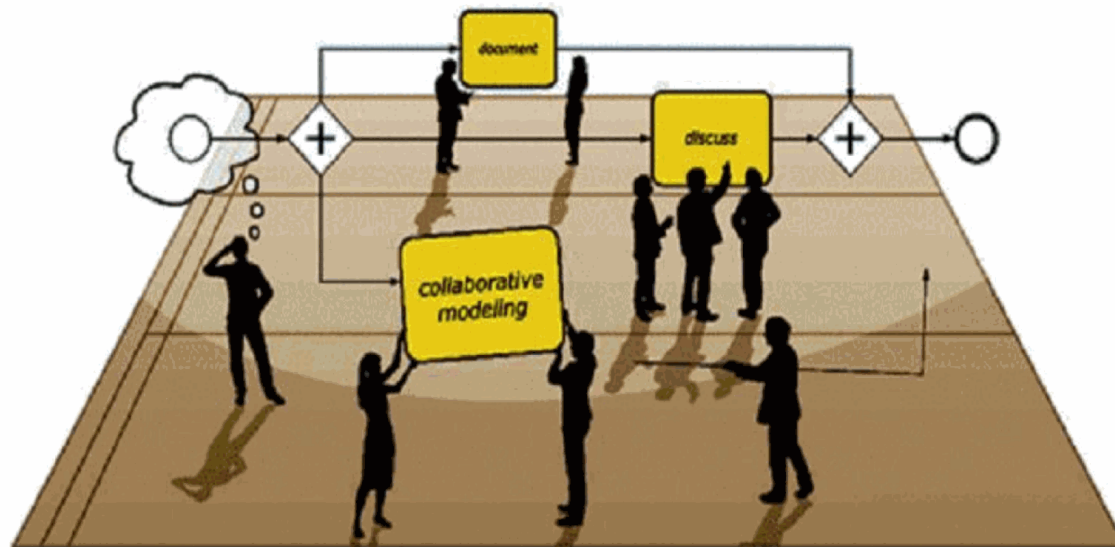


University of Pisa  
MSc in Computer Engineering  
*Supply Chain Operation Management*

---

*"Large and complex organizations are a tangible manifestation of advanced technology, more than machinery itself." (J.K. Galbraith)*

## BPMN Modeling and Simulation

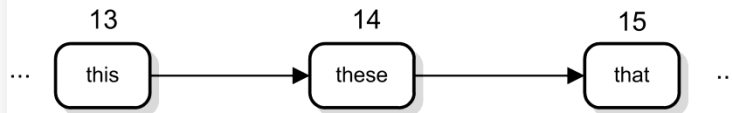


## Lectures

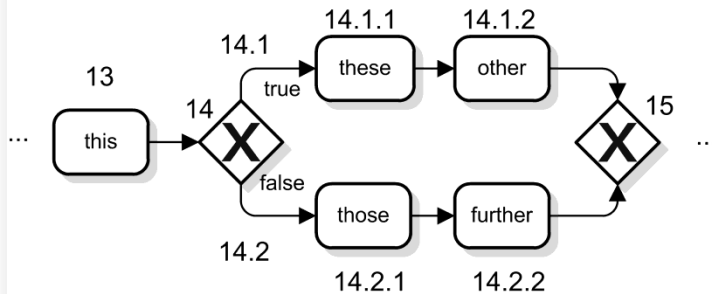
Mario G. Cimino, Department of Information Engineering, Center for Logistics Systems  
*Pisa, March-May 2016, Monday 14.30-17.30, Room: ADInform2*

- ❑ The semi-formal notation is made of short sentences, numbered so as to allow the specification of the control flows with BPMN 2. It resembles detailed use cases in UML.

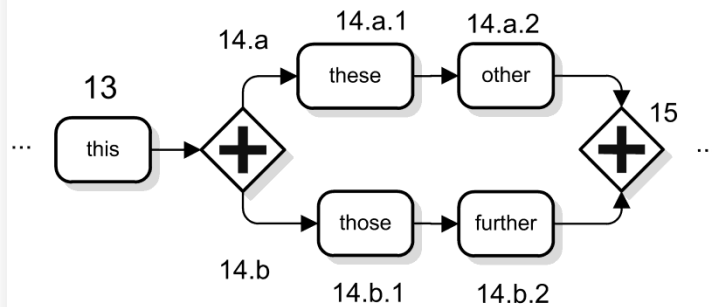
## MAPPING FROM SEMI-FORMAL TEXTUAL DESCRIPTION TO BPMN MODEL (AND VICE-VERSA)




13. *this*  
14. *these*  
15. *that*



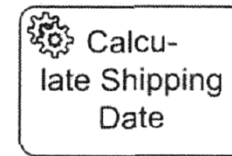
13. *this*  
14.1. If it is true ...  
14.1.1. *these*  
14.1.2. *other* → 15  
14.2. If it is false...  
14.2.1. *those*  
14.2.2. *further*  
15. ...



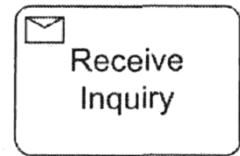
13. *this*  
14.a.1. *these*  
14.a.2. *other* → 15  
14.b.1 *those*  
14.b.2 *further*  
15. Wait for the end of 14.a and 14.b  
...

