UML 2.0

Interaction Diagrams

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- Class diagrams (+ OCL constraints)
- Package diagrams
- Component diagrams
- Deployment diagrams
- Use case diagrams
- State diagrams
- Activity diagrams
- Interaction diagrams

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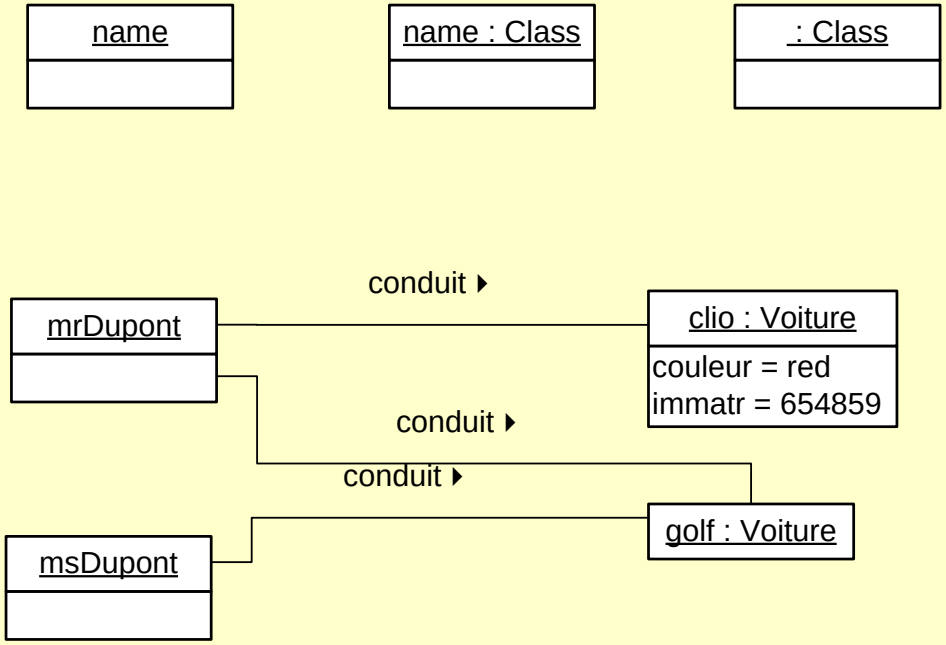
- Package diagrams
- Component diagrams
- Deployment diagrams
- ✓ Use case diagrams
- State diagrams
- Activity diagrams
- ✓ Interaction diagrams: today!

Recall: Class Diagrams

- Each UML diagram models a different point of view over the same system
- Example: Class Diagrams
  - Goal: to describe the static structure of the system, i.e. the system from a *spatial* point of view
  - Specifications: definition of classes, attributes, operations and relationships among classes
  - Class: definition domain for a set of objects which share the same characteristics
  - Relationships: aggregation, composition, generalization…

Recall: Object Diagrams

- Represent particular instances of class diagrams
- Snapshot of the system at a given point in time
- Graphical elements:



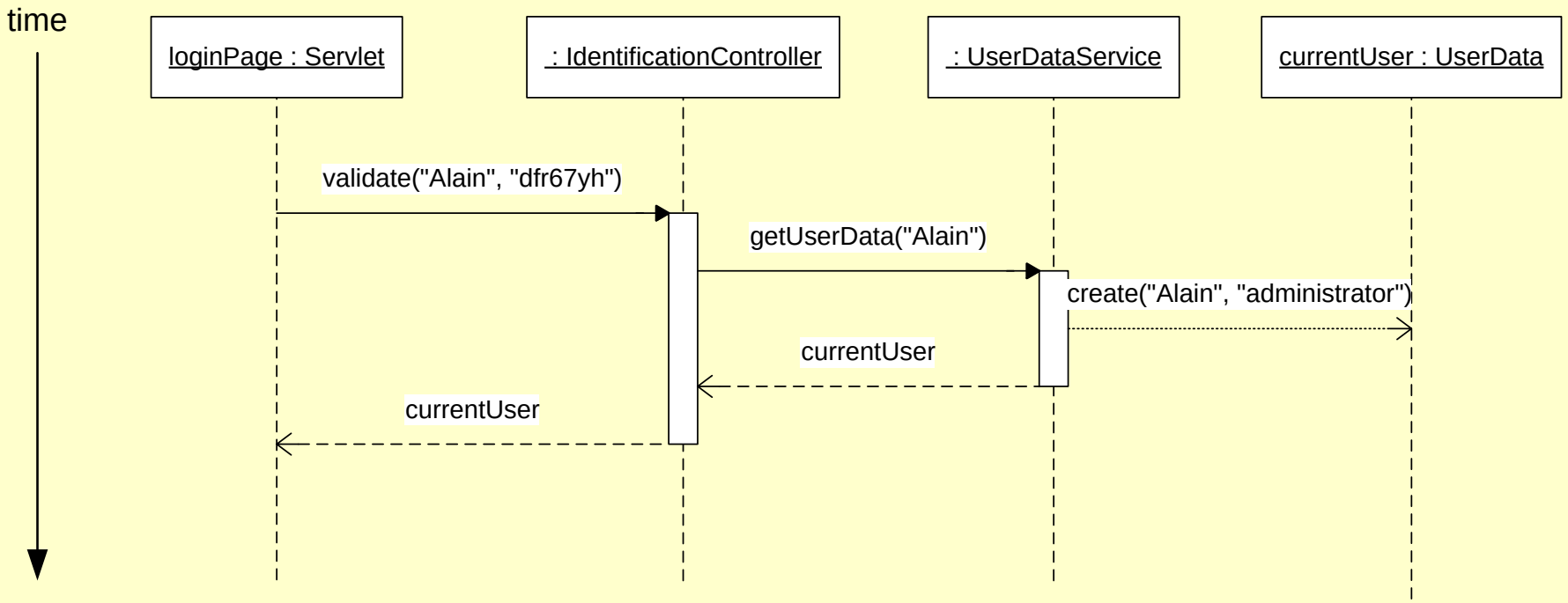
Recall: Use Case Diagrams

- Use Case Diagrams
  - Goal: describe the system from the users' point of view, i.e. identify the needs
  - Specifications: identifying actors, use cases, and the relationships among them
  - Use case: a feature of the system from the point of view of an external user
  - Relationships: generalize, include, extend

Interaction Diagrams

- Describe the dynamic structure of a system
- Represent sequences of events involving the objects of a system
- Model communication protocols between objects
  - Show interactions among the objects in a given situation
  - Sequence diagrams: interactions from “temporal” point of view (time matters)
  - Collaboration diagrams: interactions from “spacial” point of view (space matters)

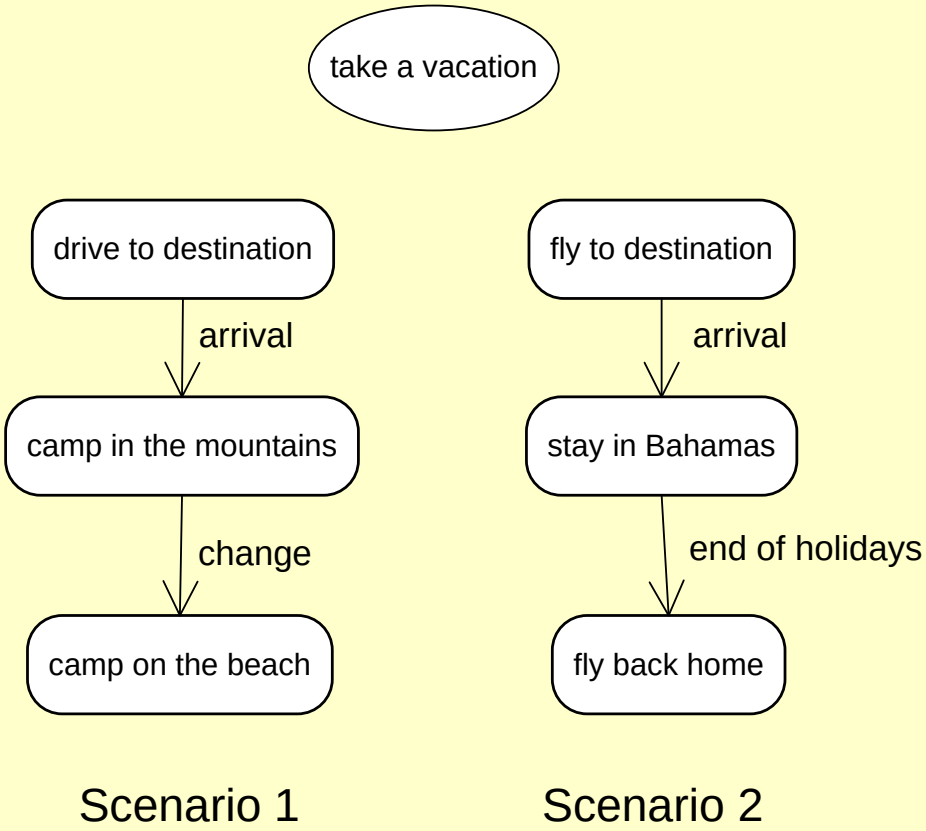
Sequence Diagram: an example



From Use Cases to Interaction Diagrams

- Use cases and Scenarios
  - A scenario is an instance of a use case
- Scenarios and Interaction Diagrams
  - Describe the interactions between the objects involved in the scenario

