Object-Oriented Design (B3)

- goals:
  - decomposition into classes
  - definition of functionality
- Booch methodology:
  - identify classes
  - identify functionality
  - identify relationships
- graphical notation e.g. UML

Responsibility-Driven Design (B3)

- Wirfs-Brock and Wilkerson c.1990
- driven by specification and delegation of responsibilities
- responsibilities delegated to classes
  - class responsible for its operations
- characterize desired behaviour
  - of system
  - of components

Analysis (U16)

- identify desired behaviour
  - what, not how
- use cases
  - major functionalities of the system
  - a set of related scenarios
- actors
  - interact with system
- example: credit-card validation system
  - actors: customer, store, bank
  - use cases:
    - perform card transaction (customer, store)
    - manage account (customer, bank)

Design (U4,U5,B3)

- identify components
  - classes, patterns, etc.
- associate behaviour with classes
  - responsibilities
  - cohesion
  - coupling
- identify relationships
  - association (“uses”)
  - aggregation (“has a”)
  - inheritance (“is a”)

Assignment of Responsibilities (B3)

- walk through scenarios
  - activities become responsibilities
- CRC cards
  - component, responsibility, collaborator
  - physical representation
- example: The Interactive Kitchen Helper

The Interactive Kitchen Helper (B3.4)

- Greeter component - offers user 5 choices
  1. Browse the database of existing recipes, without reference to any particular meal plan
  2. Add a new recipe to the database
  3. Edit or annotate an existing recipe
  4. Review an existing plan for several meals
  5. Create a new plan of meals

Greeter	
	Collaborators
Display informative initial message	Database Manager
Offer user choice of options	Plan Manager
Pass control to either Recipe Database Manager Plan Manager for processing	

Recognizing Relationships (U5)

- association
  - “uses”
  - CRC collaborators
  - 1-way or 2-way
- aggregation
  - “has a”
  - one class contains or manages objects of another class
- inheritance
  - “is a”
  - every object of one class conforms to another with additional properties

Coupling and Cohesion (B3)

- cohesion
  - how closely related are the responsibilities of a unit?
- coupling
  - how dependent are units on each other?
  - number of associations
- system should be highly cohesive, loosely coupled

Information Hiding

(B3)

- implementation hidden behind simple interface
- interface: what
- implementation: how
- Parnas's principles:
  - all required information and no more
  - user: for use of a component
  - developer: to carry out responsibilities of a component

Unified Modelling Language (U7,$U_2$3)

- Booch, Rumbaugh, Jacobson c. 1995
- standard language for graphically modelling a system
- structural modelling:
  - class diagram
  - internal structure diagram
  - collaboration diagram
  - component diagram
  - use case diagram
- dynamic modelling:
  - state machine diagram
  - activity diagram
  - sequence diagram
  - communication diagram

Use Case

- scenario – a description of specific use of the system by a user, e.g.

  Joe goes to the box-office to buy a ticket to the Ron Sexsmith concert. The clerk checks the availability. Joe chooses a seat. The clerk asks for payment. Joe hands his credit card. The clerk enters the credit card information. The system validates & bills the credit card. The system prints the ticket. The clerk gives Joe the ticket.
- use case – generalization of a set of scenarios that start with the same request to achieve the same user goal
  - goal – the business value to the user
  - system – application and hardware used by user
  - actor – an external entity that interacts with the system
- in this case, the system is the box office software & hardware, the goal is buying a ticket(s) and the actor is the clerk.

Use Case Template (Lee & Tepfenhart, Figure 3-6)

Use Case Name

Description: A one or two sentence description of the use case

Actors: Identifies the actors participating in the use case

Includes: Identifies the use cases included in it

Extends: Identifies the use cases that it may extend

Pre-Conditions: Identifies the conditions that must be met to invoke the use case

Details: Identifies the details of the use case – the action

Post-conditions: Identifies the conditions that are assured to hold at the conclusion of the use case

Exceptions: Identifies any exceptions that might arise in the execution of this use case

Constraints: Identifies any constraints that may apply

Variants: Identifies any variations that might hold for the use case

Comments: Provides any additional information that might be important in this use case