Note: In case of  : 15. Wait for the end of the ongoing activities in 14.a and 14.b

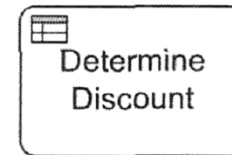
## TASK TYPES



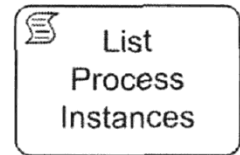
Service Task



Receive Task



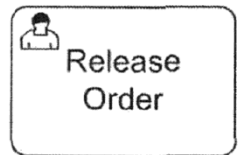
Business Rule Task



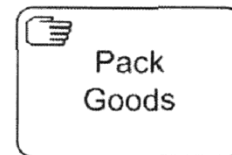
Script Task



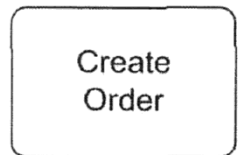
Send Task



User Task



Manual Task



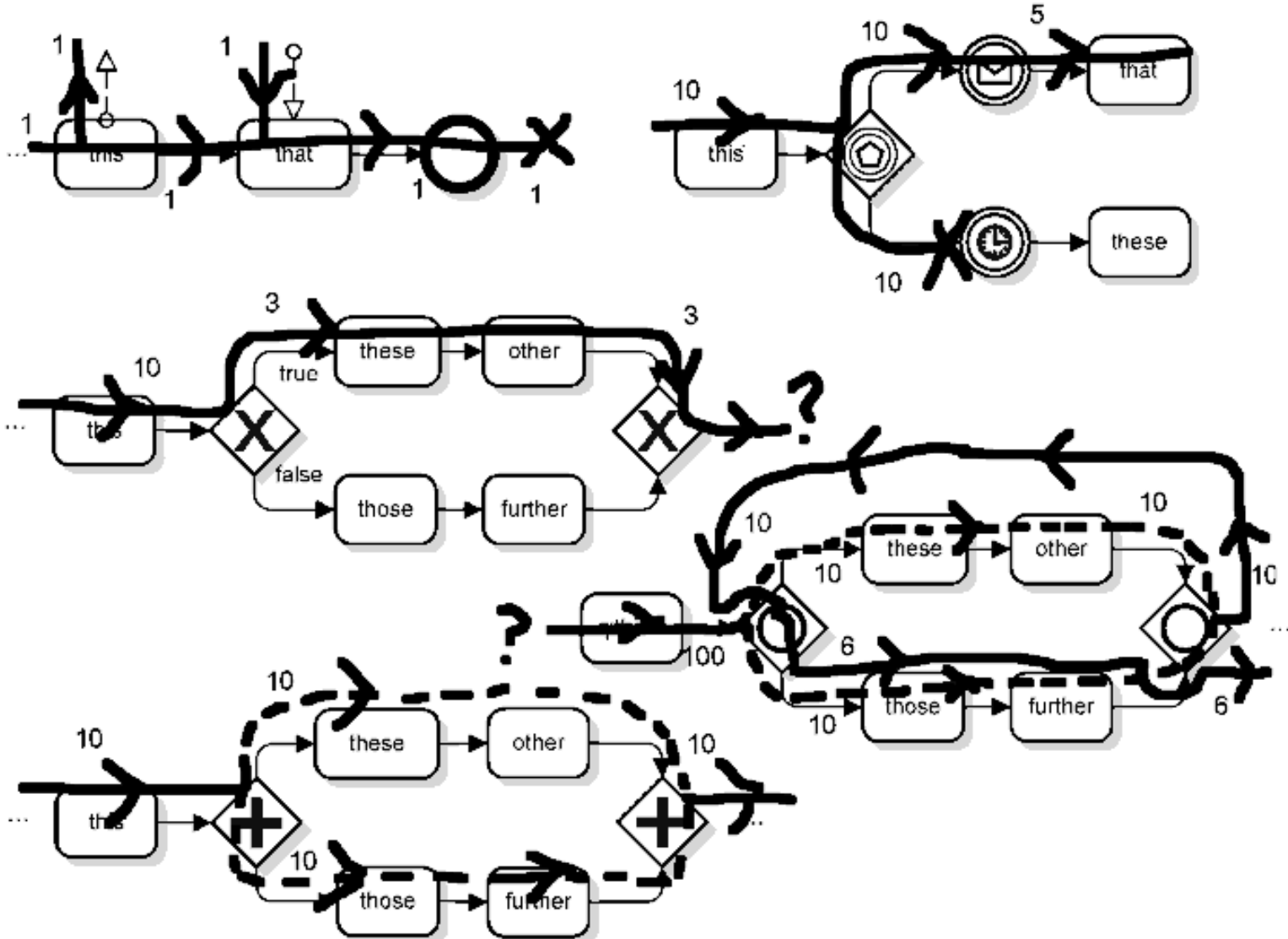
Abstract Task

## Semi-formal notation

- I. A *sequential* numbering is used to express a sequential order of execution.
- II. A new *level of numbering* is used to express a flow internal to some branch of the control flow.
- III. A new *decimal numbering* level is used to express exclusive branches (e.g. \*.1 and \*.2). In this case, each branch starts with the if keyword.
- IV. A new *alphabetic numbering* level is used to express parallel or inclusive branches (e.g. \*.a and \*.b).
- V. A joining parallel gateway is described as *wait for the end of* \*.a and \*.b
- VI. A joining inclusive gateway is described as *wait for the end of the ongoing activities in* \*.a and \*.b
- VII. A jump to a specific sentence is denoted by an arrow followed by the number of the sentence: → 14
- VIII. The End of the process is mandatory, and denoted by “→ End” (local End) or by a jump to the global end.
- IX. The task type is reported between brackets at the end of the sentence.

