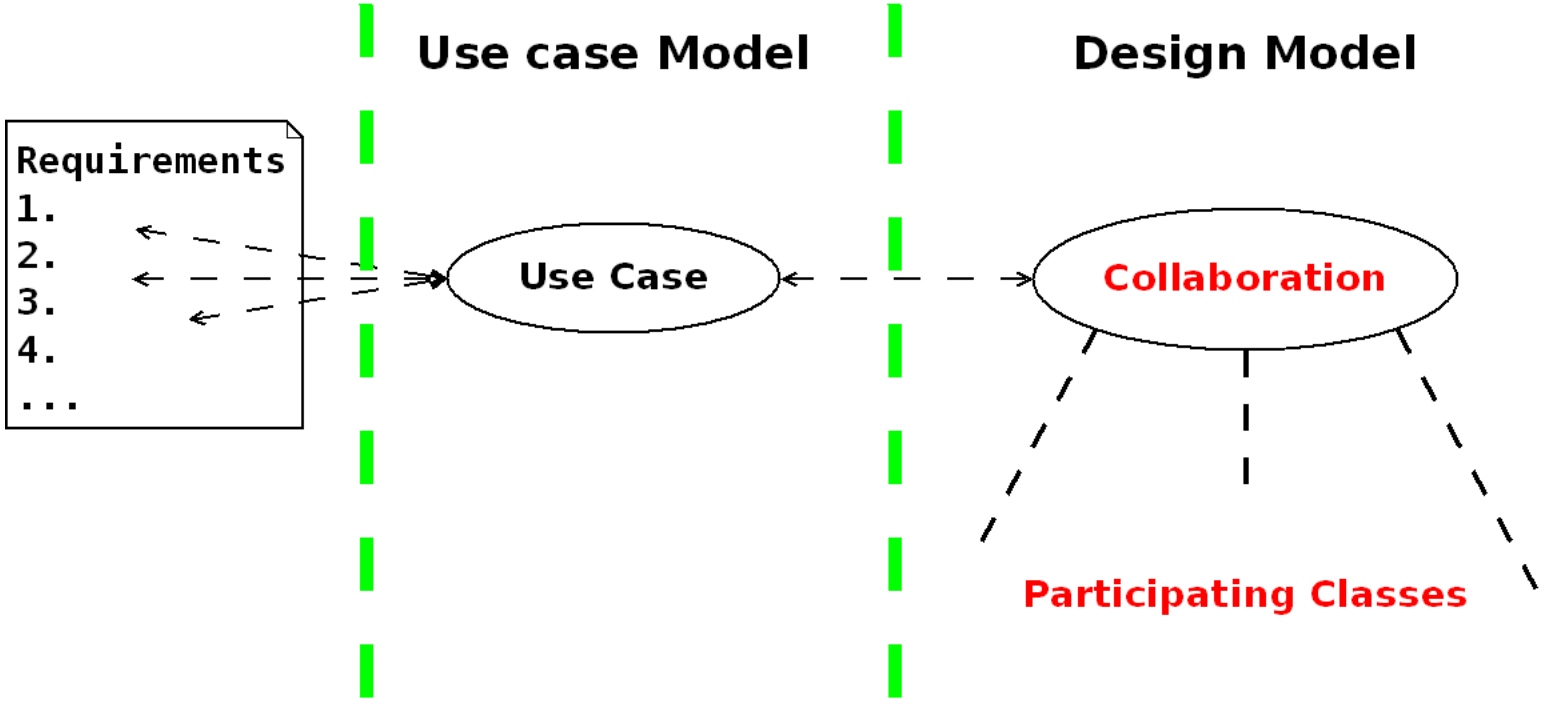
Communication Diagrams

Massimo Felici

School of informatics

Realizing Use cases in the Design Model



Slide 1: Realizing Use cases in the Design Model

- Use-case driven design is a key theme in a variety of software processes based on the UML

- UML supports specific modelling constructs that realize use cases in the implementation

- Collaborations (Communications) enhance the systematic and aggregate behavioural aspects of the system

