AMSS Lecture 9: UML Design – Additional Diagram Types

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2025

Agenda

Interaction Diagrams

- Communication Diagrams
- Interaction Overview Diagrams
- Timing Diagrams

Structure Diagrams

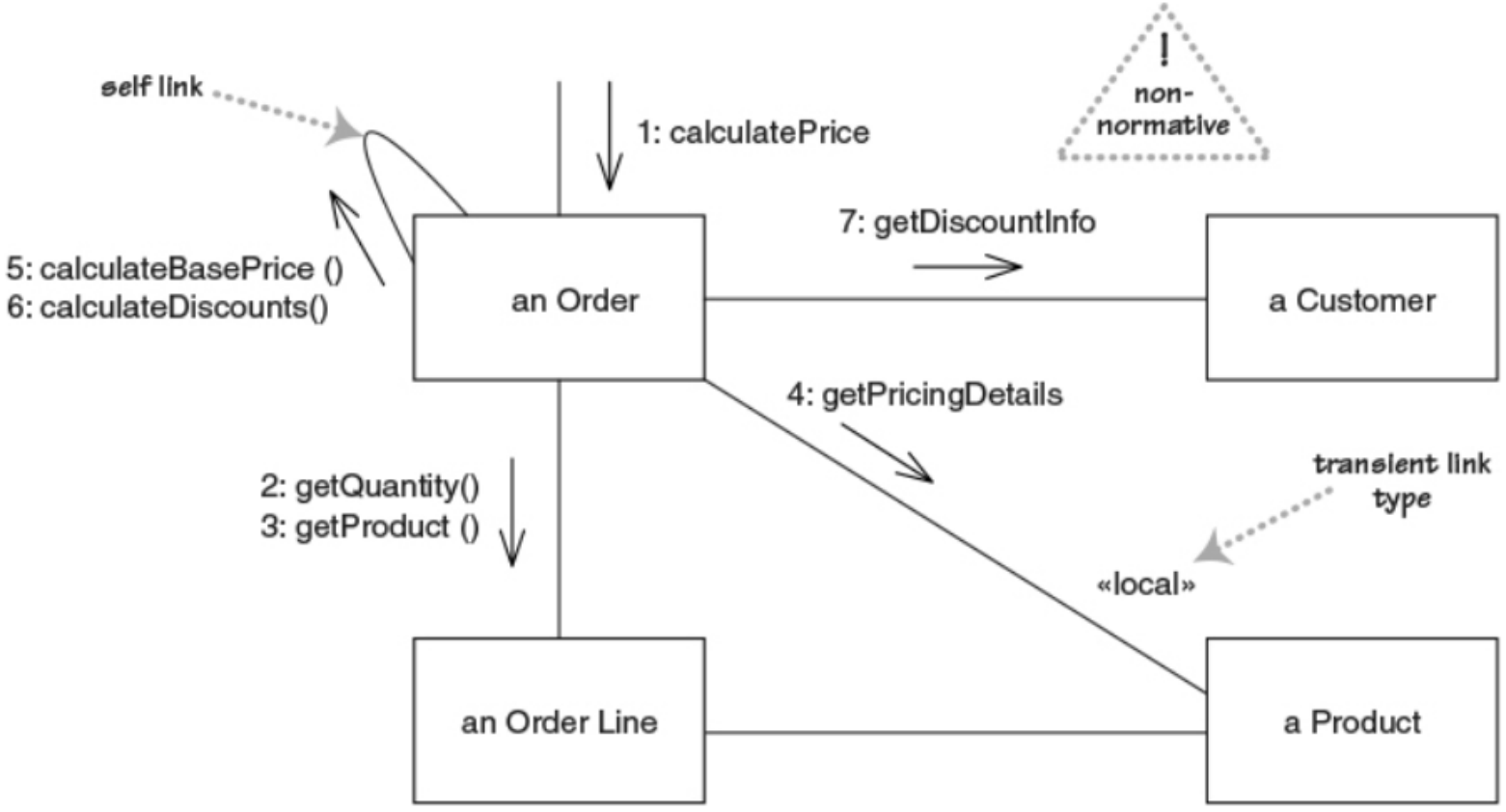
- Composite Structure Diagrams
- Profile Diagrams

Interaction Diagrams

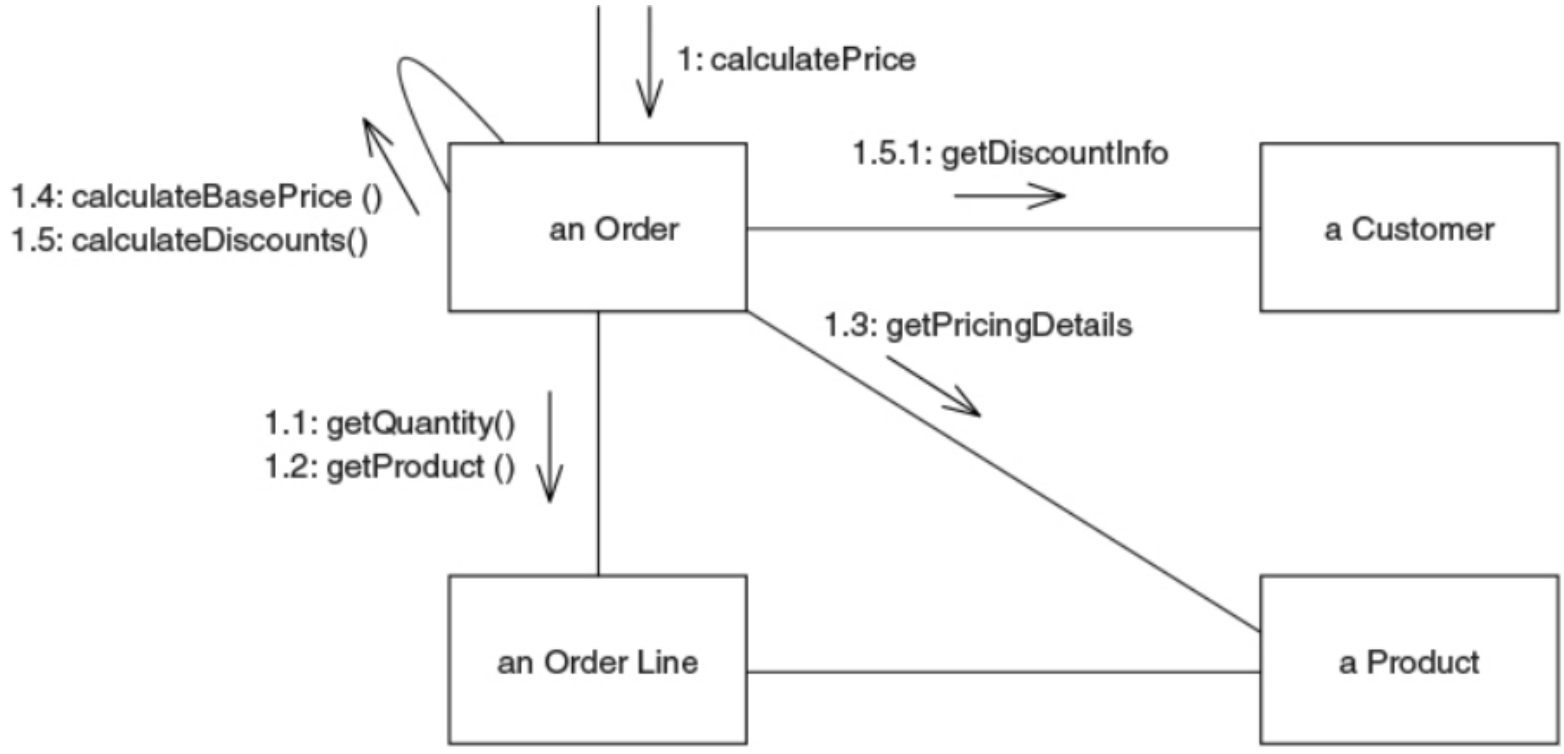
1. Communication Diagrams

Emphasize data links between participants in the interaction.