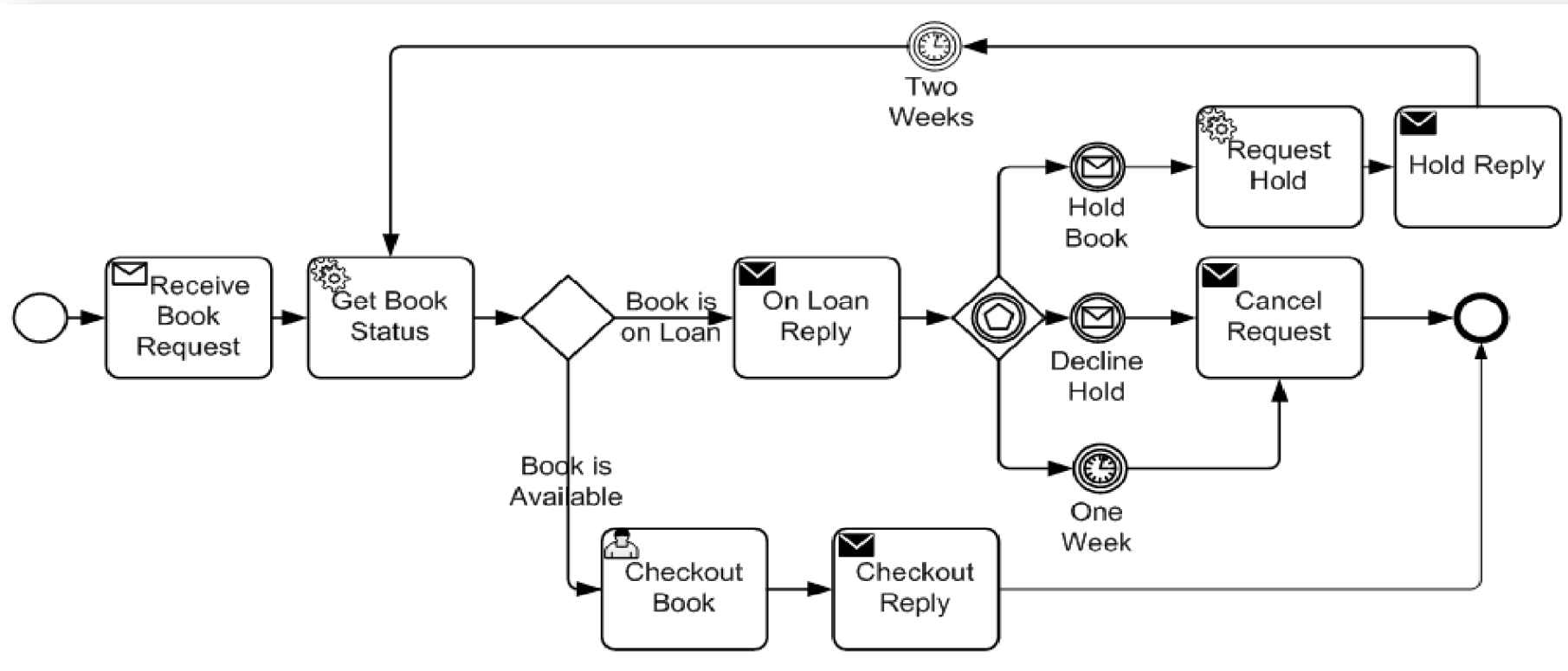
- Scenarios are represented by a solid directed arrow. A dashed arrow means parallel (“twins”) flows.