Buy Tickets

Description: A customer purchases tickets for an event from a clerk

Actors: Clerk

Includes: Make Charges

Extends: none

Pre-Conditions: Event must be scheduled

Details:

1. Clerk requests availability for number of tickets for event
2. Box-Office displays availability
3. Clerk selects seats
4. Box-Office indicates cost
5. Clerk selects credit card purchase and enters card number
6. Box-Office makes charges to credit card
7. Box-Office prints tickets

Post-conditions: Selected tickets are sold

Exceptions: Credit card not validated

Constraints: None

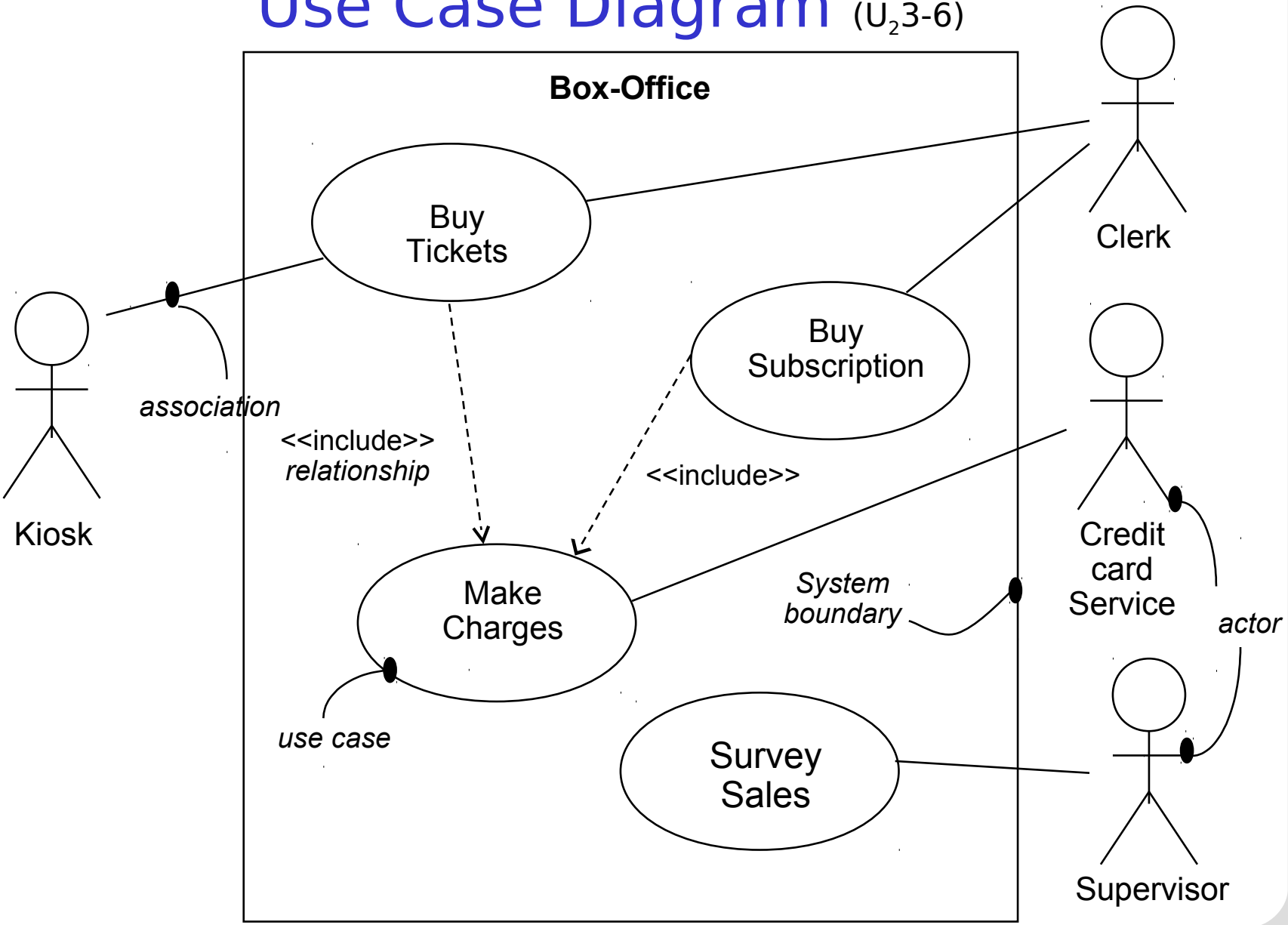
Variants: Cash purchase

Comments: None

Use Case Diagrams (U16, U17)