- Collaborations support traceability from requirements expressed in use cases into the design

Communication Diagrams

- Model collaborations between objects or roles that deliver the functionalities of use cases and operations
- Model mechanisms within the architectural design of the system
- Capture interactions that show the passed messages between objects and roles within the collaboration
- Model alternative scenarios within use cases or operations that involve the collaboration of different objects and interactions
- Support the identification of objects (hence classes) that participate in use cases

Communication Diagrams

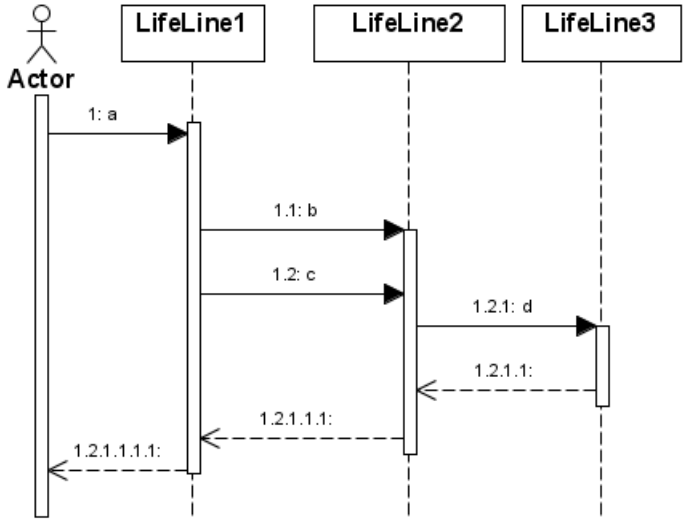
- The communication is implicit in a Sequence Diagram, rather than explicitly represented as in a Communication Diagram

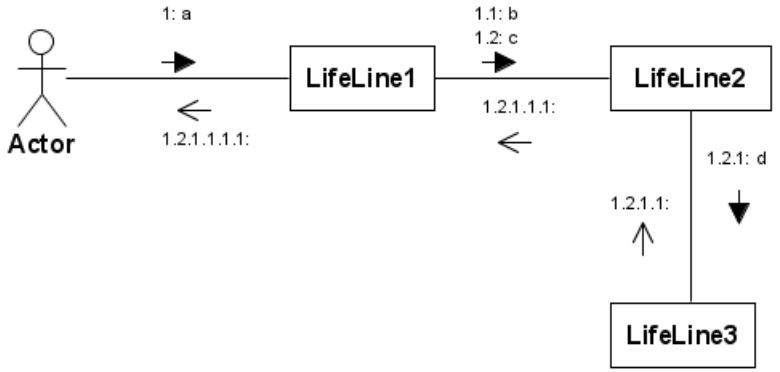
- There is some redundancy between Communication and Sequence Diagrams
  - They differently show how elements interact over time
  - They document in detail how classes realize user cases
  - Communication Diagrams show relationship between objects
  - Sequence Diagrams focus on the time in which events occur

Slide 3: Communication Diagrams

- Communication Diagrams, formerly called Collaboration Diagrams.
- UML Interaction Diagrams refine the kind of activity undertaken in checking with CRC cards.

Sequence and Communication Diagrams





Communication Diagrams

- A Collaboration is a collection of named objects and actors with links connecting them
- A Collaboration defines a set of participants and relationships that are meaningful for a given set of purposes
- A Collaboration between objects working together provides emergent desirable functionalities in Object-Oriented systems
- Objects collaborate by communicating (passing messages) with one another in order to work together

Slide 5: Communication Diagrams

- Objects and actors collaborate in performing some task. Each object (responsibility) partially supports emergent functionalities.

- Objects are able to produce (usable) high-level functionalities by working together.