SAMPLE REPRESENTATION OF SCENARIOS

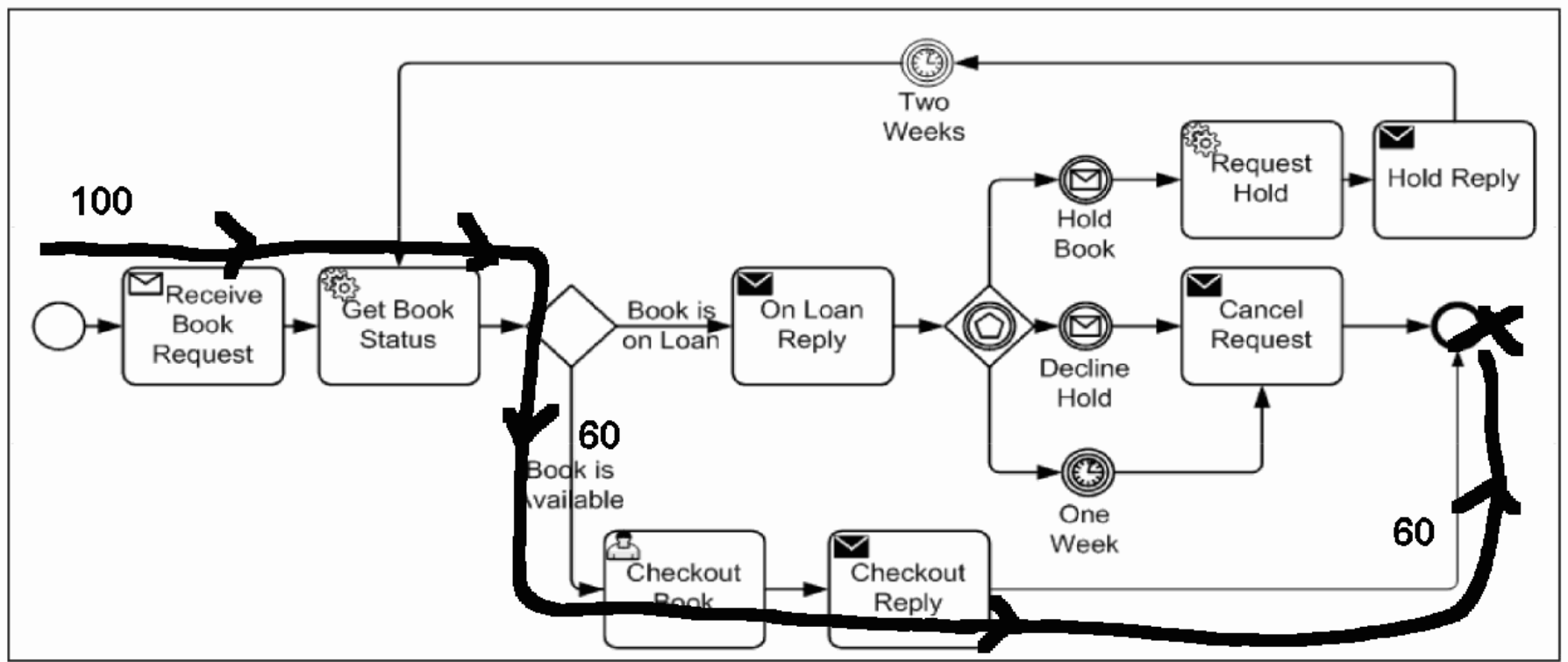


## Library

- Given 100 starting tokens, determine the number of ending tokens for each scenario (path), considering the following branching proportions at each gateway: book is available (60%), hold book (25%), decline hold (25%).

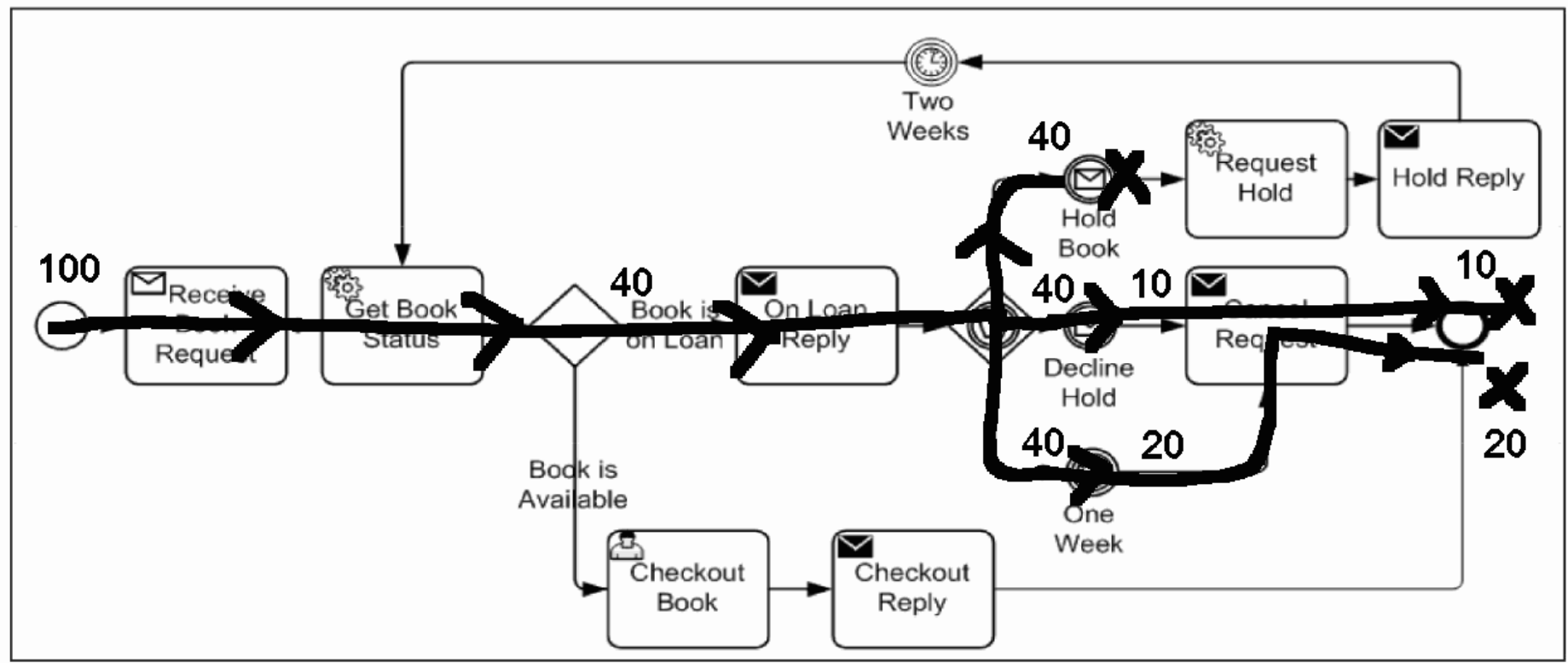


S1) AVAIL:  $100 \times 0.6 = 60$ .