- shows how use cases are related to each other and to the actors
- shows which actors participate in which use cases
- actors: “roles” played by users
- use cases: a transaction among actors and the system
- associations
  - inclusion – one use case is a part of another
  - extension – specialized version of the case
- system boundary
- example: Box-Office

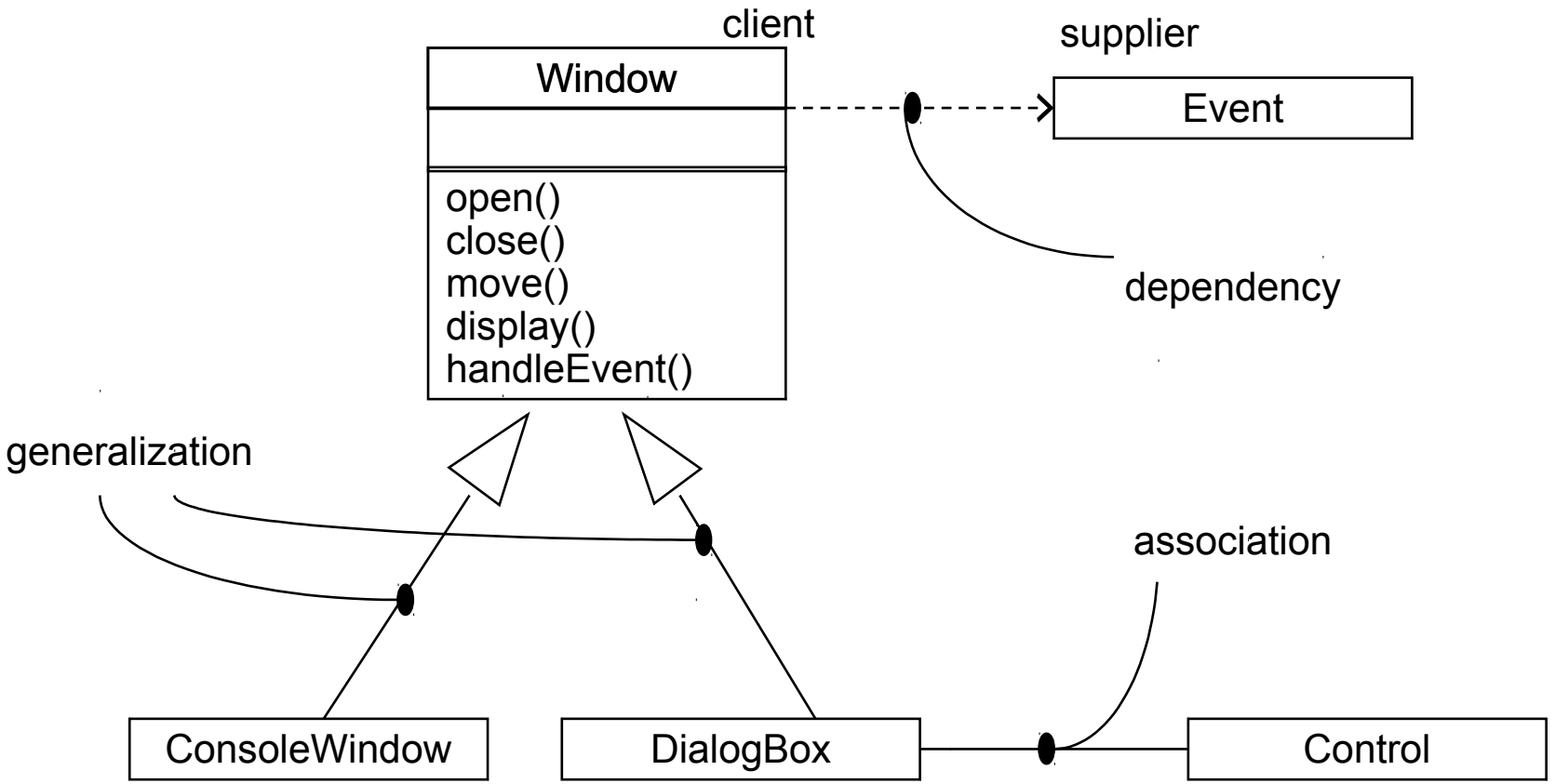
Use Case Diagram ($U_2$3-6)