From Use Cases to Scenarios

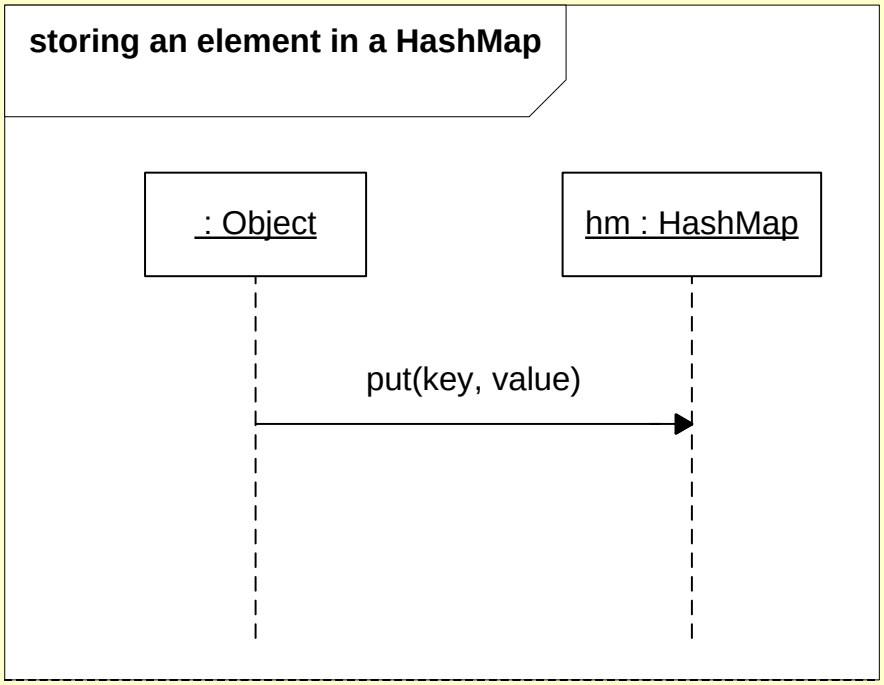


From Scenarios to Interaction Diagrams

- The interaction diagram shows how the objects involved in the scenario interact with each other
- An interaction describe the dynamic behavior of objects
- Two points of view are possible
  - Time (sequence diagram)
  - Space (collaboration diagram)
- The only possible way for an object A to interact with object B is to send a message.
  - Class A { B.sendMessage()}

Actors of an Interaction

- The actors of an interaction are instances of objects
- They are represented by objects lifelines
- The class of the objects can be specified or not

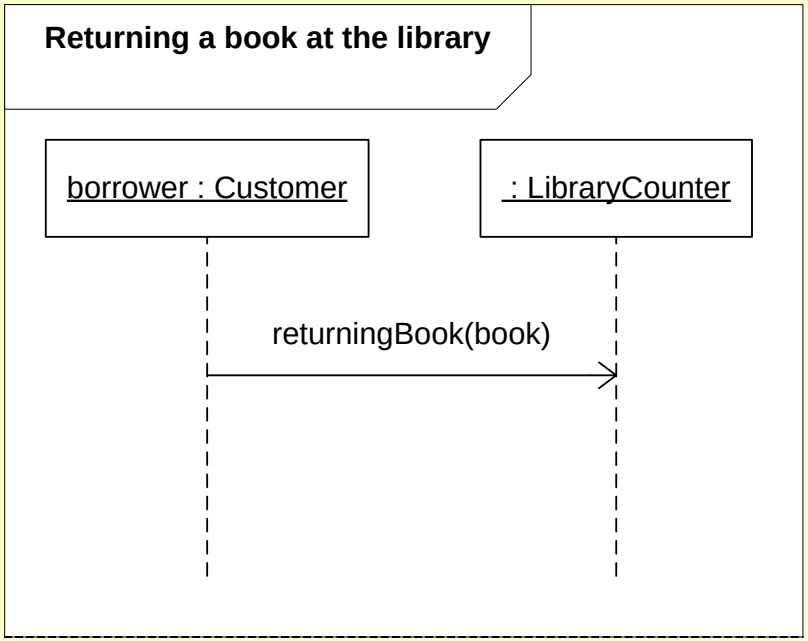


Messages

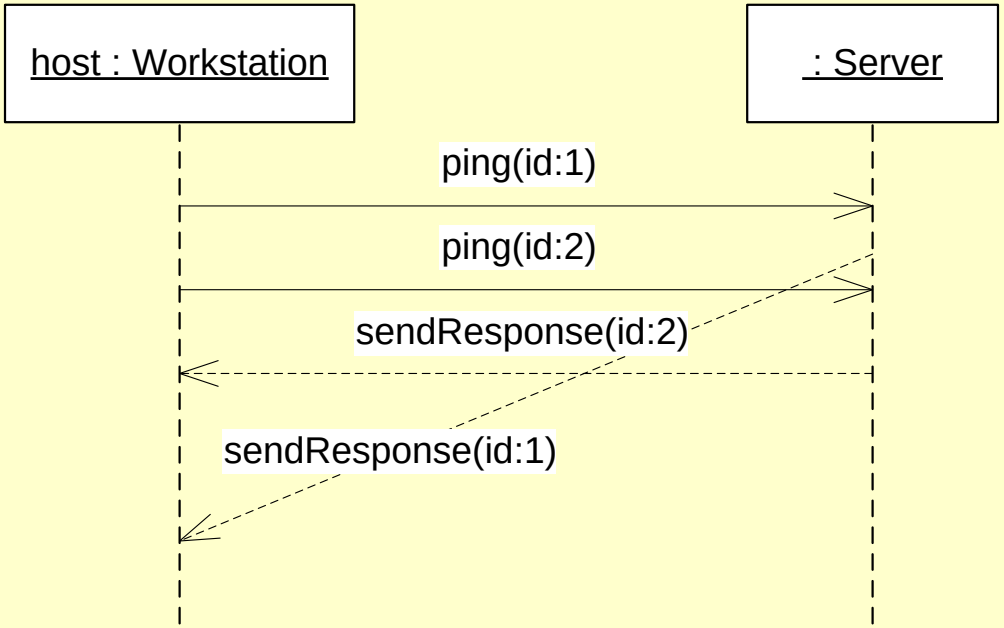
- Messages from an object to another are represented as arrows from the sender to the receiver
- Different shapes correspond to different types of messages:
  - Asynchronous: thick line with open arrow head
  - Synchronous (i.e. operation calls): filled arrow head
  - Reply message: dashed line
  - Object creation: dashed line with open arrow
  - Lost: a small circle at the arrow end of the line
  - Found: a small circle at the origin of the line

Asynchronous Messages(1)

- The sender does not stop and wait for the receiver to process the message and respond