- free placement of participants
- draw links to show how participant connect
- use numbering to show message sequence

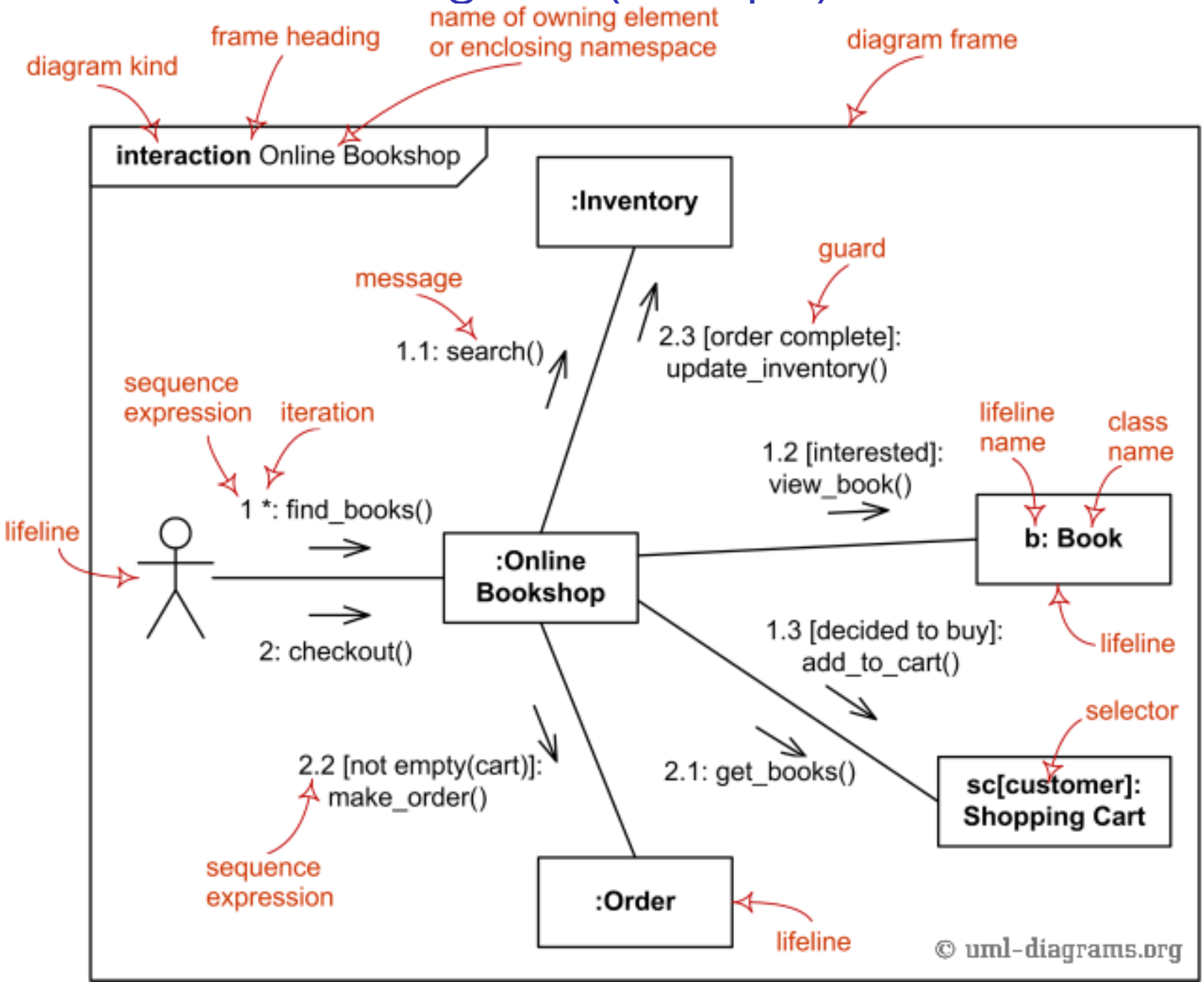


1. Communication Diagrams (nested numbering)



- Can use letters to indicate different threads
  - e.g., 1a1 and 1b1 indicate two threads within message 1
- Nested numbers can get hard to follow (e.g., 1.1.1.2.1.1.)
  - Some people prefer using flat numbers as on previous slide
- Don't have precise notation for control logic

1. Communication Diagrams (example)



1. Communication Diagrams vs. Sequence Diagrams

- **Sequence diagrams** highlight temporal sequencing.
- **Communication diagrams** highlight structural organization

Aspect	Sequence Diagram	Communication Diagram
Focus	Flow of messages	Structural relationships among objects
Emphasis	*When* messages occur	*Which* objects interact
Layout	Vertical lifelines; message flow top-to-bottom	Graph layout; objects linked by message paths
Best For	message order, concurrency, timing	Collaboration structure and object roles
Mesage Order	Vertical position	Explicit sequence numbers (1, 1.1, 2...)
Use Case	Complex logic, workflows, time-dependent behavior	High-level interaction patterns object relationships