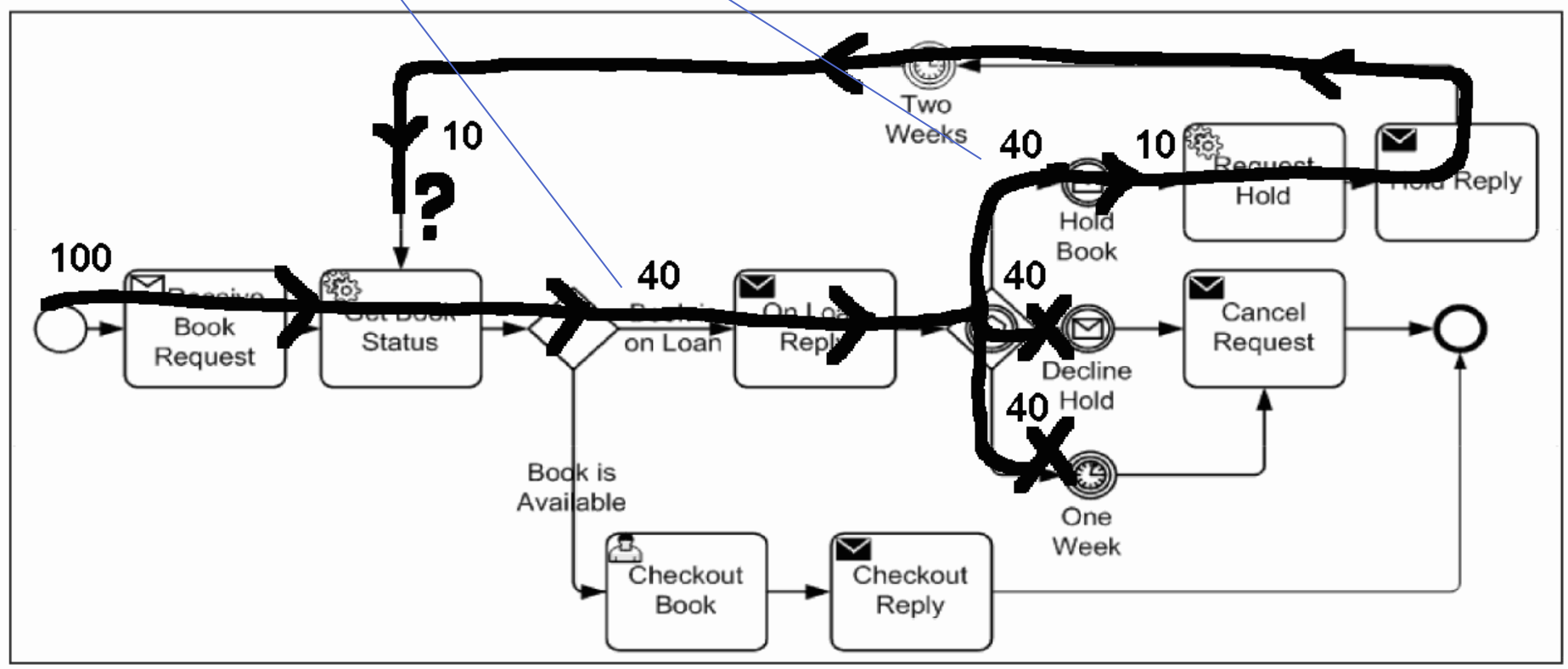
S2) NO AVAIL & ONE WEEK:  $100 \times 0.4 \times 40 \times 0.5 = 20$ .

S3) NO AVAIL & DECLINE:  $100 \times 0.4 \times 40 \times 0.25 = 10$ .



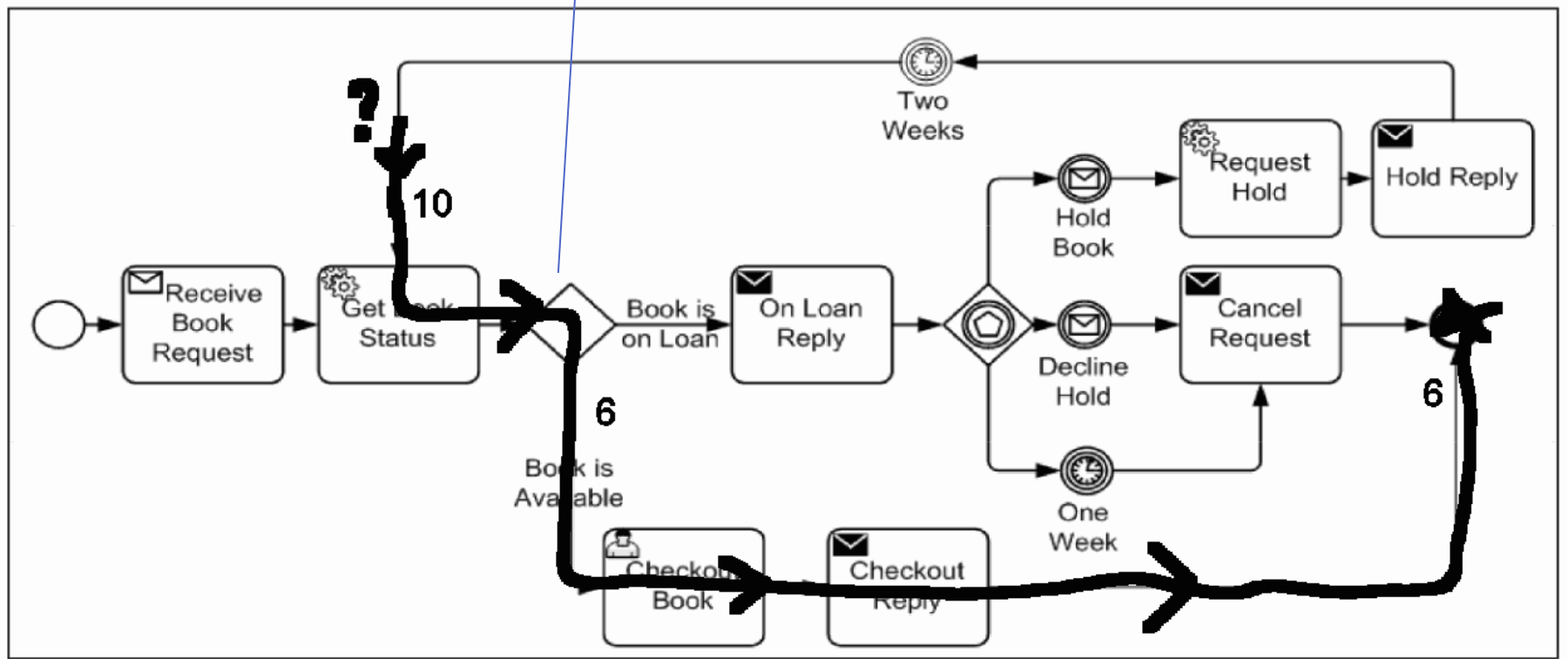
For a better clarity, at the exam represent each scenario (S2, S3) on a different sheet.