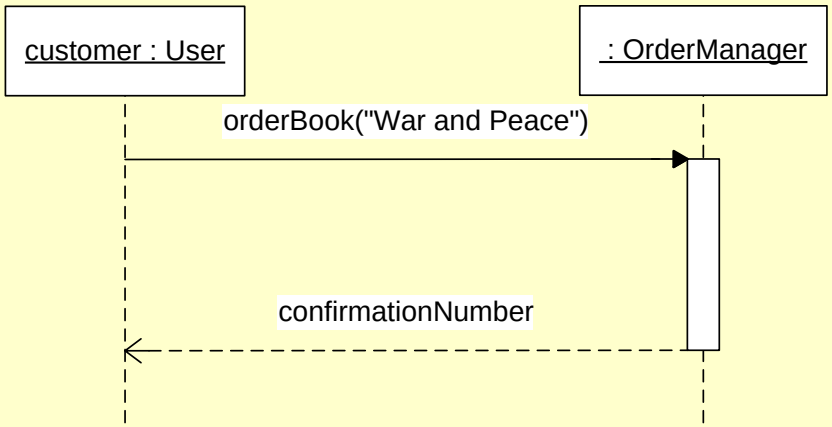


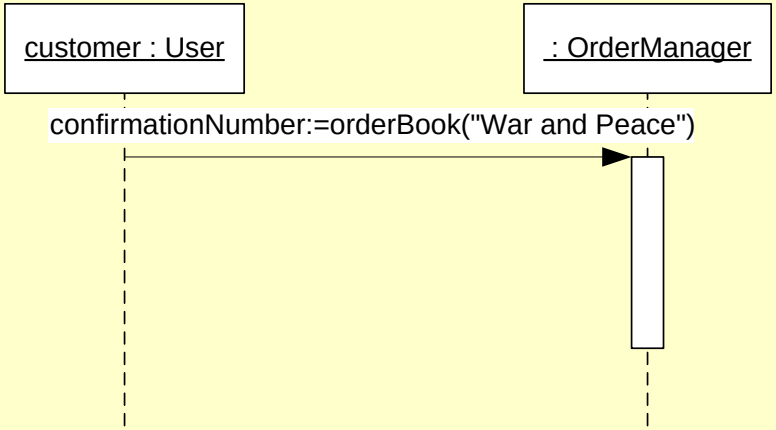
Asynchronous Messages(2)



Synchronous Messages

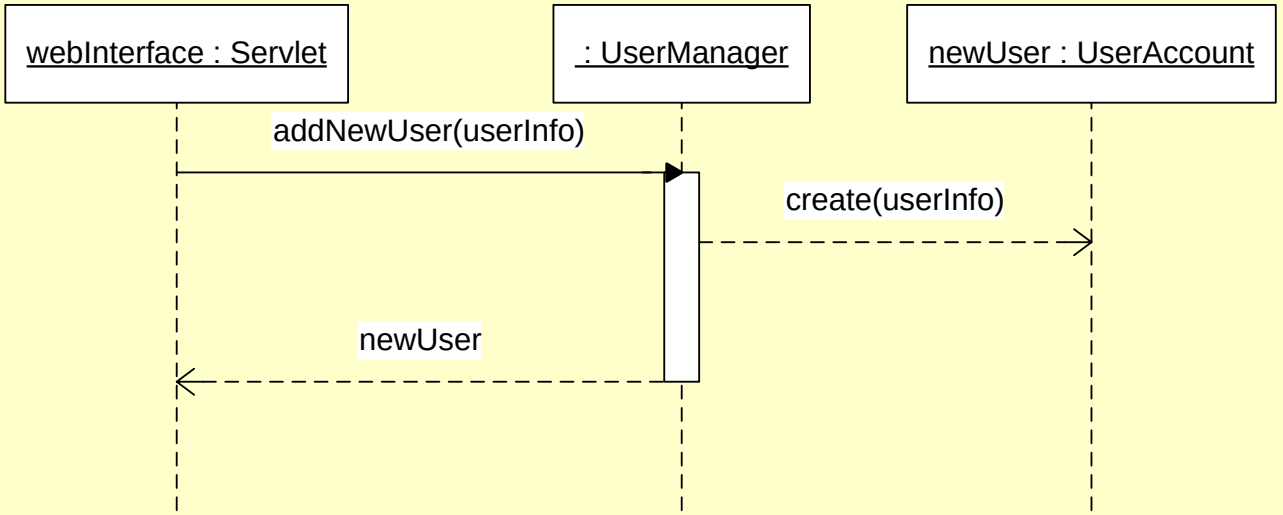
- The sender stops and waits for the receiver to process the message and respond
- Method calls are (usually) synchronous messages
- The value returned is represented either by a dashed arrow, or specified as the return type of the message





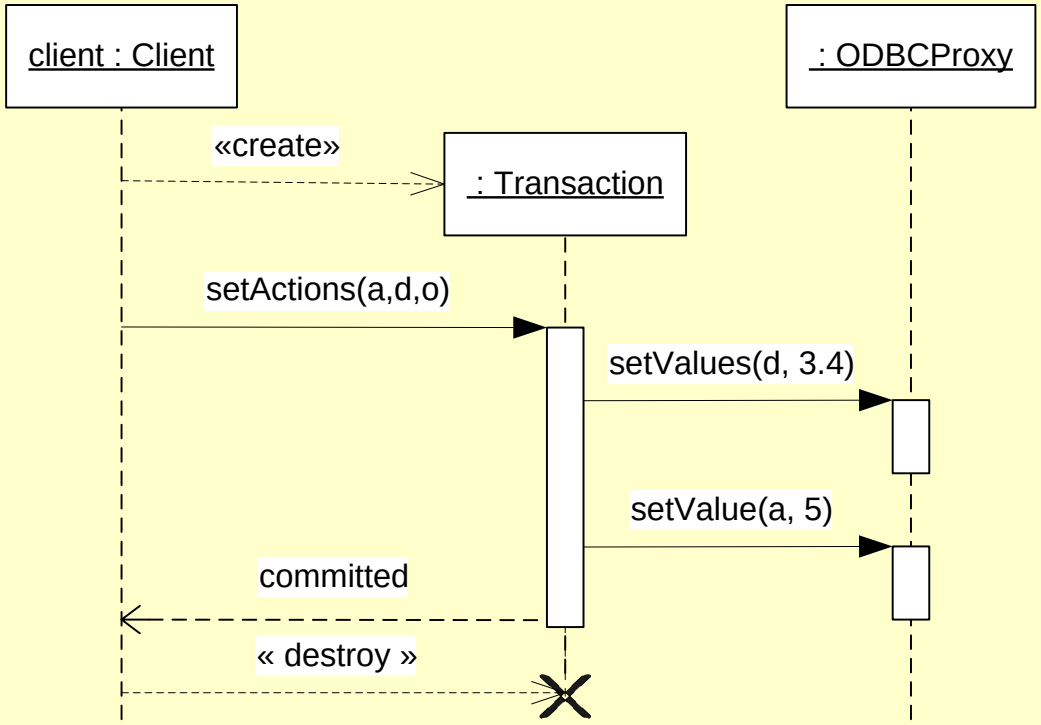
Creation messages

- Special messages provoking the instantiation of a class



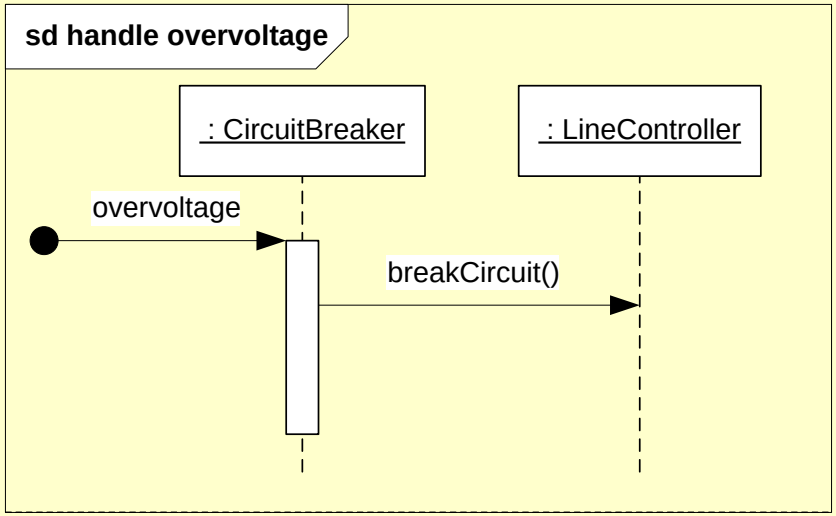
Destroy messages

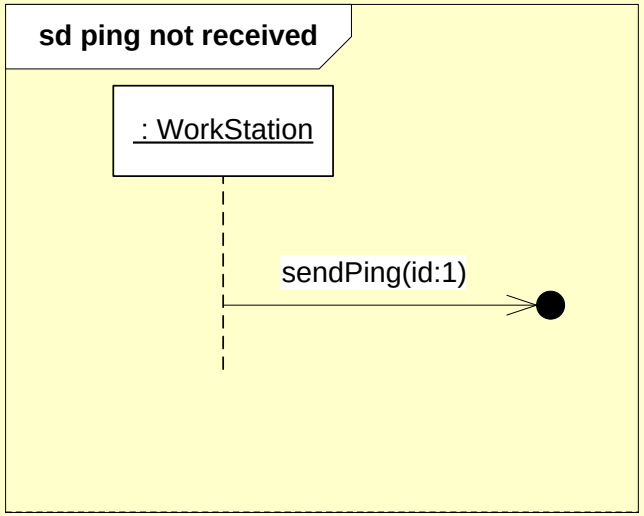
- Messages provoking the dismissal of an object