Interactive Exercise

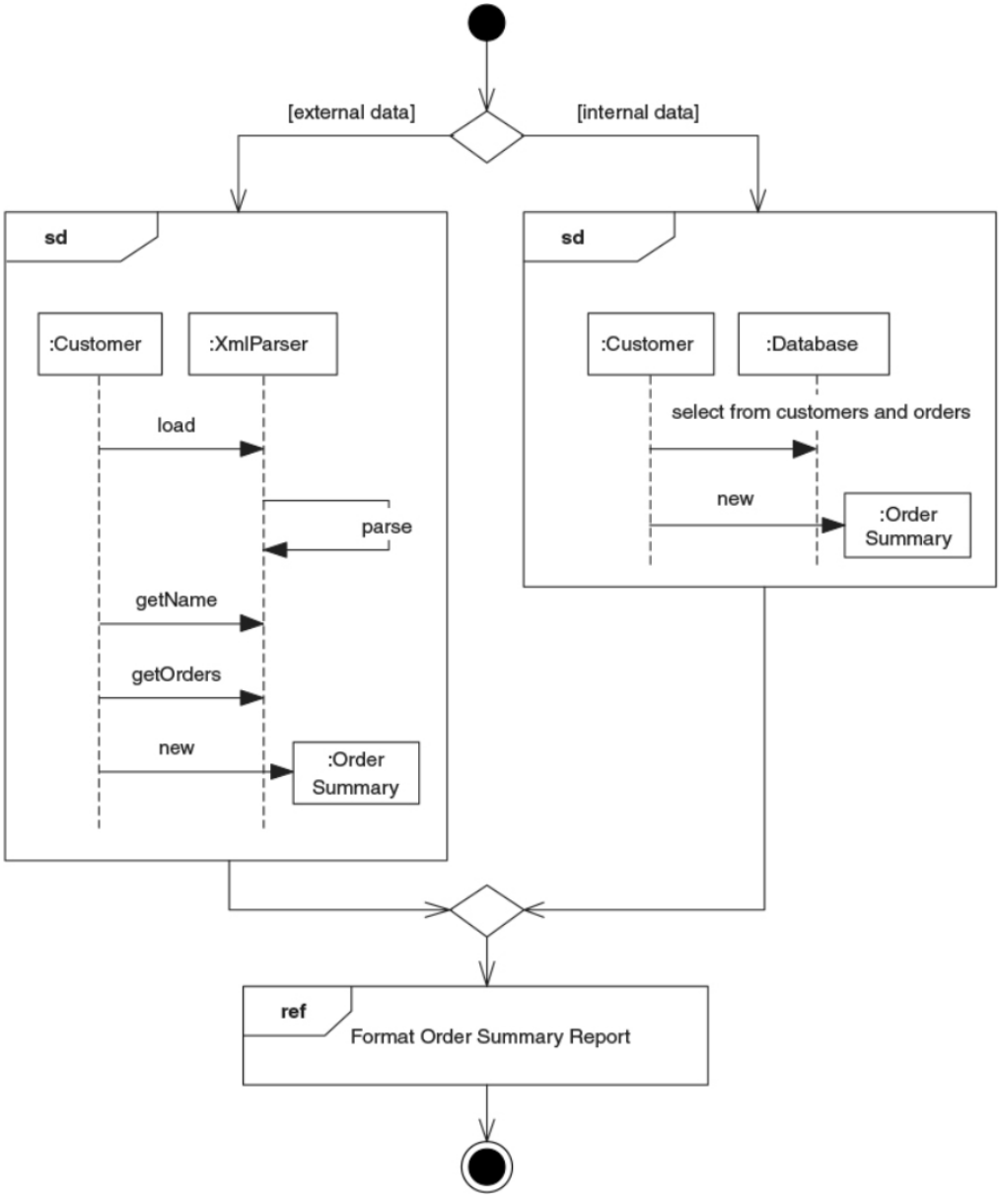
Task

Model the basic interactions within an online ordering system when a customer places a food order online.

Guidelines

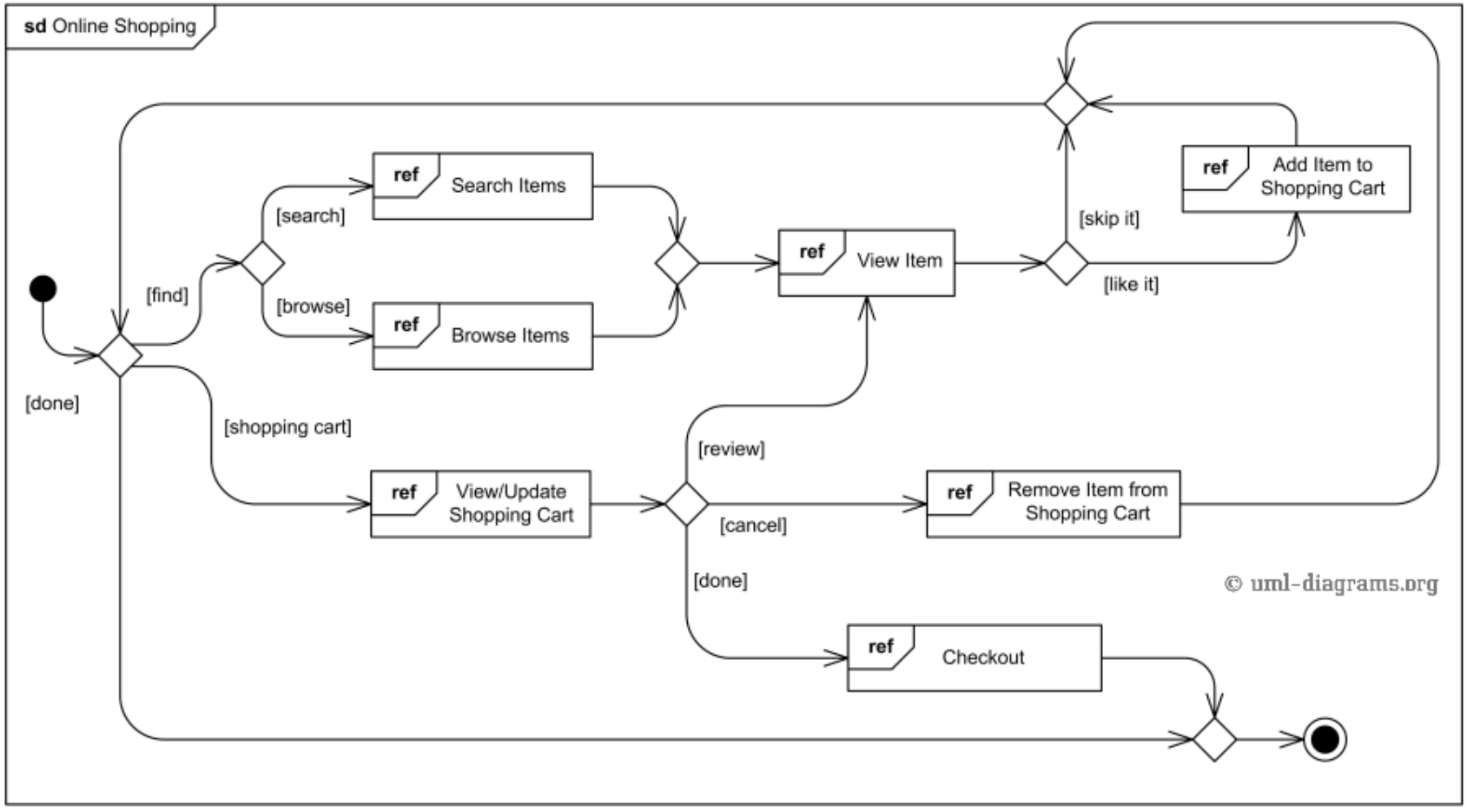
- Use at least 4 objects (CustomerApp, OrderService, RestaurantSystem, PaymentService).
- Number your messages.
- model possible failures.