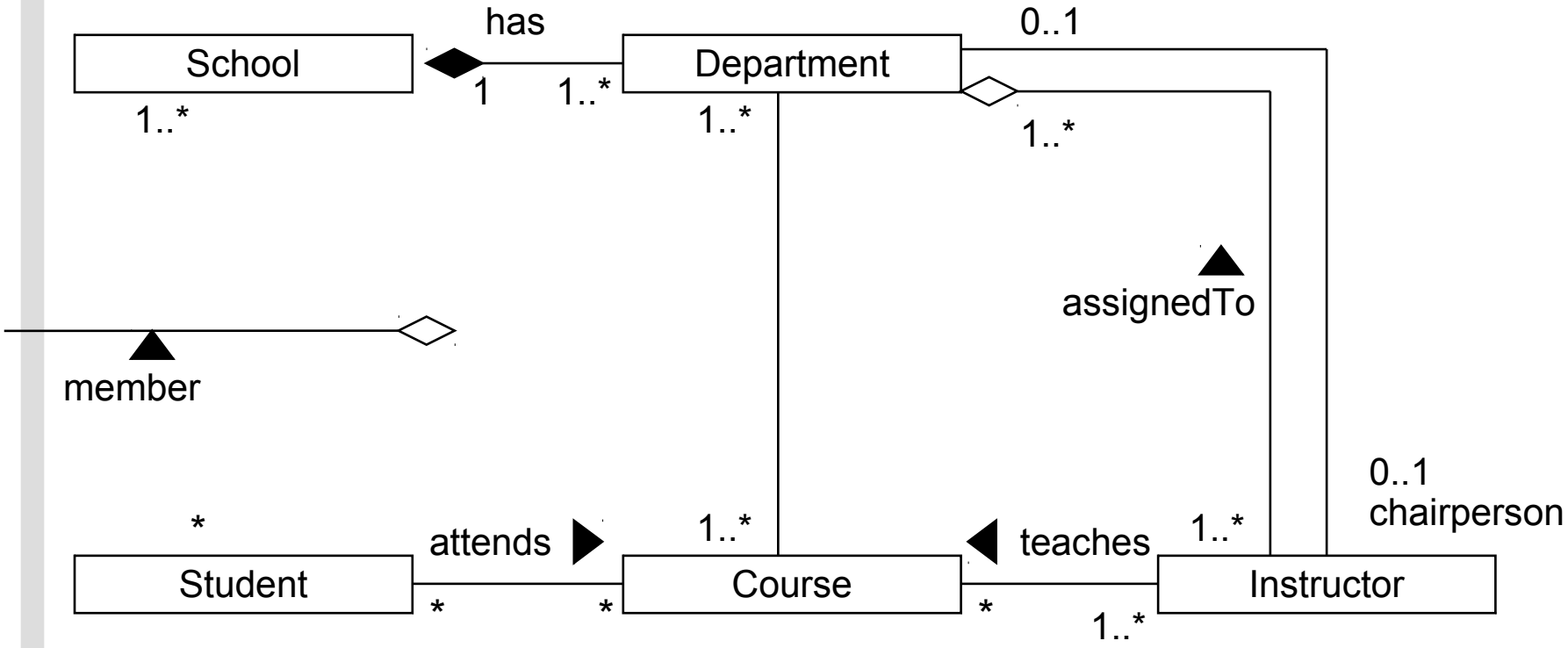
Class Diagrams (U4,U5,U8)

- depict static structure
- classes:
  - name
  - attributes
  - operations
  - responsibilities
- relationships:
  - association
  - aggregation and composition
  - inheritance
- advanced features: multiplicity, named relationships, dependencies, visibility
- examples