Lost & Found Messages

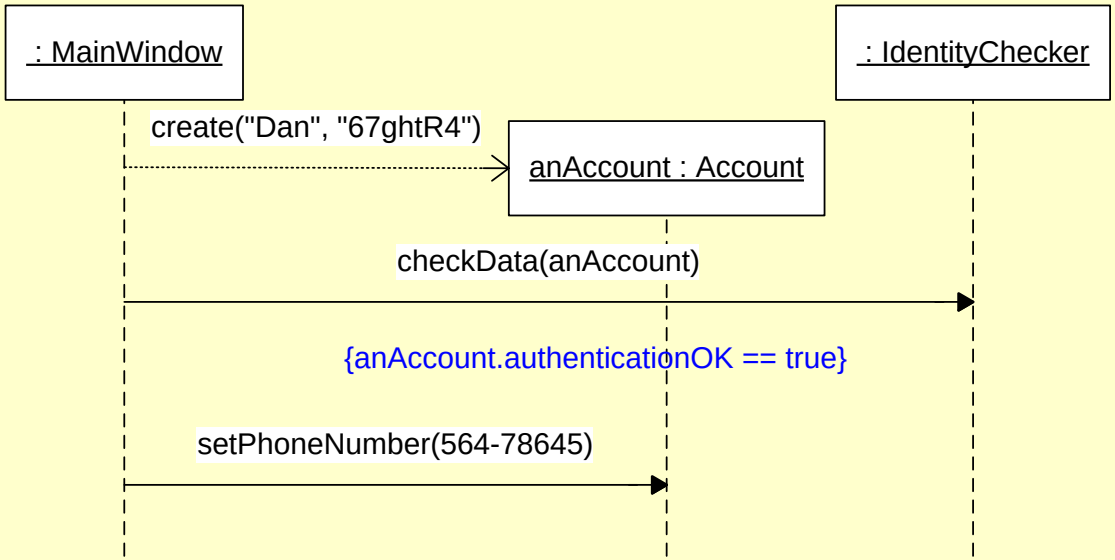
- Found message: the sender is unknown/unspecified
- Lost message: it never reached the receiver
- Lost/found are relative notions





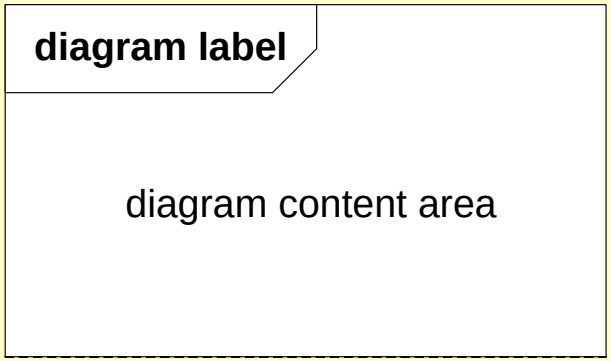
State Invariants

- State Invariants: conditions that must be true from a certain point onward



Frames

- Frames are named interaction fragments
- Special operators exist in order to specify special conditions for its execution (e.g. exclusive, alternative, conditional, parallel…)
- Introduced for the first time in UML 2.0 (they don't exist in UML 1.x)

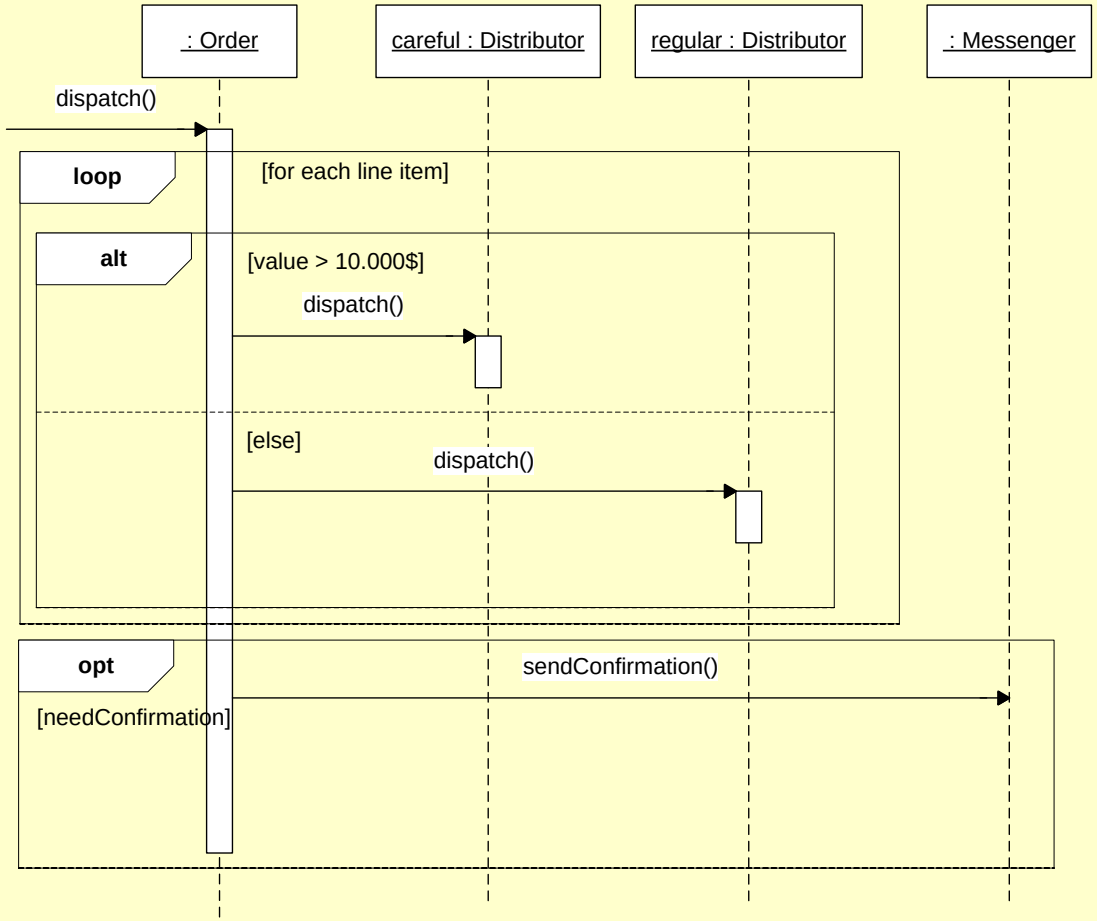


Frames operators

- **sd**: sequence diagram, used to surround and name an entire sequence diagram
- **alt**: alternative multiple fragments, only the fragment whose condition is true will execute
- **opt**: optional, if the condition is true the fragment will execute (equivalent to an Alt with only one trace)
- **par**: parallel, each fragment will run in parallel
- **loop**: the fragment may execute multiple times, controlled by a guard
- **critical**: critical region, the fragment can have only one thread executing it at once
- **neg**: negative, the fragment shows an invalid interaction
- **ref**: reference, refers to an interaction defined in another diagram