2. Interaction Overview Diagrams

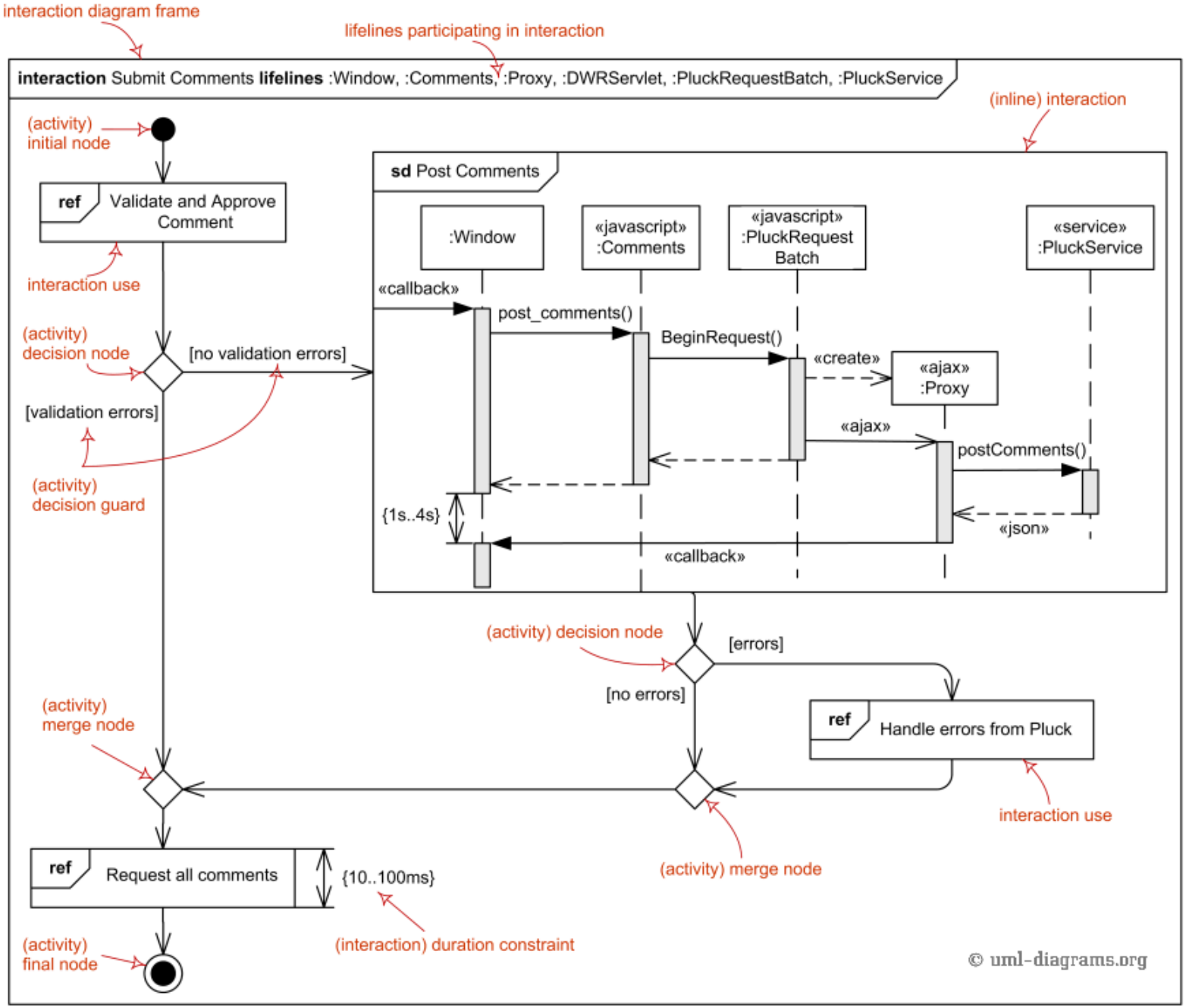


- Activity diagrams where actions are Interaction Diagrams (or references).
- High-level control flow combining multiple interactions.

2. Interaction Overview example (all references)



2. Interaction Overview example



2. Interaction Overview exercise (Library Book Borrowing)

Task

Create an Interaction Overview Diagram (IOD) that shows the control flow of a user borrowing a book through an online library portal.

Guidelines

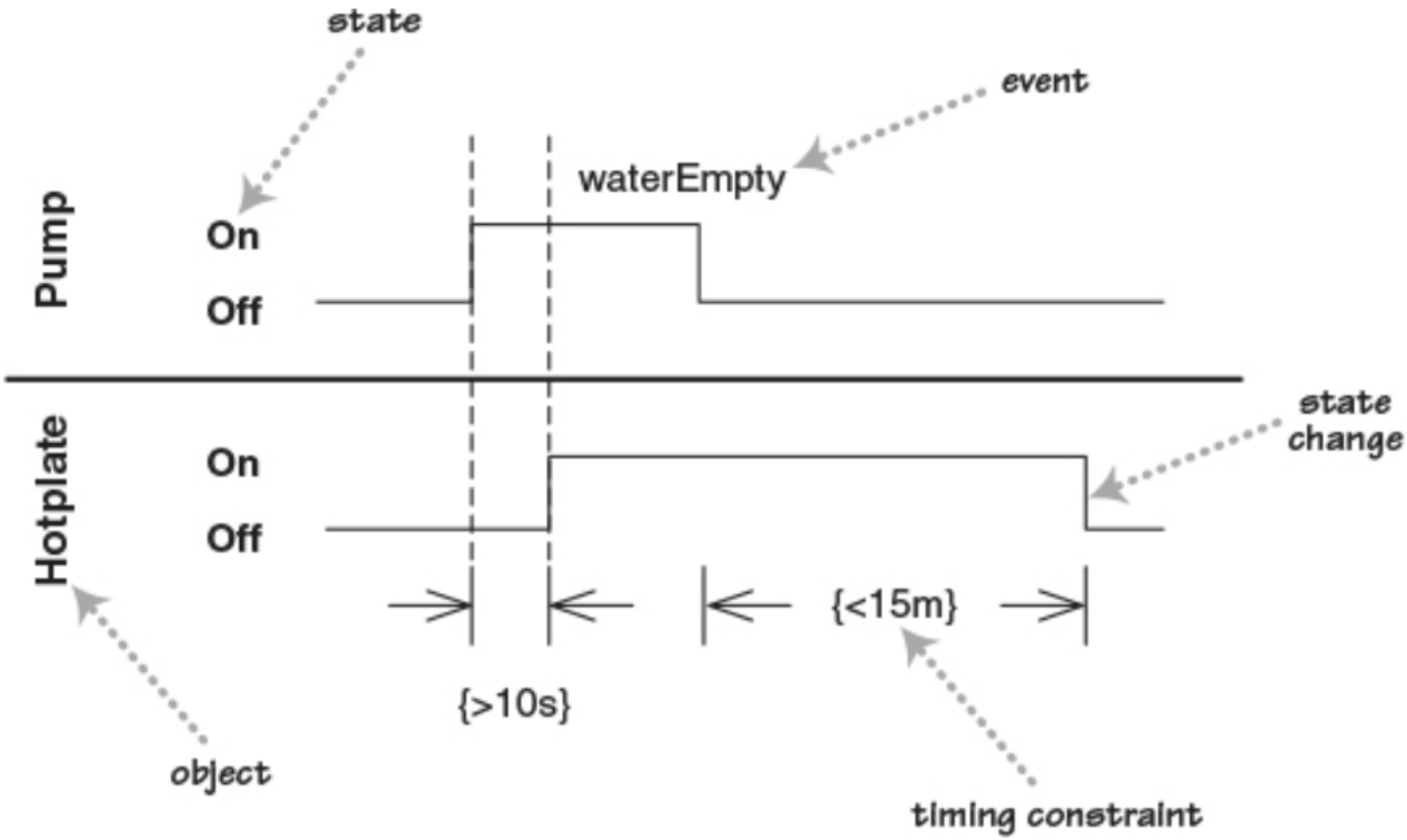
The diagram must include at least one interaction sub-diagram, such as a short sequence diagram or communication diagram.
The system consists of:

- UserPortal
- SearchService
- CatalogService
- LoanService
- NotificationService