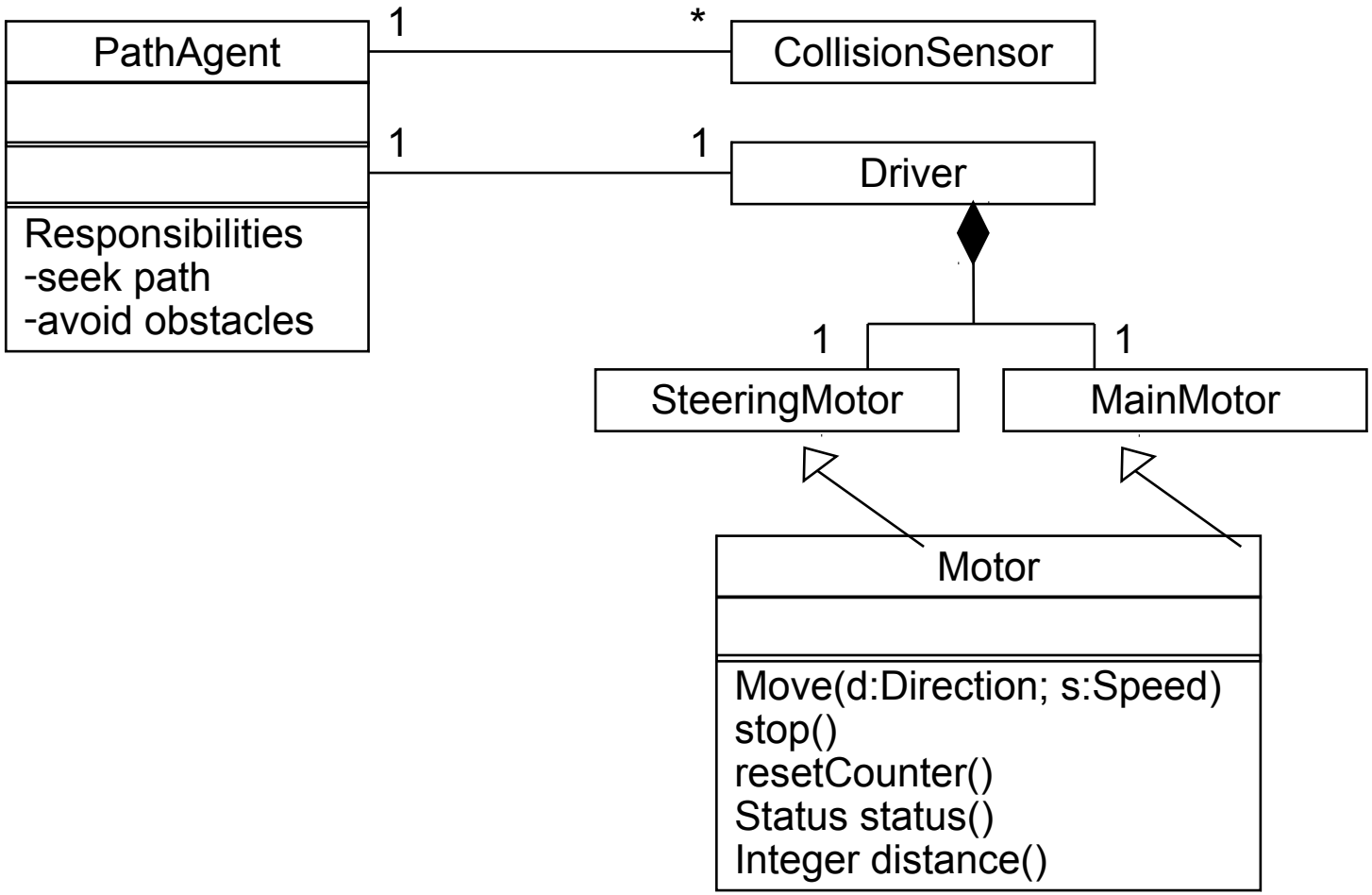
Relationships (U5-1)



Structural Relationships (U5-10)



Modeling Simple Collaborations (U8-2)