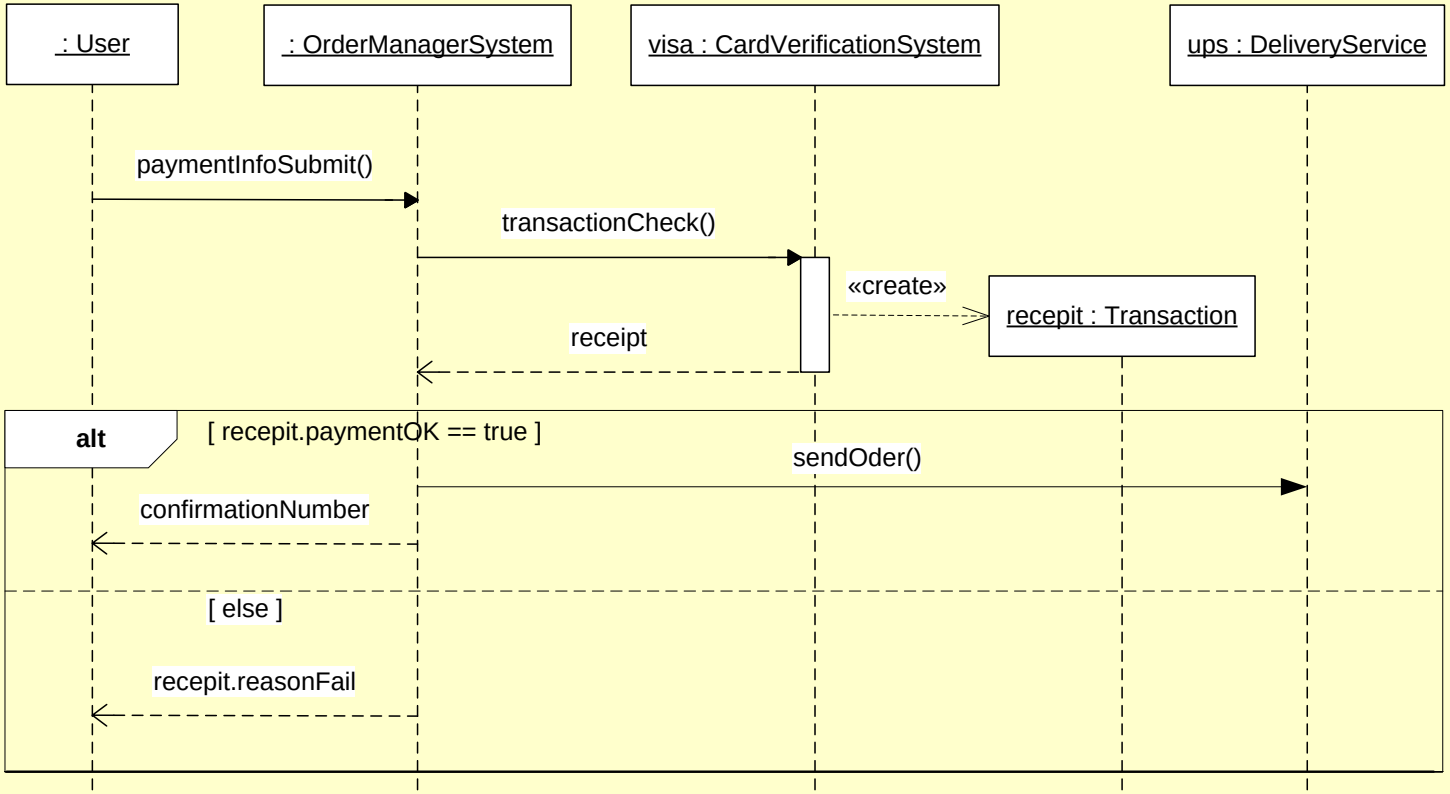
Frames: example

```
procedure dispatch
  foreach (lineitem)
     if (product.value>10k)
          careful.dispatch()
     else
          regular.dispatch()
     end if
   end for
   if (needsConfirmation)
          messanger.sendConfirm()
end procedure
```



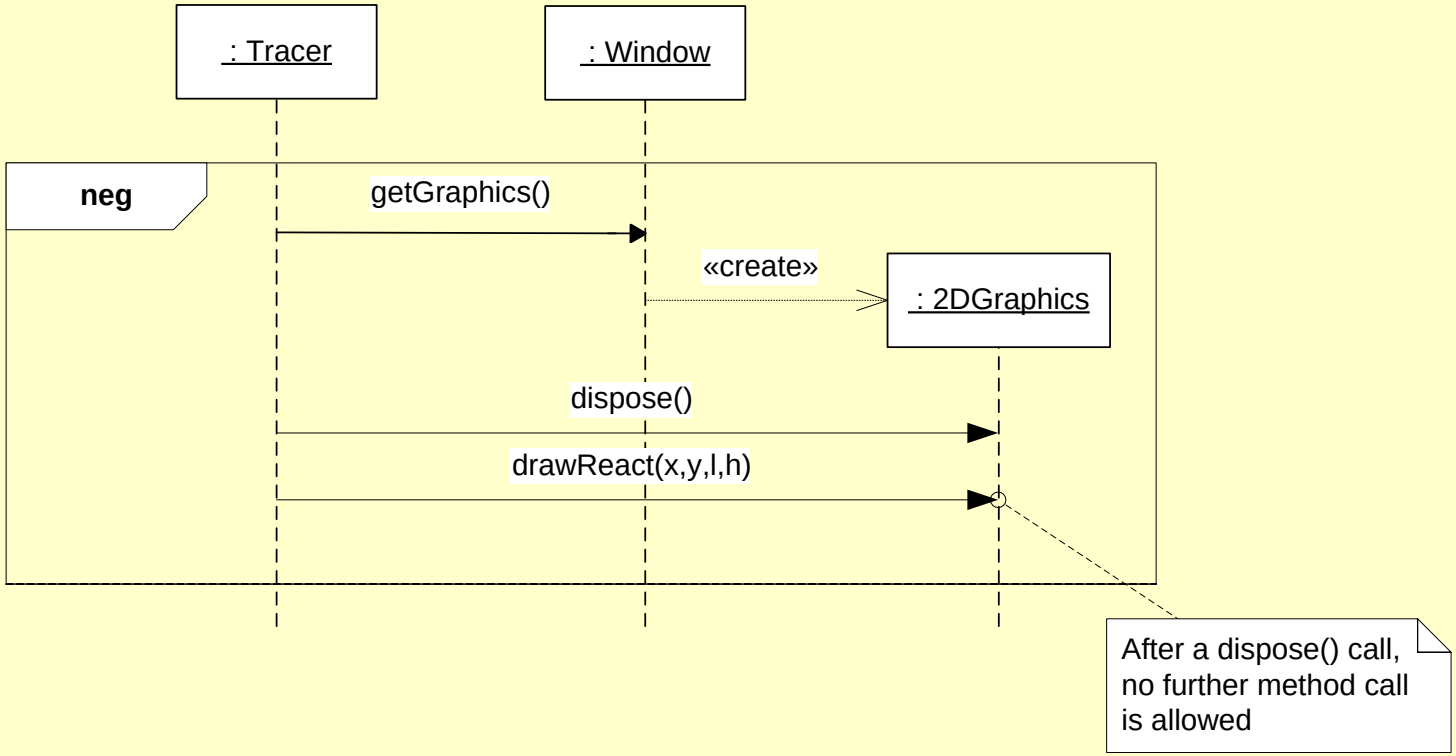
Frames: alt operator

- **alt**: selects one among several sequence fragments depending on a boolean guard