3. Timing Diagrams

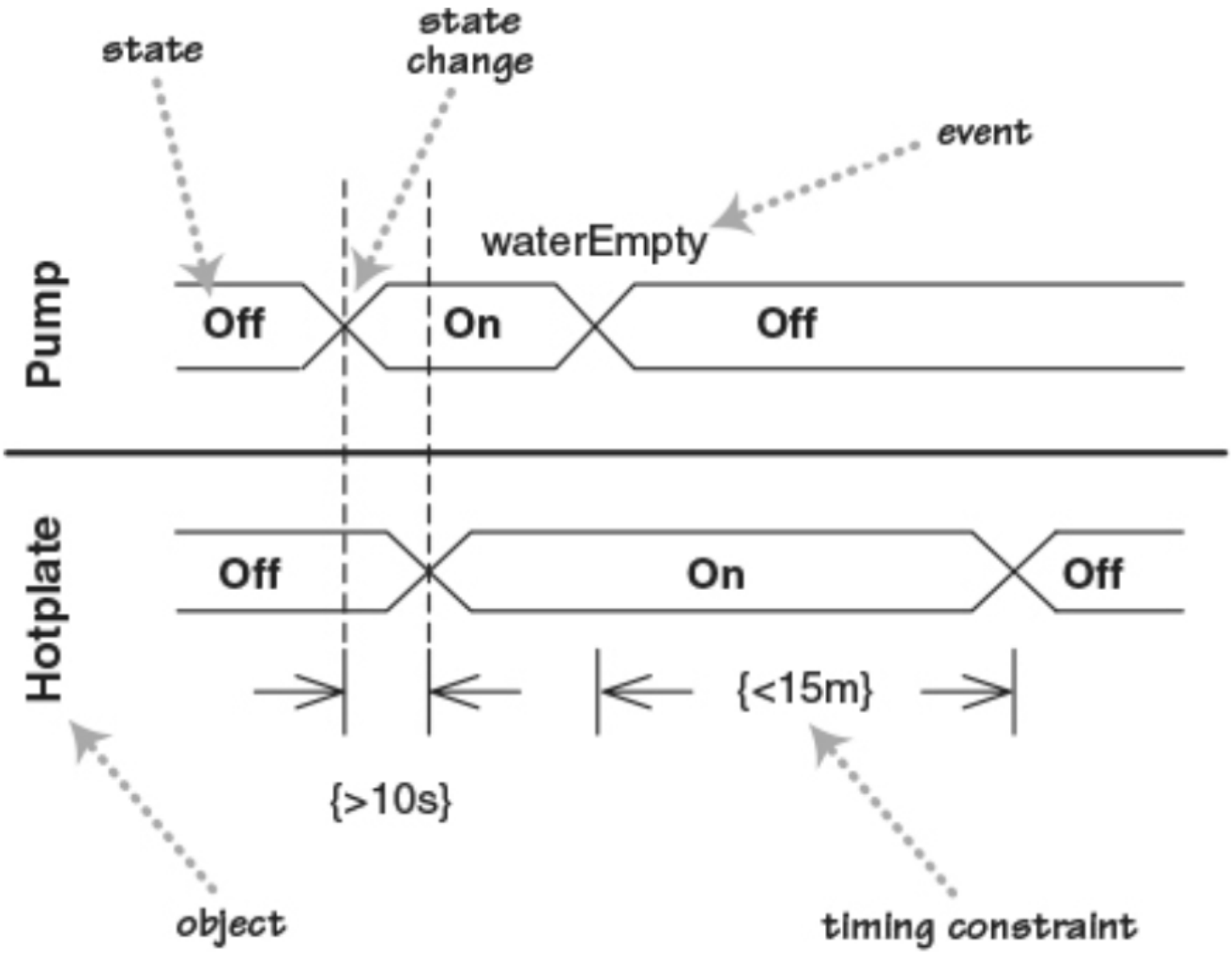
Focus: timing constraints between state changes on different objects

- Show the *change of state over time*.
- Hardware design: modelling of real-time / cyberphysical systems

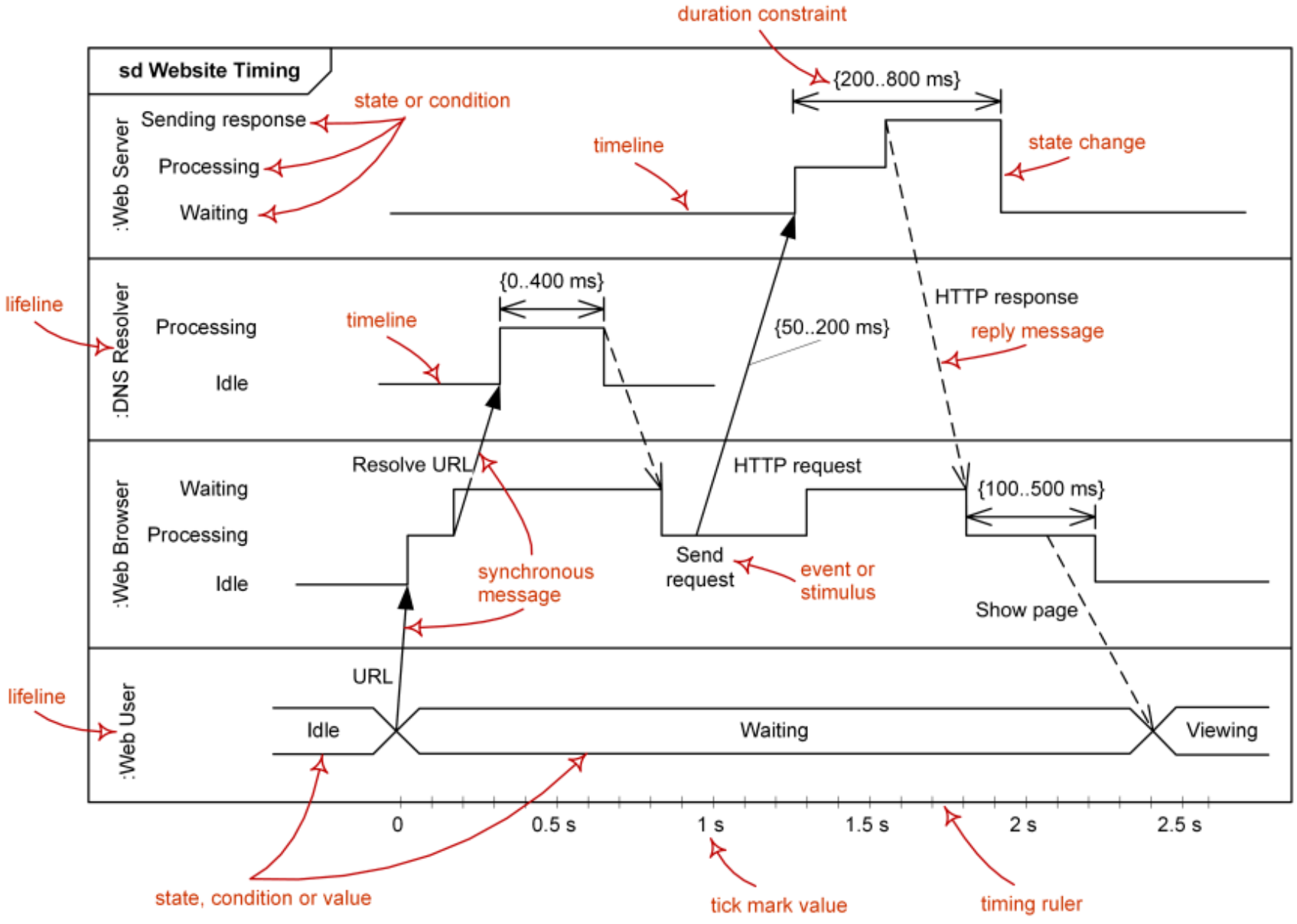


3. Timing Diagrams with cross state-changes

- Useful when there are more states



3. Timing diagrams example (including messages)



3. Timing Diagram exercise

Create a UML Timing Diagram showing how three components in a smart-home lighting system (motion sensor, light controller, light) change states over time and respond to each other.