Collaborations

Actors

- Each Actor is named and has a role
- One actor will be the initiator of the use case

Objects

- Each object in the collaboration is named and has its class specified
- Not all classes need to appear
- There may be more than one object of a class

Links

- Links connect objects and actors and are instances of associations
- Each link corresponds to an association in the class diagram

Interactions

- Use Cases and Class Diagrams constrain interactions
- Associations and Links in a Collaboration Diagram show the paths along which messages can be sent from one instance to another
- A message is the specification of a stimulus
- A stimulus represents a specific instance of sending the message, with particular arguments

Communication Diagrams

- Specification level shows generic cases of collaborations (communications)

  Generic form captures a collaboration among class roles and association roles and their interactions

- Instance level shows a specific instance of an interaction taking place and involving specific object instances

  Instance form captures a scenario among objects conforming to class roles and links conforming to association roles

Lifelines and Links

- Participants on a collaboration diagram are represented by a rectangle
- The syntax for the name of a lifeline

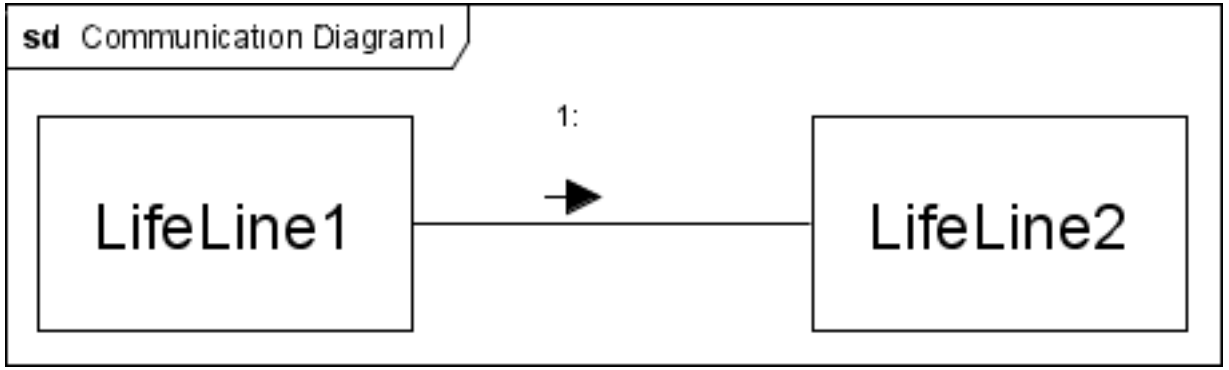
  `[connectable-element-name]['['selector']'][:class-name][decomposition]`

- A communication link is shown with a single line that connects two participants

Slide 9: Lifelines and Links

- In UML 2.0 lifeline names are no longer underlined.
- UML 2.0 introduces rectangular frames around communication diagrams.