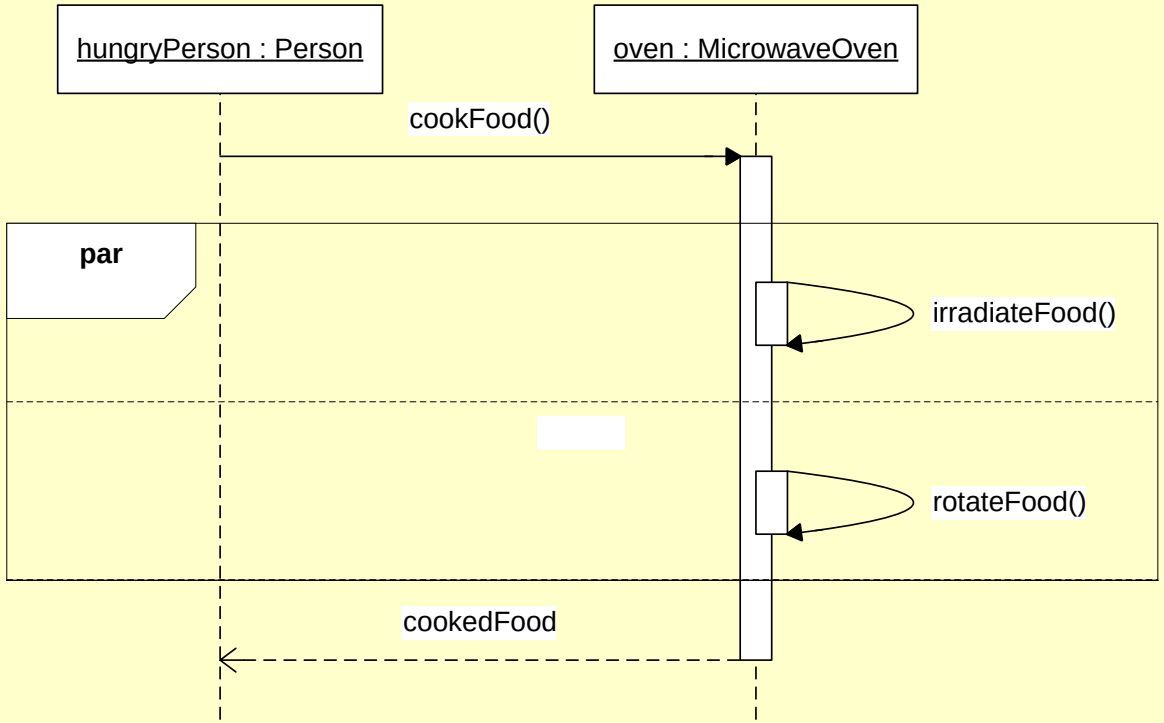
Frames: neg operator

- **neg**: describes an invalid sequence, usually associated with a comment explaining why it is forbidden



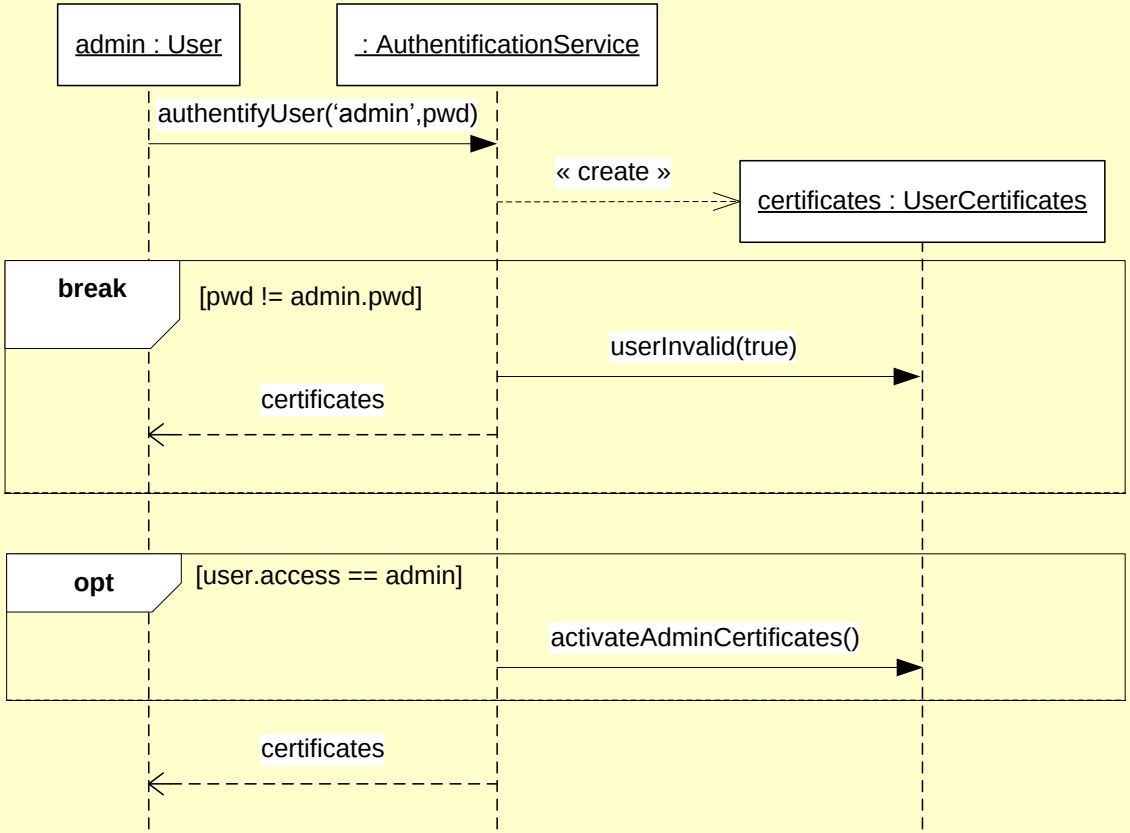
Frames: par operator

- **par**: the two sequences must be executed in parallel



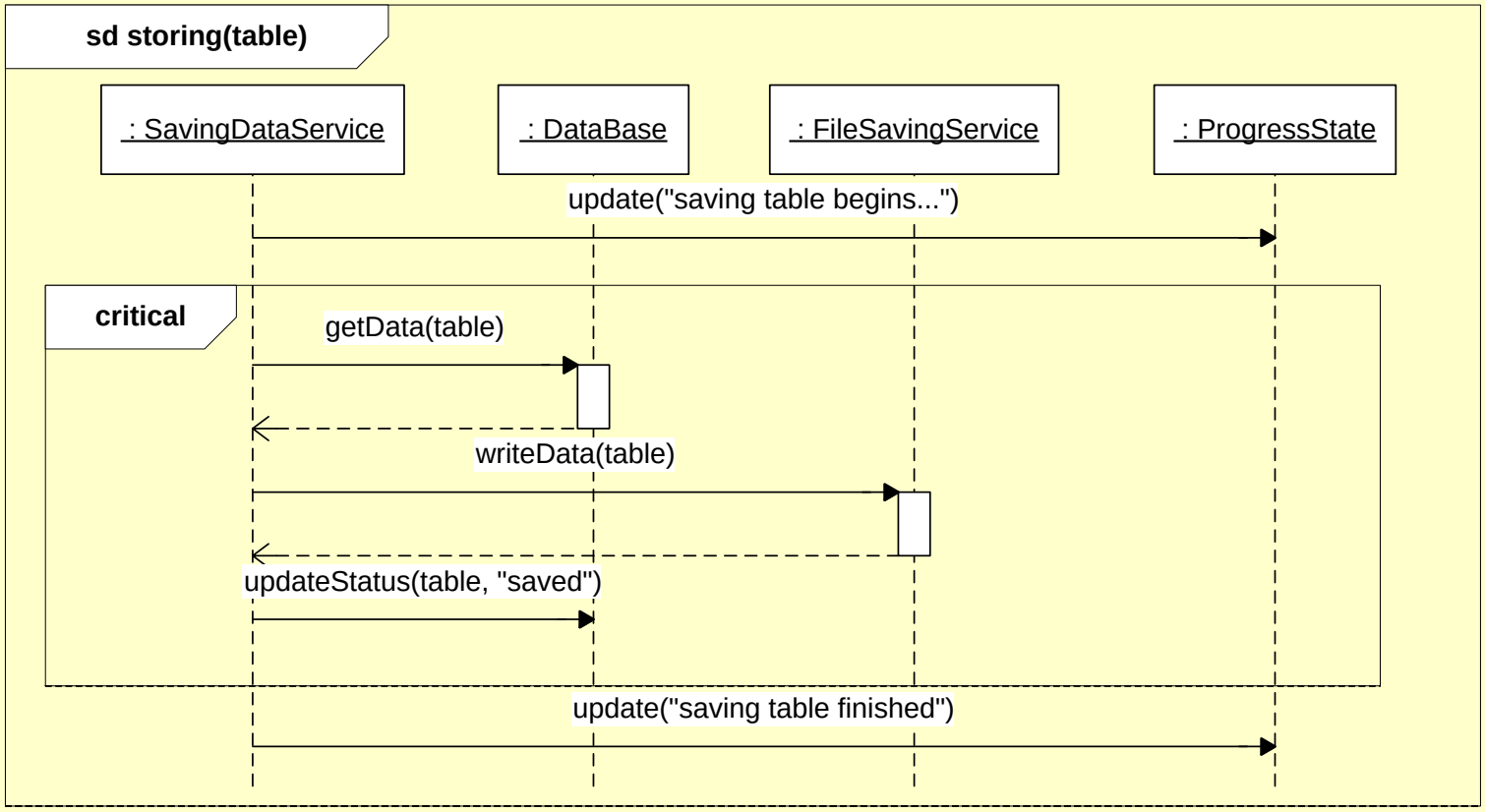
Frames: break operator

- **break:** the fragment is executed and then terminates the surrounding interaction