Initial States

- MotionSensor = DetectingMotion
- LightController = Active
- Light = ON

Sequence of Events

1. At t = 0s, the MotionSensor switches to NoMotion.
2. After 10 seconds of no motion, the LightController transitions from Active → WaitingToOff.
3. At t = 12s, the MotionSensor briefly detects motion again (DetectingMotion), causing:
   LightController → Active (cancel auto-off)
4. At t = 18s, MotionSensor returns to NoMotion.
5. After another 10 seconds of continuous no motion (i.e., at t = 28s), LightController sends command Light = OFF

Structure Diagrams

4. Composite Structure Diagrams

Used to show:

- internal structure
  - interactions with environment through ports
- behavior of a collaboration

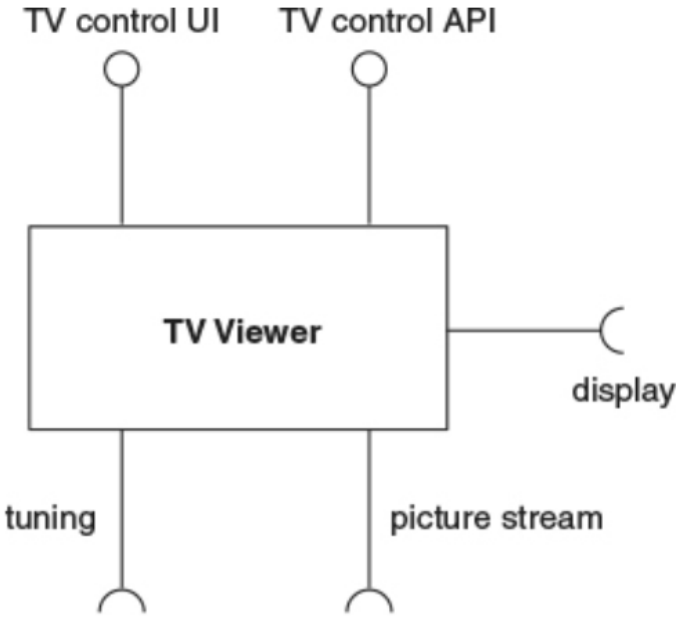


Figure 1: TV Viewer Class

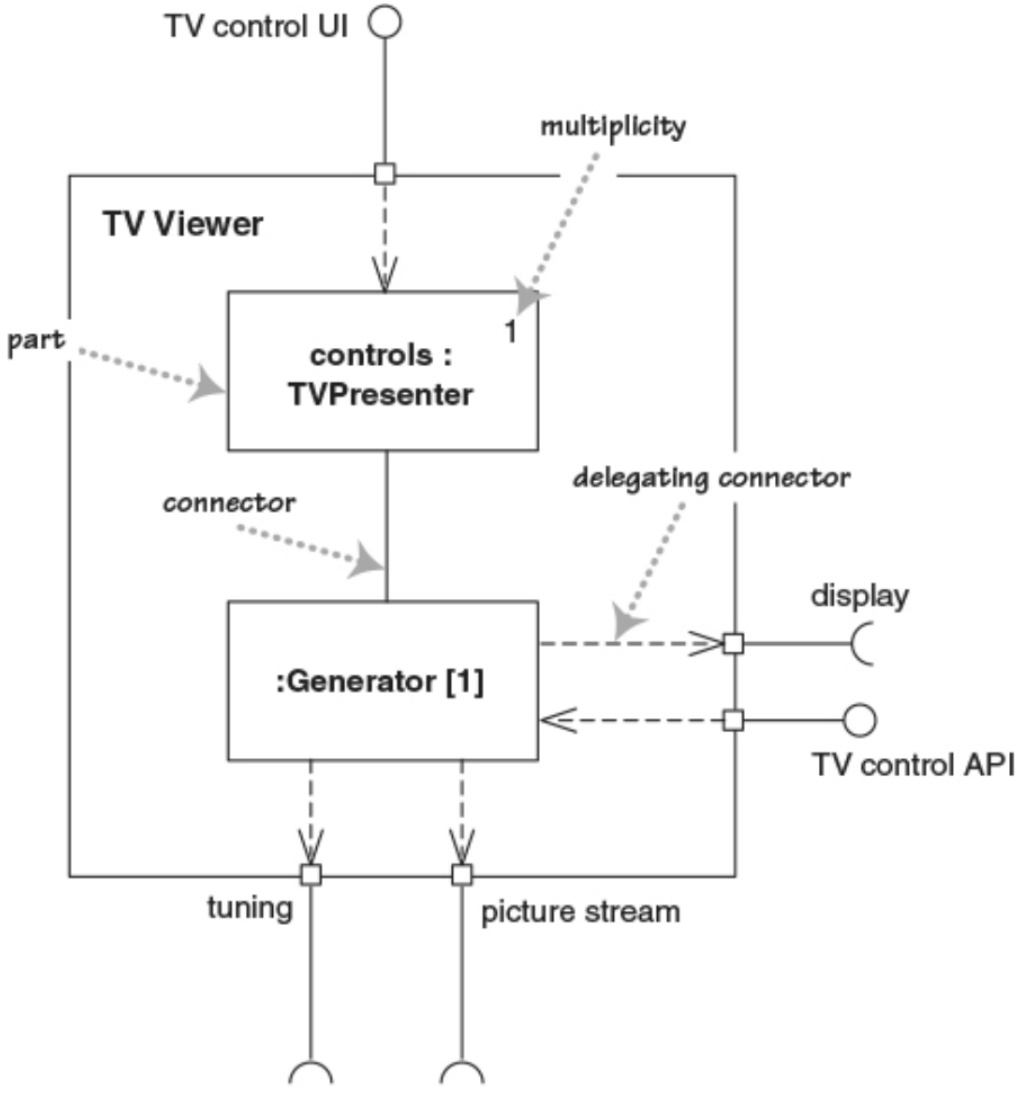
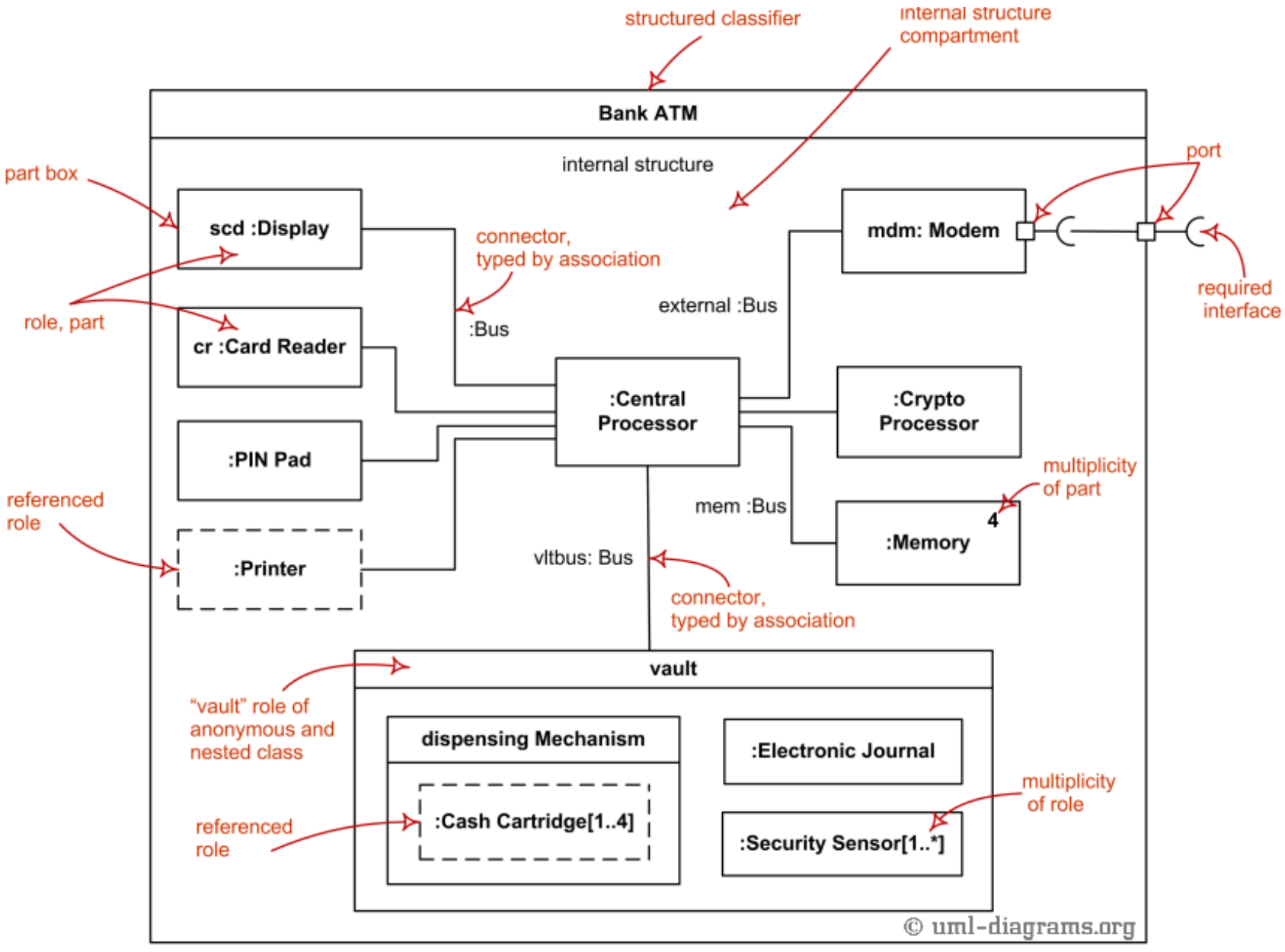