S4) NO AVAIL & HOLD & AVAIL:  $100 \times 0.4 \times 0.25 \times 10 \times 0.6 = 6$ .





**S4) NO AVAIL & HOLD & AVAIL:  $100 \times 0.4$  &  $40 \times 0.25$  &  $10 \times 0.6 = 6$ .**



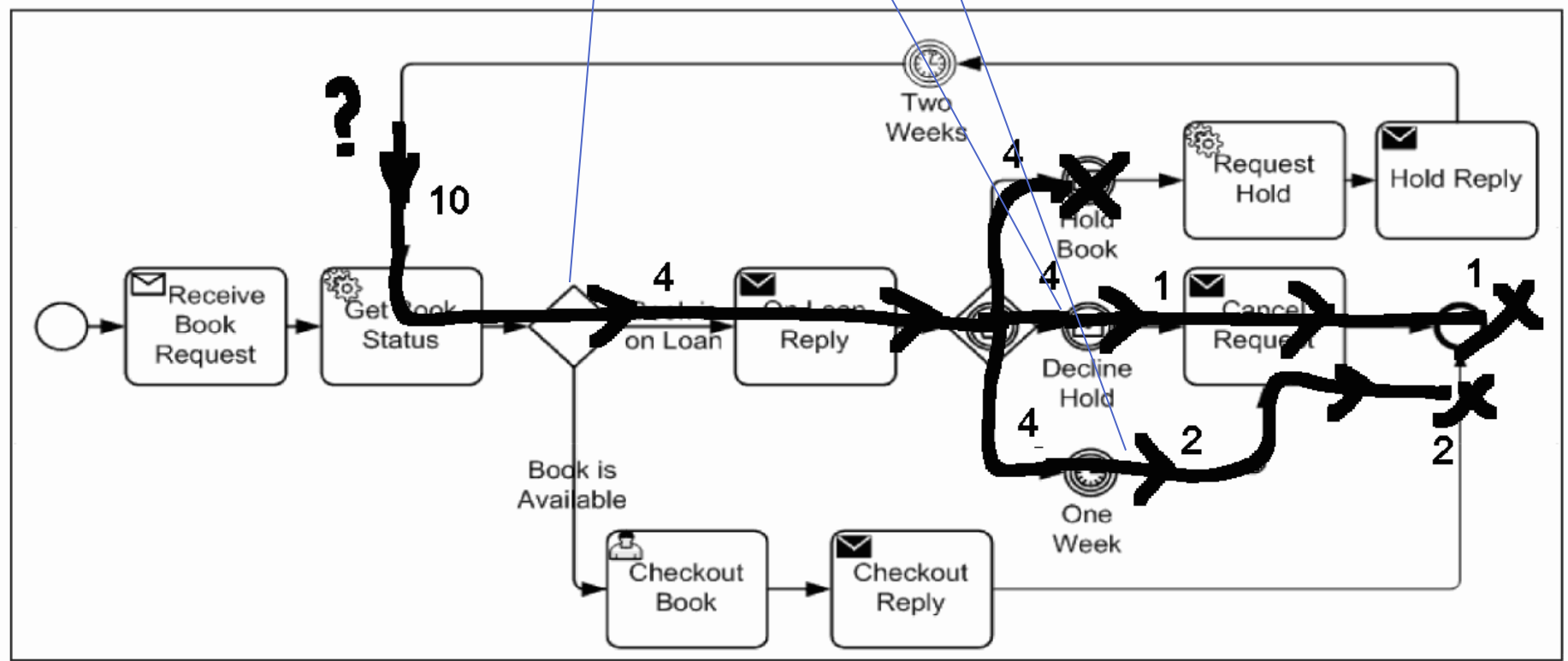
S5) NO AVAIL & HOLD & NO AVAIL & ONE WEEK:

$$100 \times 0.4 \& 40 \times 0.25 \& 10 \times 0.4 \& 4 \times 0.5 = 2.$$

S6) NO AVAIL & HOLD & NO AVAIL & DECLINE:

$$100 \times 0.4 \& 40 \times 0.25 \& 10 \times 0.4 \& 4 \times 0.25 = 1.$$

The first picture of S5,S6 is the same as the first picture of S4. In the following, only the second picture is represented