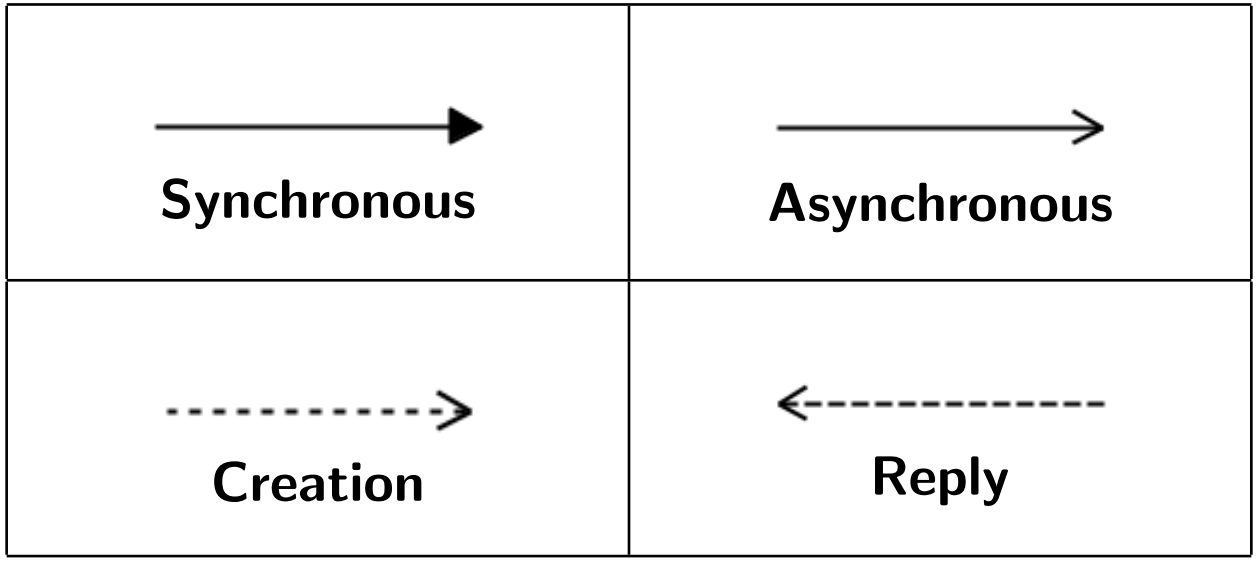
Communication Diagrams



Messages

- A message on a communication diagram is shown using an arrow from the message sender to the message receiver
- Message Signature: return-value, message-name, argument-list
- Each message in a collaboration diagram has a sequence number. The top-level message is numbered 1. Messages sent during the same call have the same decimal prefix but suffixes of 1, 2, etc. according to when they occur.

Messages



Messages

- Procedural or Synchronous: A message is sent by one object to another and the first object waits until the resulting action has completed.
- Asynchronous: A message is sent by one object to another, but the first object does not wait until the resulting action has completed.
- Flat: Each arrow shows a progression from one step to the next in a sequence. Normally the message is asynchronous.
- Return: the explicit return of control from the object to which the message was sent.

Messages

- Messages occurring at the same time: Adding a number-and-letter notation to indicate that a message happens at the same time as another message
- Invoking a message multiple times: Looping constraint, e.g., `*[i=0..9]`
- Sending a message based on a condition: A guardian condition is made up of a logical boolean statement, e.g., `[condition=true]`
- When a participant sends a message to itself

Messages

- The message is directed from sender to receiver
- The receiver must understand the message
- The association must be navigable in that direction
- Law of Demeter
- Dealing with a message m an Object O can send messages to:
  - Itself
  - Objects sent as argument in the message m
  - Objects O creates in responding to m
  - Objects that are directly accessible from O, using attribute values

Slide 15: Messages

Suggested Readings

- K.J. Lieberherr, I.M. Holland. Assuring good style for object-oriented programs. IEEE Software 6(5):38-48, 1989.