Figure 2: TV Viewer as Composite Structure

4. Composite Structures example (internal structure)



4. Composite Structures example (collaboration)

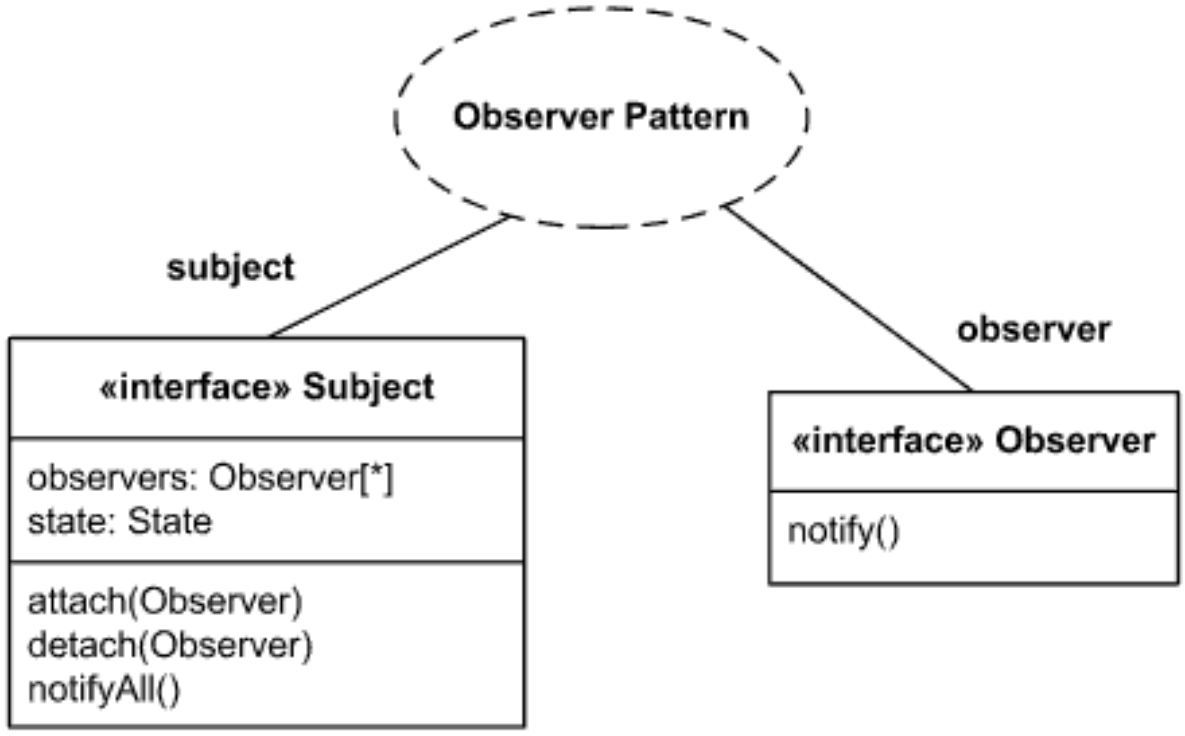


Figure 3: Observer design pattern as a composite structure

- Collaboration icon is connected to each of the rectangles
- Rectangles denote interfaces
  - types of properties of the collaboration.
- Each line is labeled by the name of the property (role).

4. Composite Structures exercise

Create a Composite Structure Diagram showing the internal structure of an AudioPlayback component in a music-player app.

Scenario

You are given a component called AudioPlayback, responsible for decoding and playing audio files. Internally, it contains three parts:

- Decoder
- Buffer
- OutputDevice (e.g., speakers or headphone jack)

AudioPlayback component interacts with environment through:

- controlPort – receives play/pause/stop commands
- audioPort – sends raw audio samples to hardware