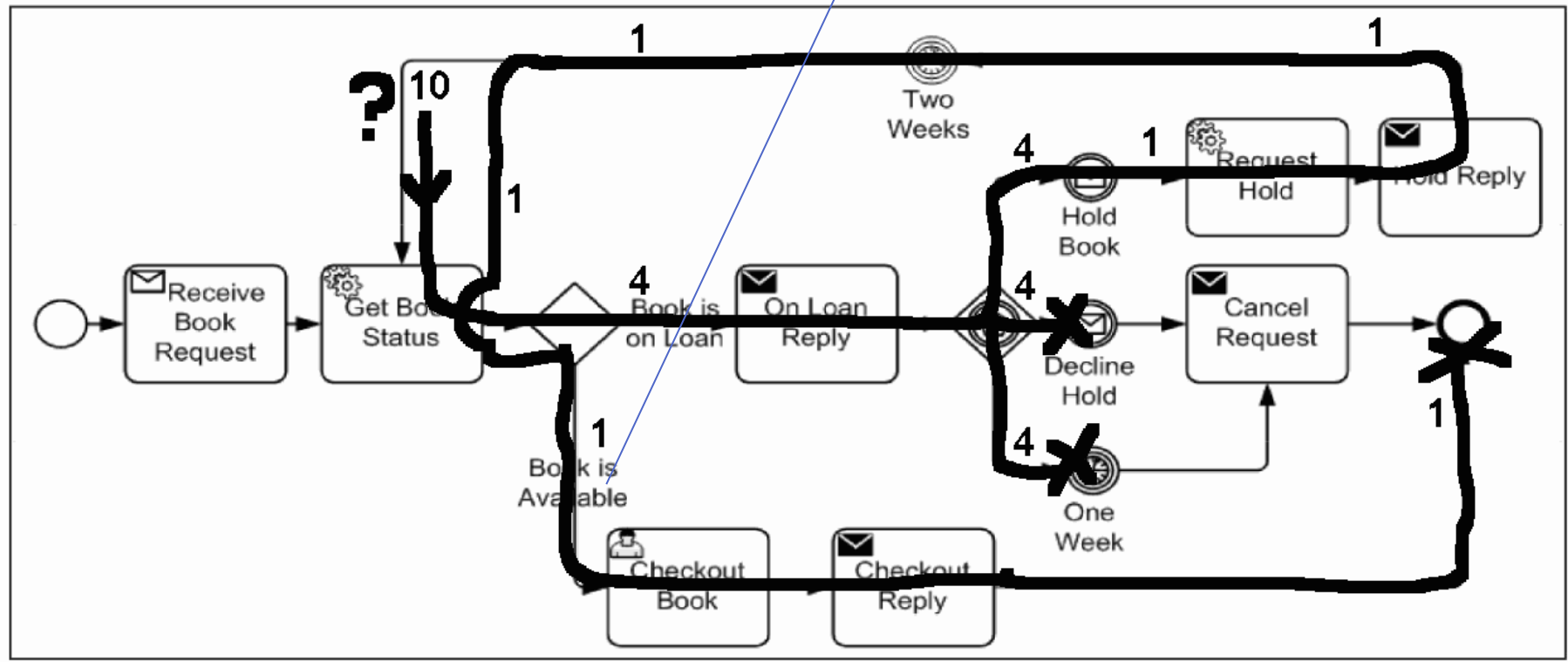


For a better clarity, at the exam represent each scenario (S5, S6) on a different sheet.

S7) NO AVAIL & HOLD & NO AVAIL & HOLD & AVAIL:

$$100 \times 0.4 \& 40 \times 0.25 \& 10 \times 0.4 \& 4 \times 0.5 \& 1 \times 0.6 = 1.$$

The first picture of S7 is the same as the first picture of S4. In the following, only the second picture is represented



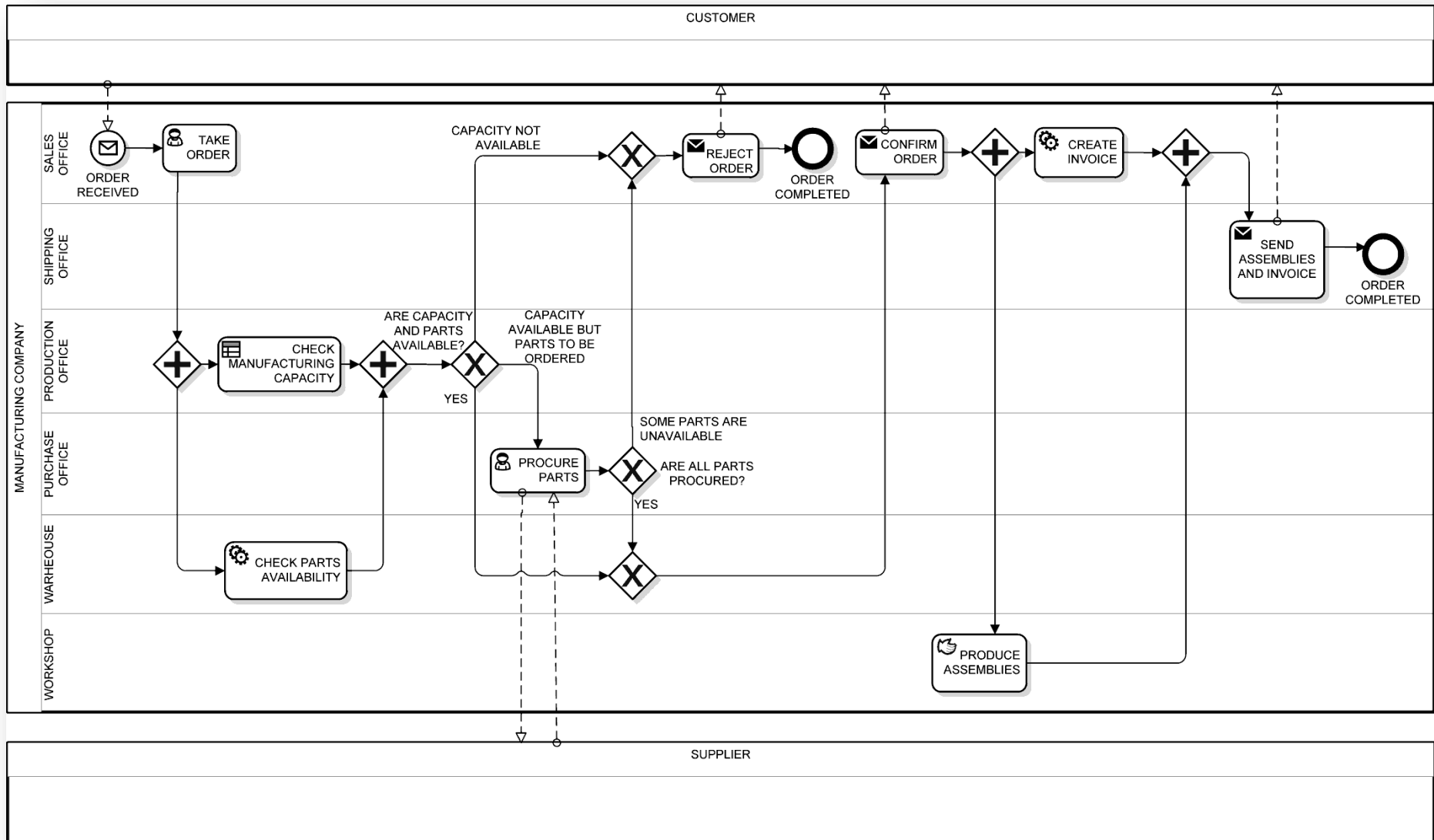
$$\text{TOTAL TOKENS: } S1+S2+S3+S4+S5+S6+S7 = 60 + 20 + 10 + 6 + 2 + 1 + 1 = 100.$$