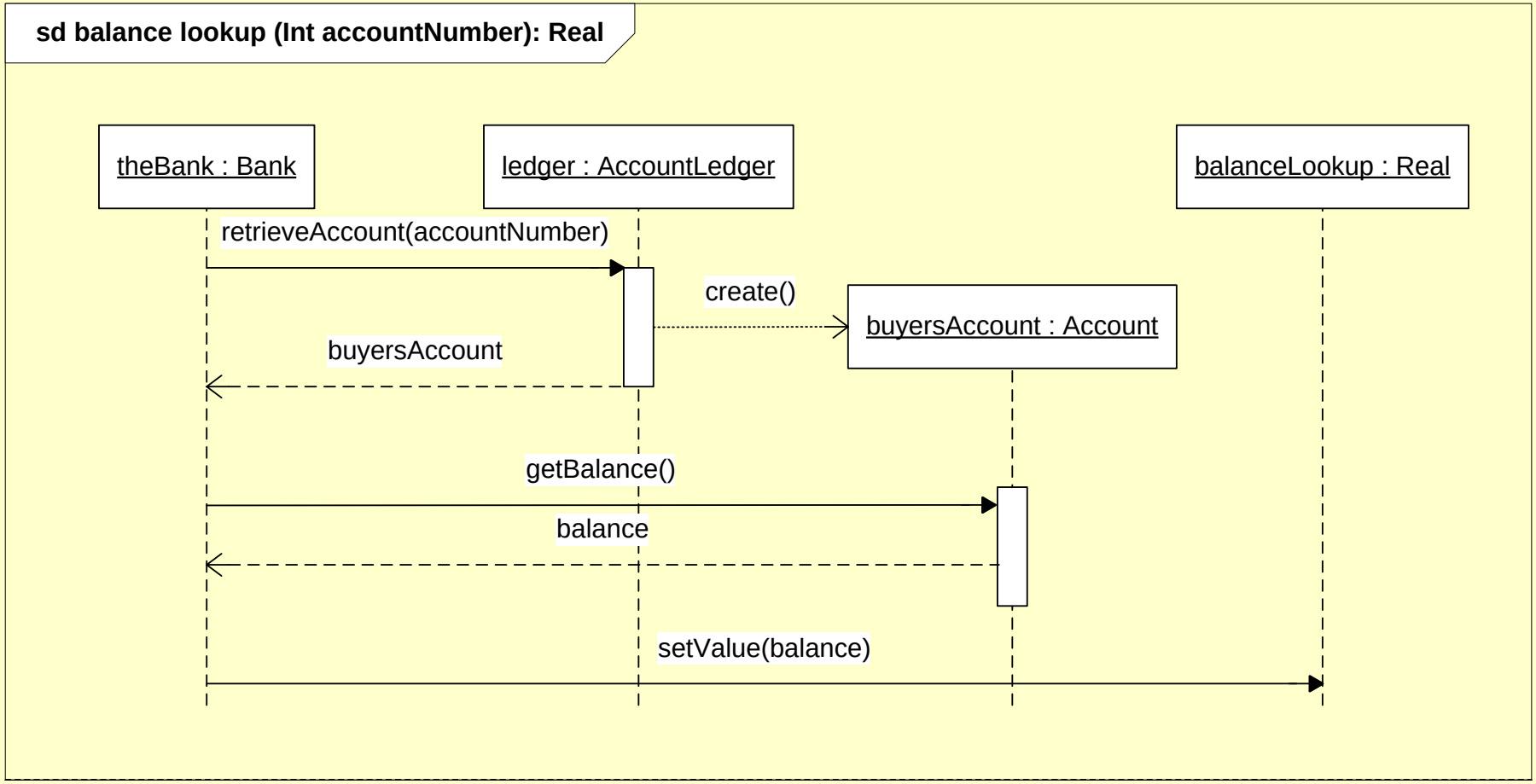


Frames: critical operator

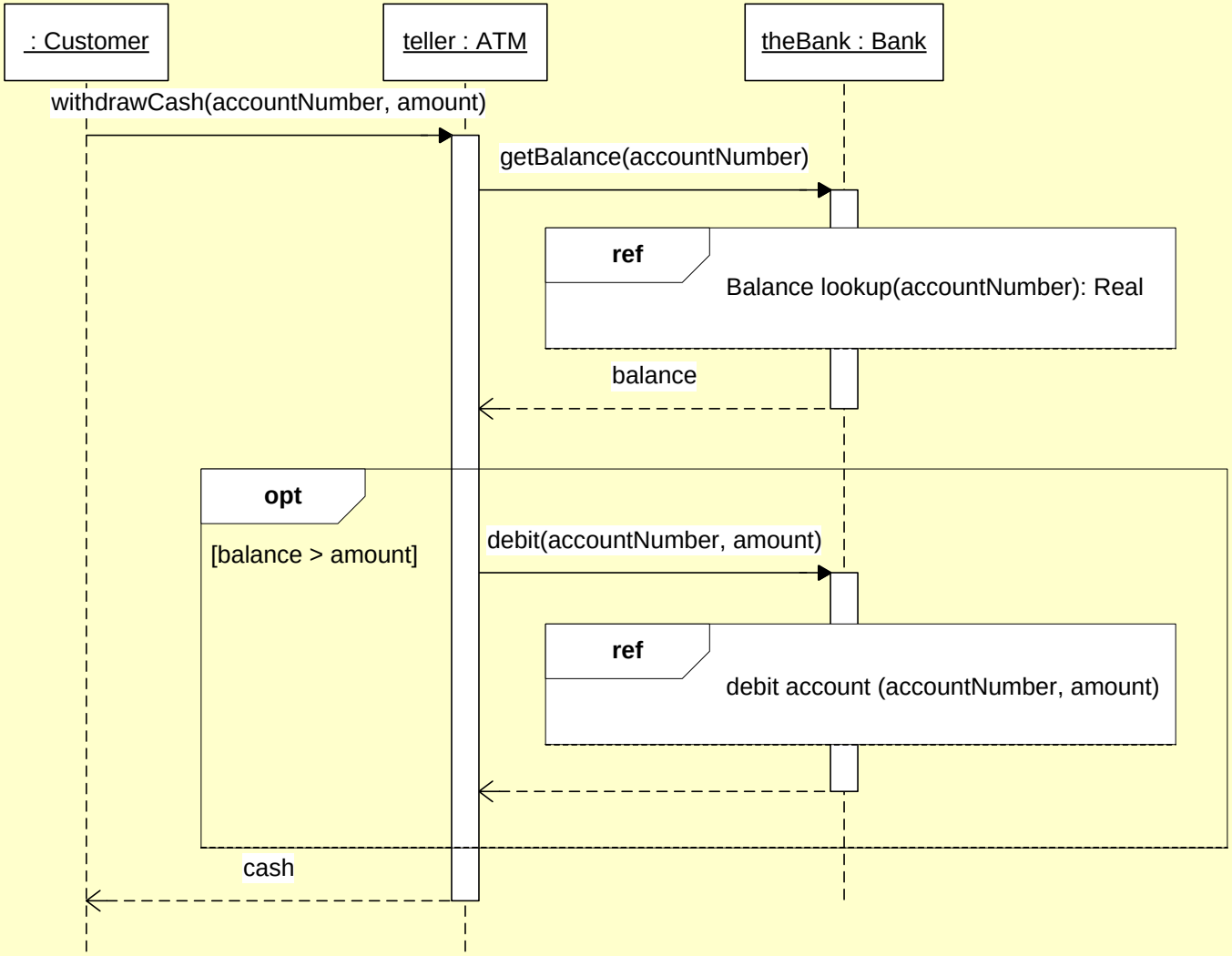
- **critical**: describes a sequence which must be executed as a single operation, i.e. atomically