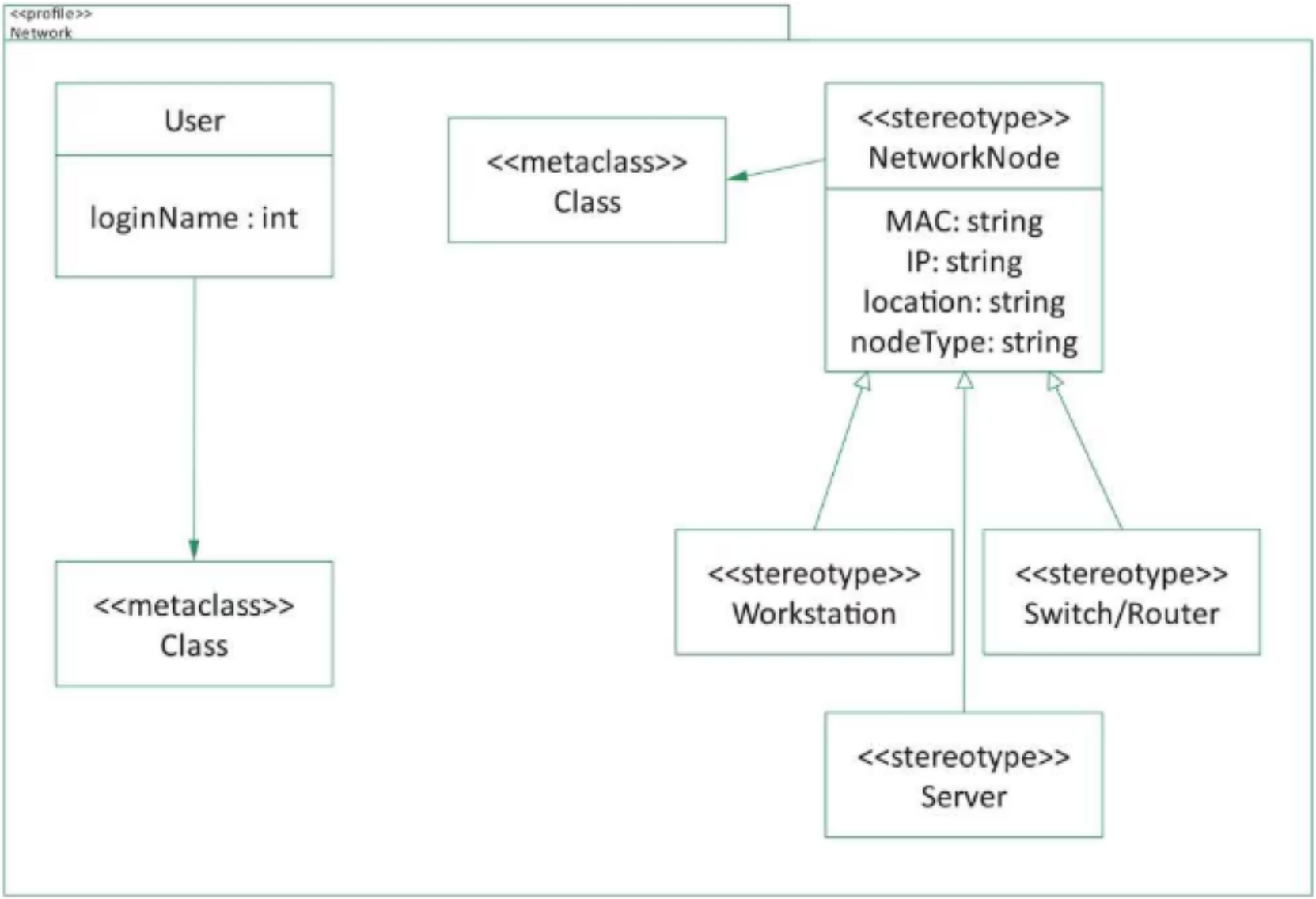
Optional additions

- A visualizer
- A volume control

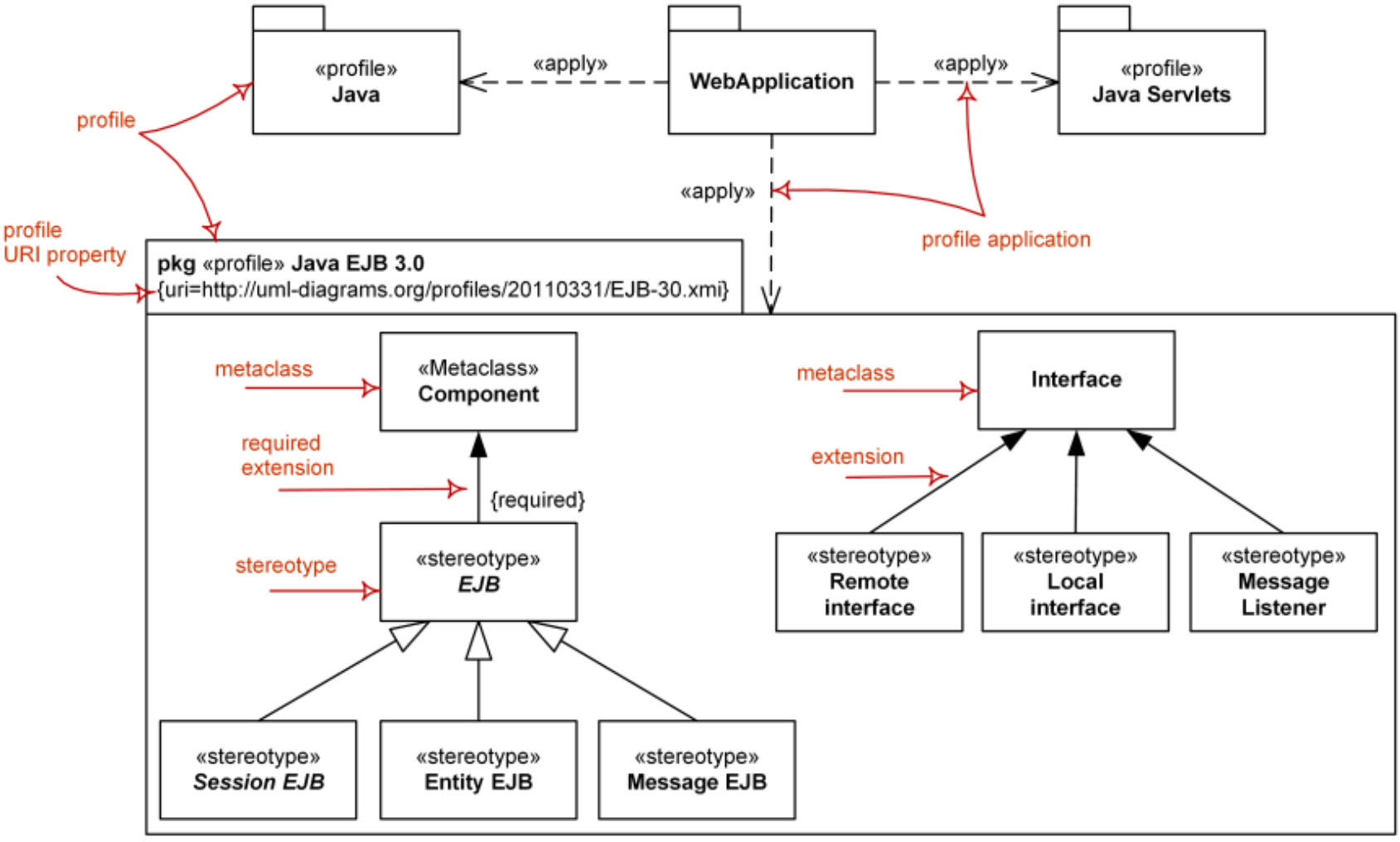
5. Profile Diagrams

Define UML *extensions* for domain-specific modeling.

- custom stereotypes, tagged values, and constraints.



5. Profile Diagram example



5. Profile Diagrams exercise (Secure Web Services profile)

Create a UML Profile Diagram that extends UML to better describe security characteristics of web-service components.

Tasks

1. Create a WebSecurity profile
2. Add stereotypes
    a. SecureCompoent extends Component with encryption and CA tags
    b. SensitiveData extends Class with a dataCategory tag
    c. AuthRequired extends Operation with authLevel tag
3. Add at least one constraint
    - e.g., SensitiveData must have at least one private attribute

Wrap-Up

Summary Table

Diagram Type	Purpose
Communication	Data links and message sequence
Interaction Overview	High-level flow
Timing	Time-based behavior
Composite Structure	Internal architecture
Profile	Domain specific extensions