Example: create a handoff diagram

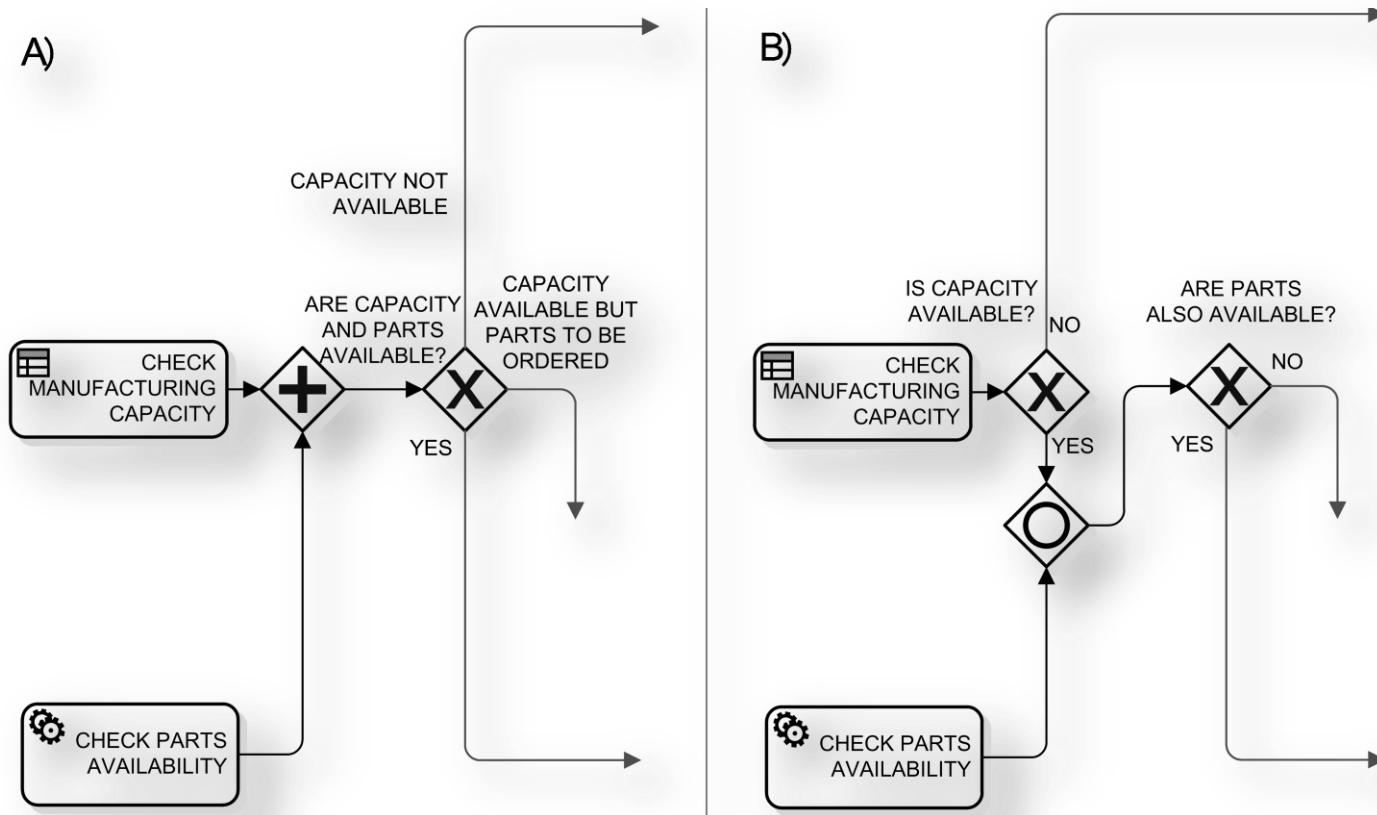
### *Manage orders in a manufacturing company*

Order processing in a manufacturing company takes place after an order has been received from a **customer**. The order is first taken by the **sales office**. Both manufacturing capacity and parts availability are then checked, via appropriated business rules and an automated information service, by the **production office** and the **warehouse**, respectively. Subsequently, an order rejection is sent to the **customer** by the **sales office** if capacity is not available. Otherwise, if parts are also available, an order confirmation is automatically sent to the **customer** by the **sales office**. Therefore, both assemblies and invoice are produced, by human operatives at the **workshop** and by the **sales office** via an automated information service, respectively. Finally, assemblies and invoice are sent to the **customer** by the **shipping office**. In contrast, if there are parts to be ordered, the **purchase office** procures such parts, purchasing them from **suppliers**, so as to allow the aforementioned process to continue once such parts are available. However, if some parts are still unavailable (they cannot be procured), a rejection is then sent to the customer by the **sales office**.

## The BPMN model of the manufacturing company at the handoff level



## Different modeling of the decision nodes



- B is formally more efficient than A, because it does not require tasks synchronization when capacity is not available: it is a good executable model
- A is simpler than B in terms of layout: it is a good handoff model, especially if *to check manufacturing capacity* is slower than *to check parts availability* (which makes the two models equivalent in terms of efficiency)