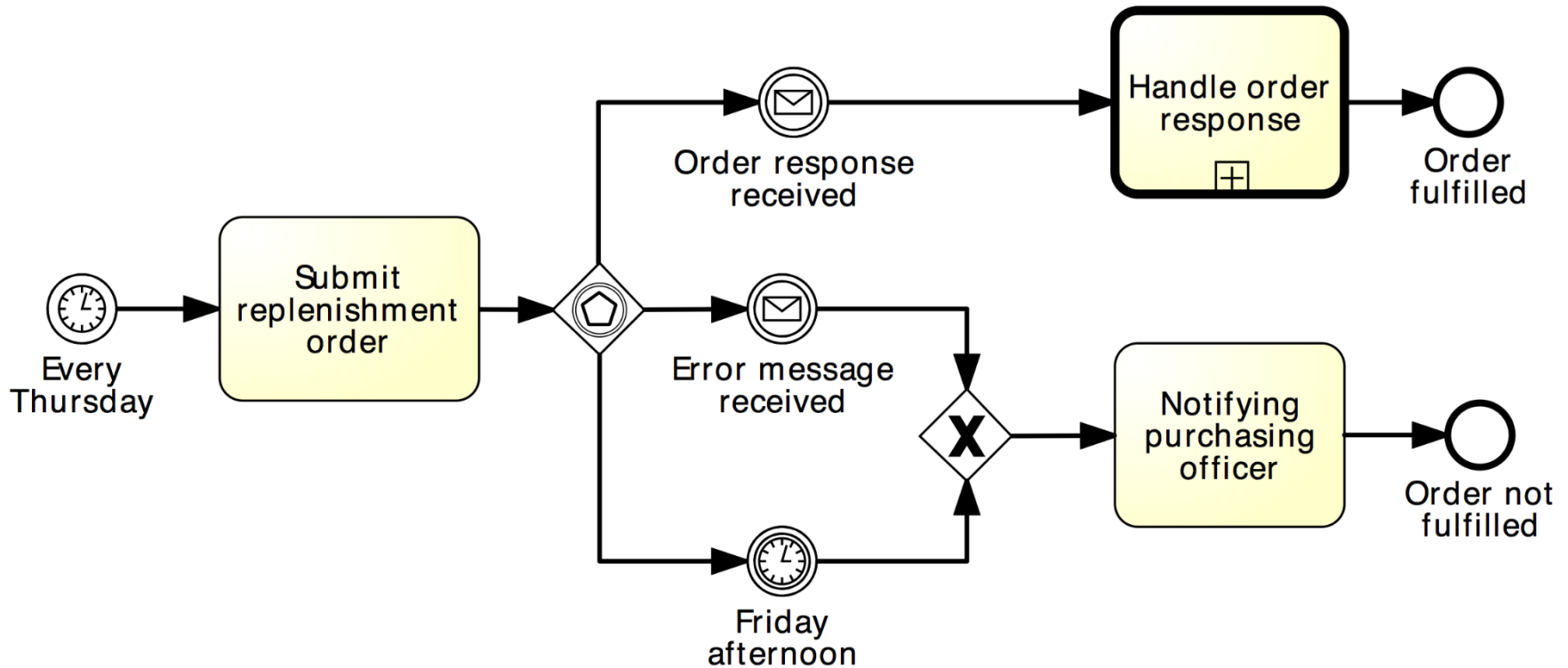


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Stock replenishment

A restaurant chain submits a purchase order (PO) to replenish its warehouses every Thursday. The restaurant chain's procurement system expects to receive either a "PO Response" or an error message. However, it may also happen that no response is received at all due to system errors or due to delays in handling the PO on the supplier's side. If no response is received by Friday afternoon or if an error message is received, a purchasing officer at the restaurant chain's headquarters should be notified. Otherwise, the PO Response is processed normally.

Solution: event-driven XOR split





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Workflow patterns

In addition to the branching and merging types we have looked at, there are other much more complex patterns

Note: Not all are well supported by BPMN and UML activity diagrams

For animations of workflow patterns see

<http://www.workflowpatterns.com/patterns/index.php>



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Generating Code from Process Diagrams