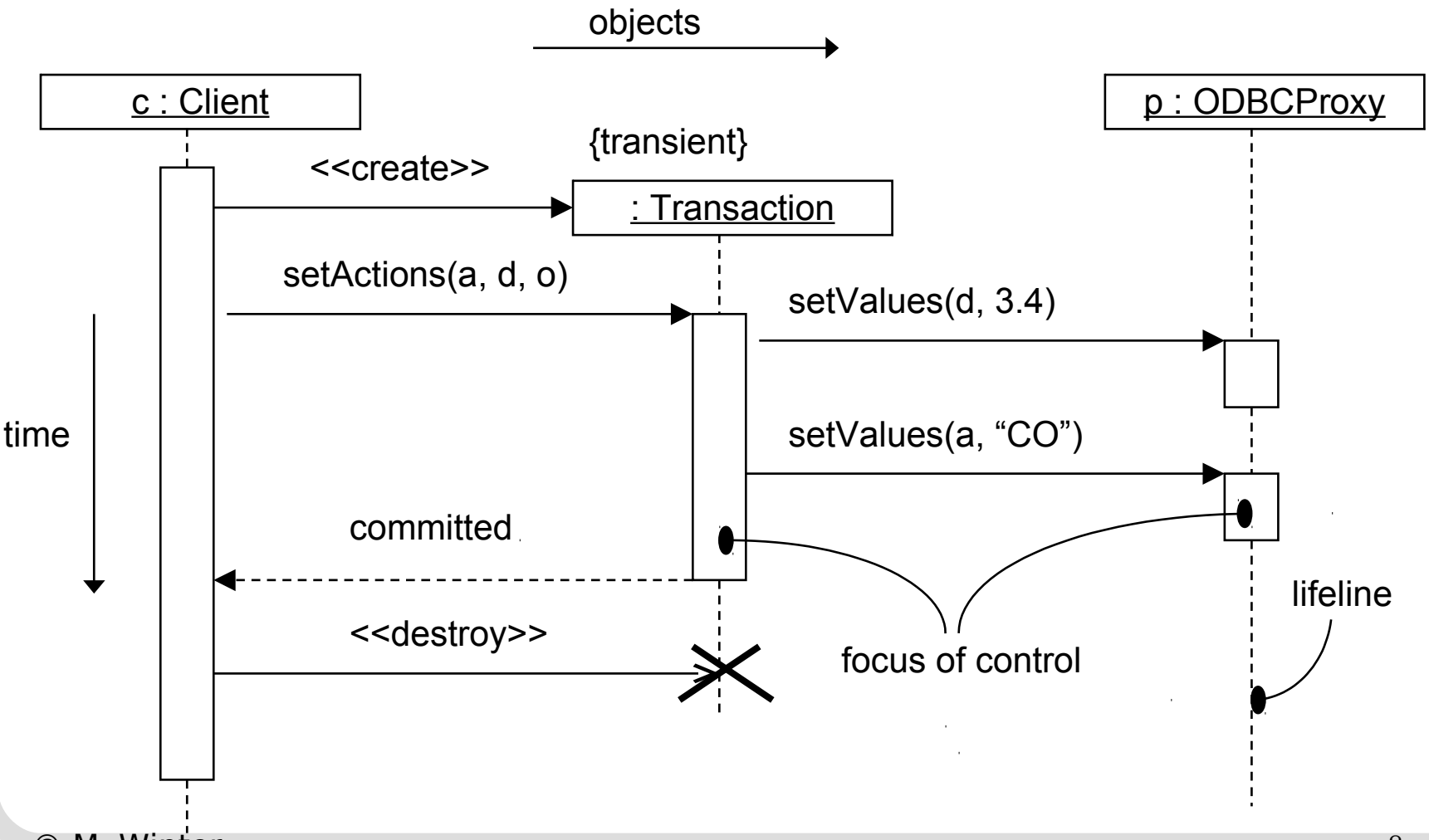
Dynamic Modelling (U7, U18)

- modelling the behaviour of a system
- use case diagrams
- collaboration diagrams
  - flow of function calls between objects
  - emphasis: structural relationship
- sequence diagrams
  - interaction of objects as messages are passed
  - emphasis: timing
- state diagrams
  - sequence of states for an object
  - states, events and transitions
- activity diagrams
  - flowcharts
  - emphasis: flow of control from activity to activity

Sequence Diagrams (U18)

- objects
- messages
- object lifeline
- focus of control
- time-ordering of messages
- timing constraints
- examples: ODBC, phone call

Sequence Diagram (U18-2)



Sequence Diagram (U18-4)