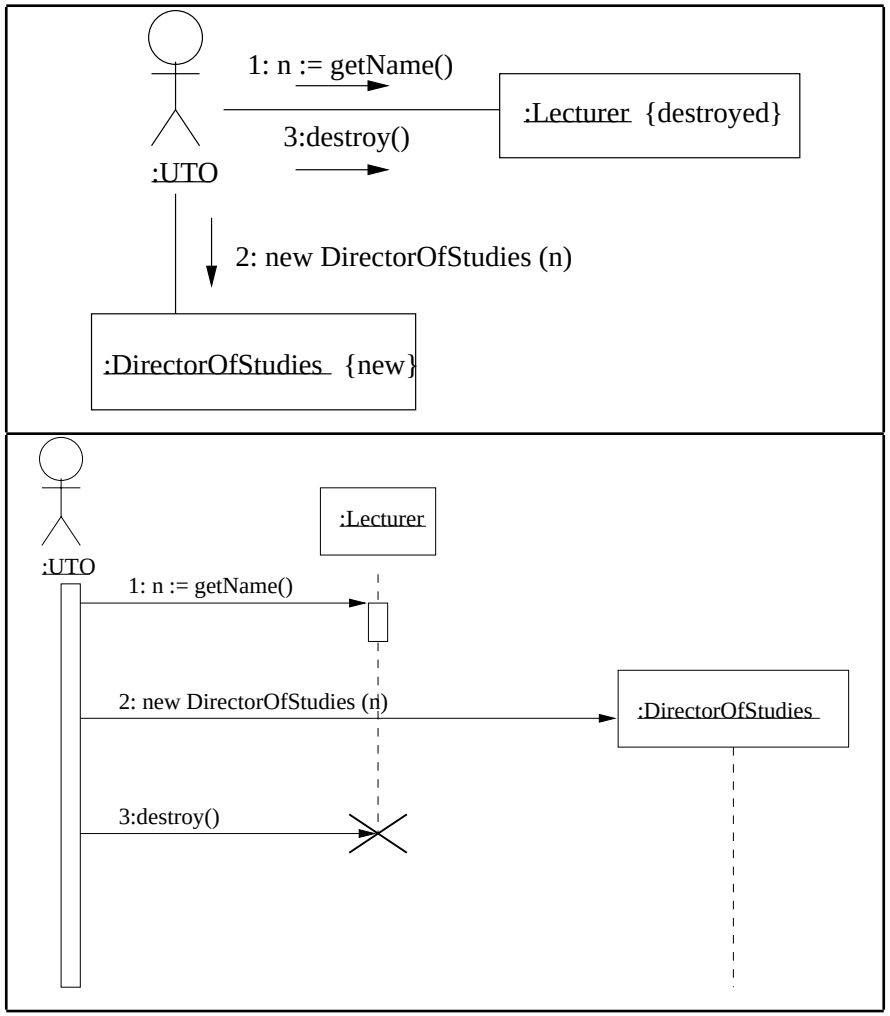
Flow of Control

- **Procedural interactions**
  At most one object is computing at any time
- **Activation**
  An object has a live activation from when it receives a message until it responds to the message
- **Waiting for response**
  Synchronous messages on sending a message to another object, an object will wait until it receives a response
- **Activation task**
  Activations are stacked and the top activation has control. When the top action responds the next to top regains control and so on...

Creation and Deletion

- In Sequence Diagrams, It is possible to use the lifelines
  - New objects have their icon inserted when they are created
  - Destroyed objects have their lifeline terminated with $\times$
- In Communication Diagrams the objects are labelled:
  - New for objects created in the collaboration
  - Destroyed for objects destroyed during the collaboration

Slide 17: Example



Communication vs. Sequence Diagrams

	Communication Diagrams	Sequence Diagrams
Participants	✓	✓
Links	✓	
Message Signature	✓	✓
Parallel Messages	✓	✓
Asynchronous messages		✓
Message Ordering		✓
Create & Maintain	✓	

Slide 18: Communication vs. Sequence Diagrams

- Shows participants effectively: Both Communication and Sequence diagrams show participants effectively
- Showing the links between participants: Communication diagrams explicitly and clearly show the links between participants
- Showing message signatures: Both Communication and Sequence diagrams show messages effectively
- Support parallel messages: Both Communication and Sequence diagrams show parallel messages effectively
- Support asynchronous messages: Sequence diagrams explicitly and clearly show the links between participants
- Easy to read message ordering: Sequence diagrams explicitly and clearly show message ordering
- Easy to create and maintain: Communication diagrams do have the edge on the ease-of-maintenance

Constructing Communication Diagrams

1. Identify behaviour
2. Identify the structural elements
3. Model structural relationships
4. Consider the alternative scenarios

Slide 19: Constructing Communication Diagrams

1. Identify behaviour whose realization and implementation is specified

2. Identify the structural elements (class roles, objects, subsystems) necessary to carry out the functionality of the collaboration; Decide on the context of interaction: system, subsystem, use case and operation

3. Model structural relationships between those elements to produce a diagram showing the context of the interaction

4. Consider the alternative scenarios that may be required; Draw instance level collaboration diagrams, if required; Optionally, draw a specification level collaboration diagram to summarise the alternative scenarios in the instance level sequence diagrams

Readings

Required Readings

- UML course textbook, Chapter 10 on More on Interaction Diagrams

Suggested Readings

- K.J. Lieberherr, I.M. Holland. Assuring good style for object-oriented programs. IEEE Software 6(5):38-48, 1989.

Summary

- Interaction Diagrams
  - Sequence Diagrams
  - Communication Diagrams
- Communication Diagrams Rationale
- Communication Diagrams
  - Collaborations
  - Interactions
  - Messages
- Constructing Communication Diagrams