Generating Code from Process Diagrams



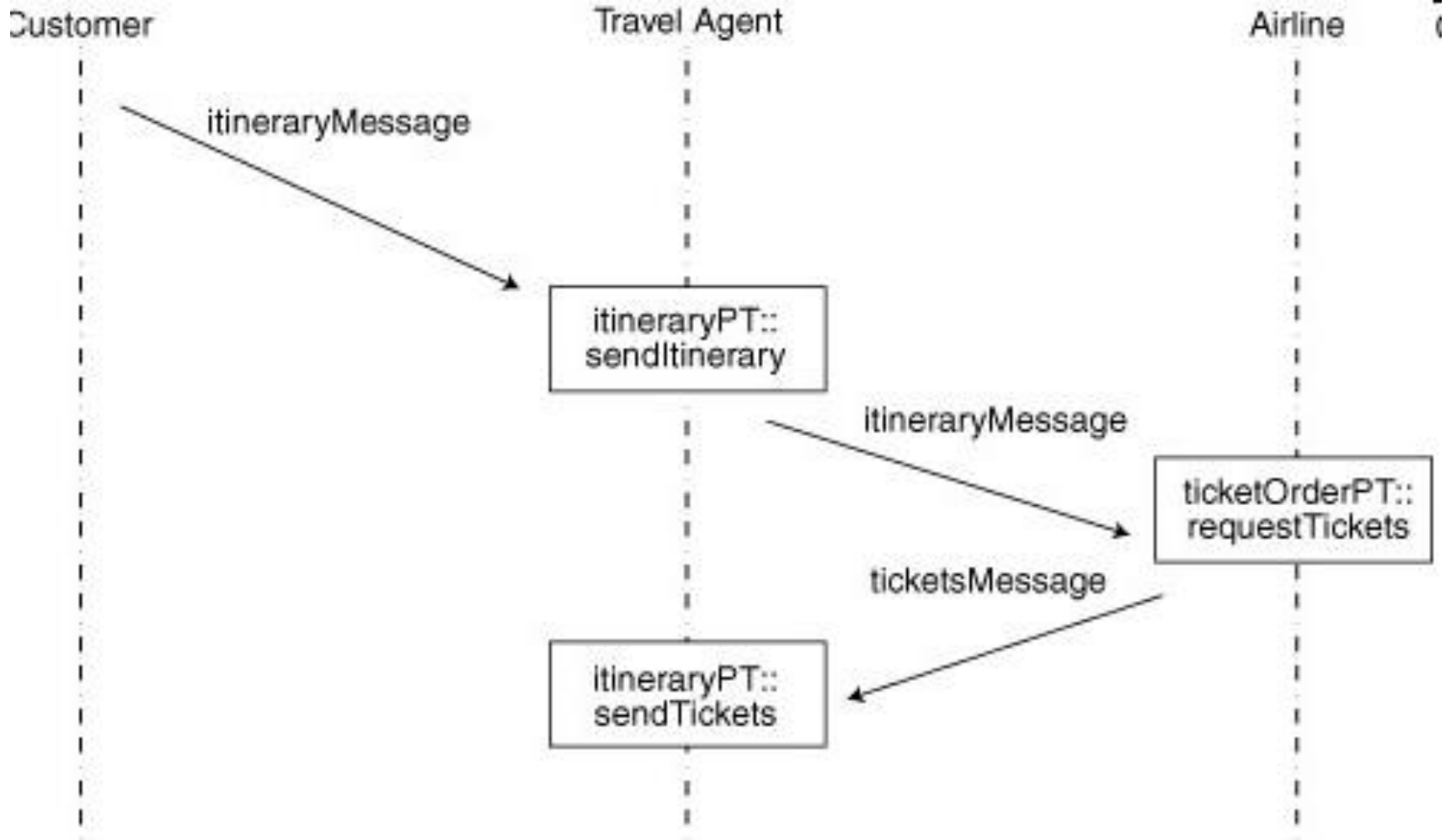
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- **Business Process Execution Language for Web Services (BPEL4WS)**, is an XML-based process definition language. That is, a language to specify executable processes
- It comes from the OASIS group and is the process definition language specification with the strongest backing (IBM, Microsoft, Oracle)
- The BPMN specification includes a mapping to BPEL4WS, which facilitates the execution of BPMN-designed processes

BPEL4WS Example – sequence diagram for travel agent application



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From: <http://www.ibm.com/developerworks/library/ws-bpelwp>

BPEL4WS Example – fragment of BPEL



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```
1 <process name="ticketOrder">
2   <partners>
3     <partner name="customer"
4       serviceLinkType="agentLink"
5       myRole="agentService"/>
6     <partner name="airline"
7       serviceLinkType="buyerLink"
8       myRole="ticketRequester"
9       partnerRole="ticketService"/>
10  </partners>
11  <containers>
12    <container name="itinerary" messageType="itineraryMessage"/>
13    <container name="tickets" messageType="ticketsMessage"/>
14  </containers>
15  <flow>
16    <links>
17      <link name="order-to-airline"/>
18      <link name="airline-to-agent"/>
19    </links>
20    <receive partner="customer"
21      portType="itineraryPT"
22      operation="sendItinerary"
23      container="itinerary"
24      <source linkName="order-to-airline"/>
25    </receive>
26    <invoke partner="airline"
27      portType="ticketOrderPT"
28      operation="requestTickets"
29      inputContainer="itinerary"
30      <target linkName="order-to-airline"/>
31      <source linkName="airline-to-agent"/>
32    </invoke>
33    <receive partner="airline"
34      portType="itineraryPT"
35      operation="sendTickets"
36      container="tickets"
37      <target linkName="airline-to-agent"/>
38    </receive>
39  </flow>
40 </process>
```


Generating Code from Process Diagrams (ctd)



- The following link provides a more detailed example of the design and development of a BPEL application that supports a case management process:
<https://www.ibm.com/developerworks/library/ws-soacastudy/index.html>

Ref: Ruzek. B. & Pratt. B. (2010) SOA in Practice: Case Study in BPEL and SCA from: <https://www.ibm.com/developerworks/library/ws-soacastudy/index.html>

Learning Objectives Revisited



- Can you create process models using BPMN?
- Are you aware of the variety of software that can be used to support business process modelling/management
- What is the relationship between BPMN and process definition languages such as Business Process Execution Language for Web Services (BPEL4WS)?



Additional References

- Dunie, R. & Cantara, M. (2015) Market Guide to Business Process Management Platforms. Gartner Report: ID Number G00262755
- Dumas, M., La Rose, M., Mendling, J. and Reijers, H. A. (2013) *Fundamentals of Business Process Management*. Springer.
- Recker, J. C. (2012) “Modelling with tools is easier, believe me”: the effects of tool functionality on modeling grammar usage beliefs. *Information Systems*, 37(3), 213-226.
- Ruzek. B. & Pratt. B. (2010) SOA in Practice: Case Study in BPEL and SCA from: <https://www.ibm.com/developerworks/library/ws-soacasestudy/index.html>
- *Workflow Patterns (2010)* <http://www.workflowpatterns.com>.