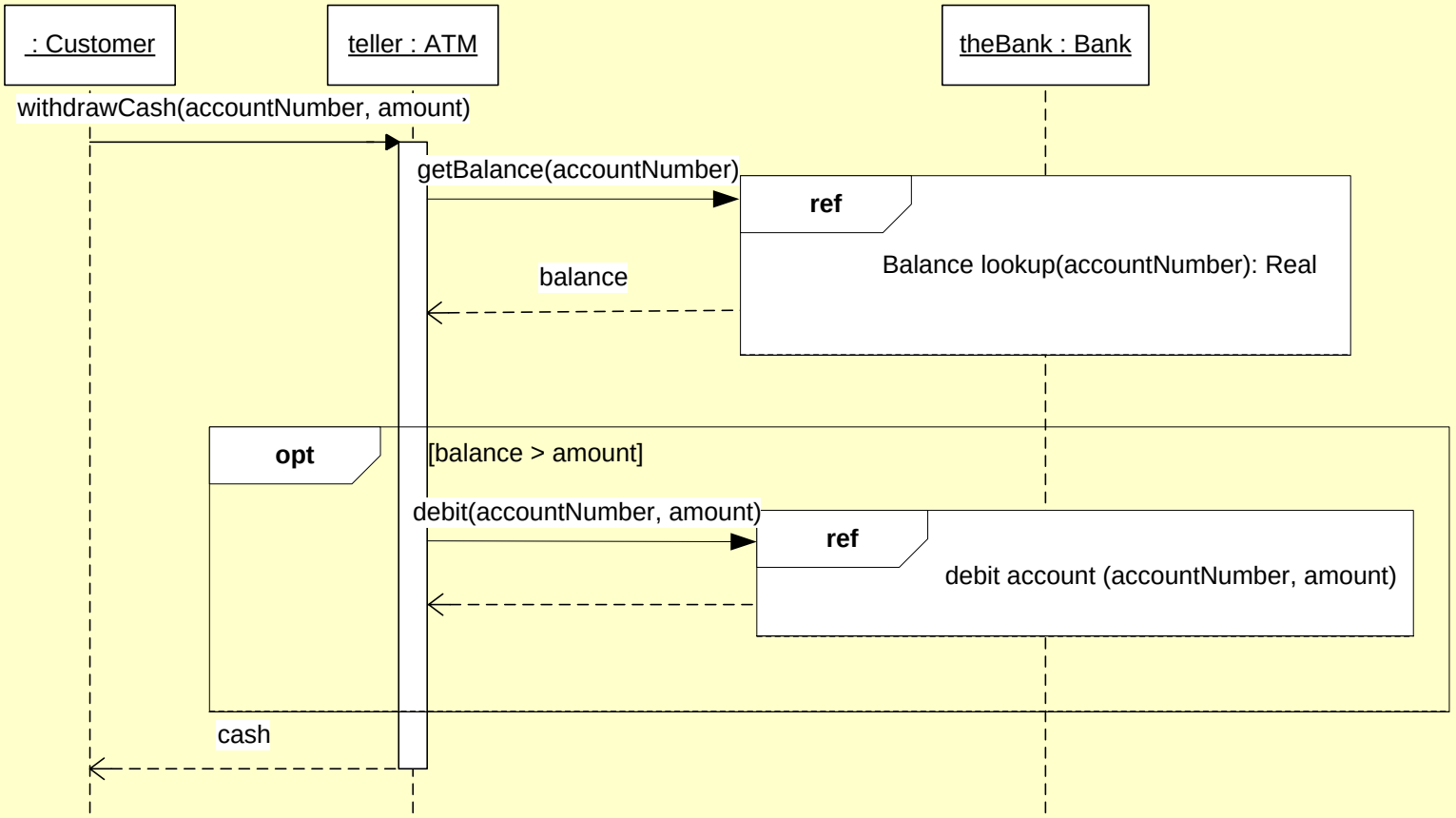
Frames: passing parameters



Frames: referencing other frames



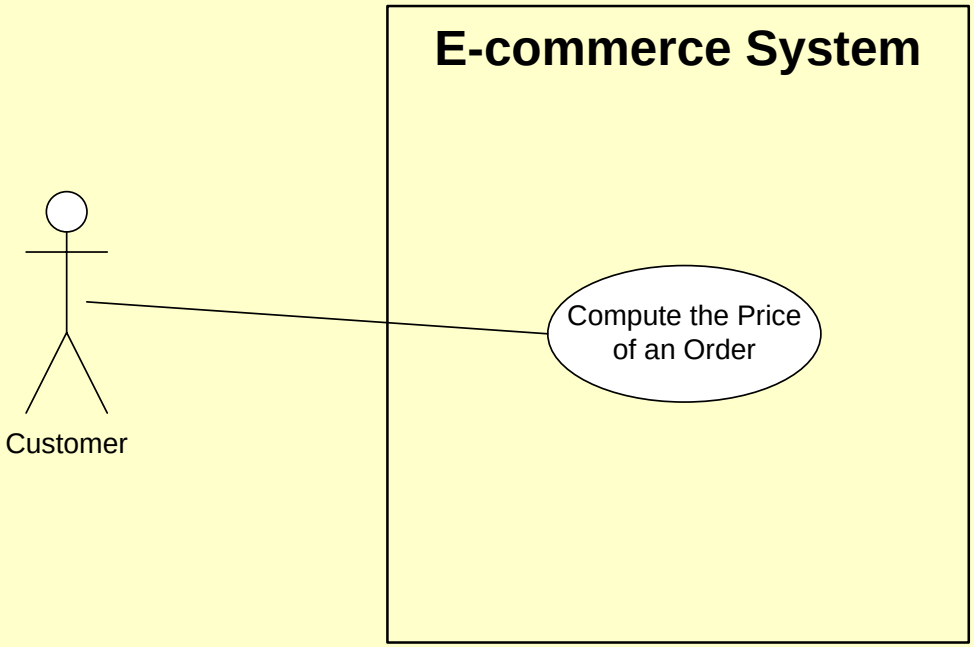
Frames: Gates



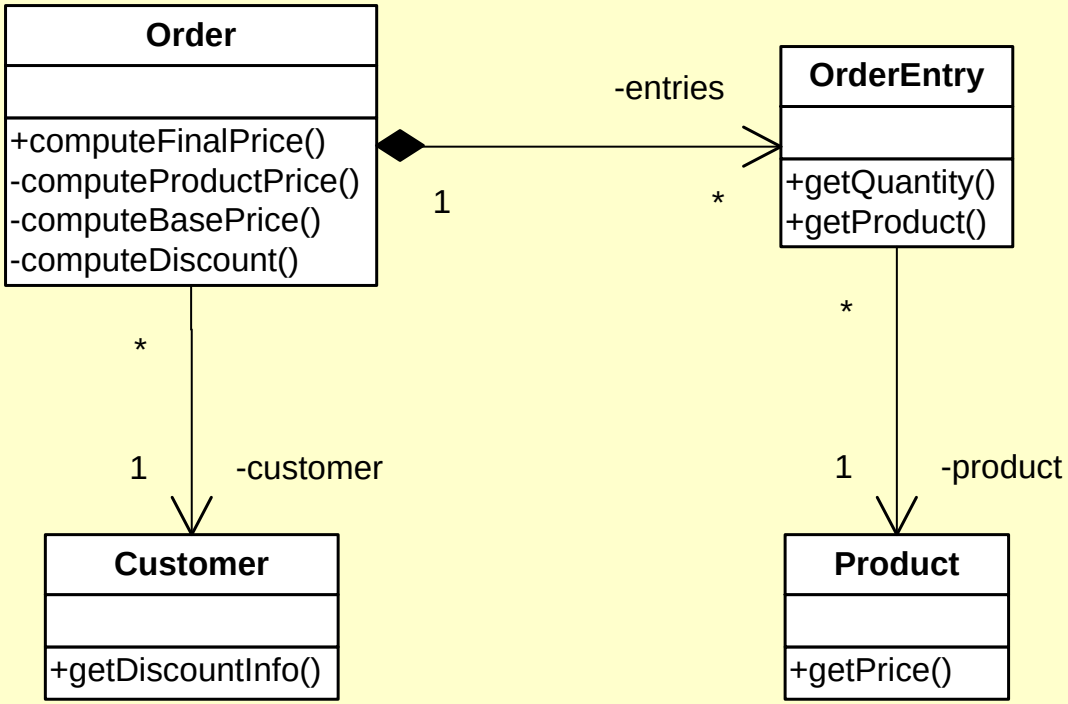
Example: Price of an Order

- A software application gives a customer the possibility to compute the final price of an order
- An order is made of a set of entries and is associated to only one customer
- An order entry is defined by
  - the product
  - the quantity of the product which is ordered
- A product stores some information about its price
- A customer can have special discounts

Compute the Price of an Order: Use Case



Compute the Price of an Order: Class Diagram



Compute the Price of an Order: Sequence Diagram