Mastering Object-Oriented Analysis and Design with UML

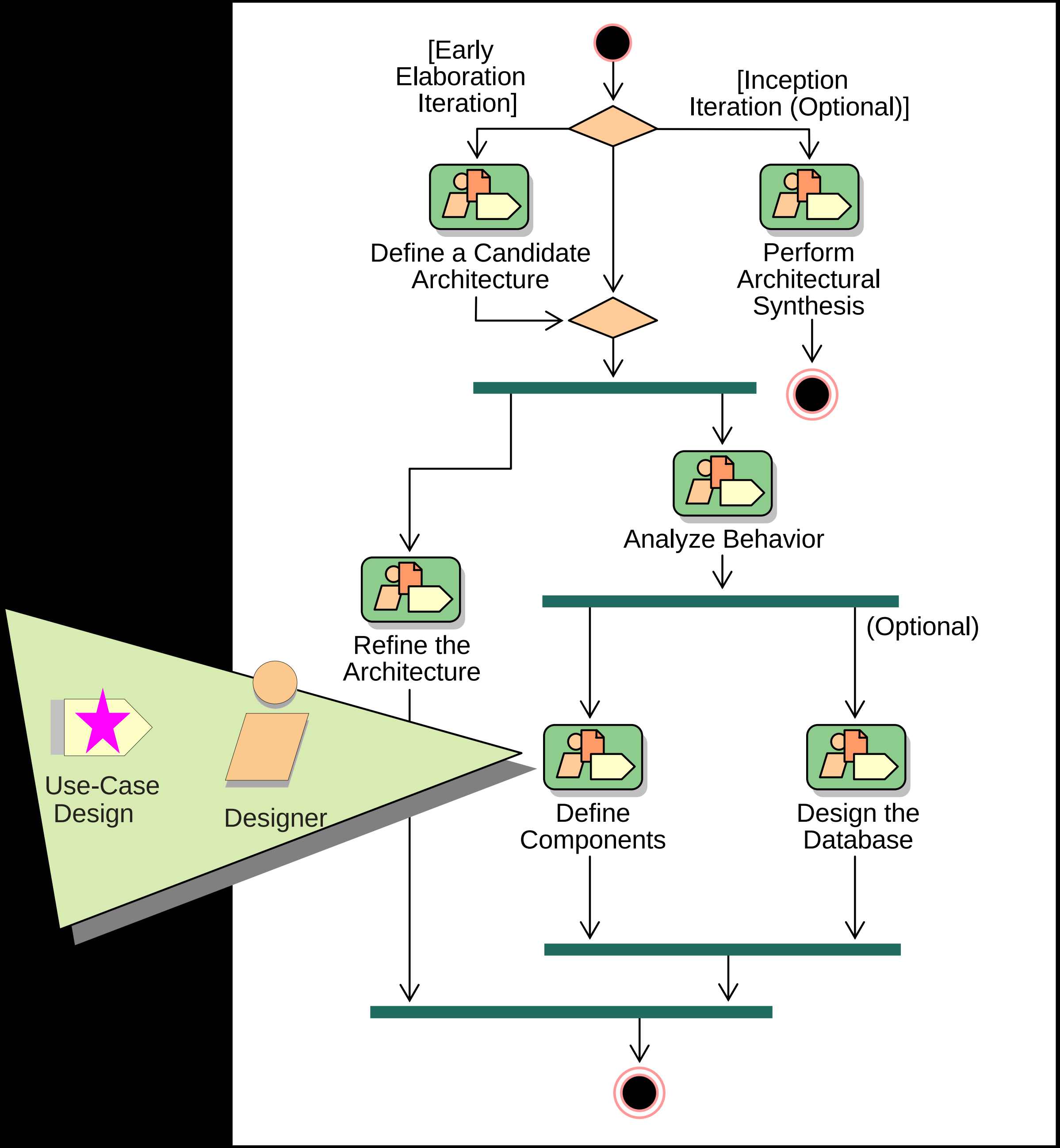
Module 9: Use-Case Design

Rational. software

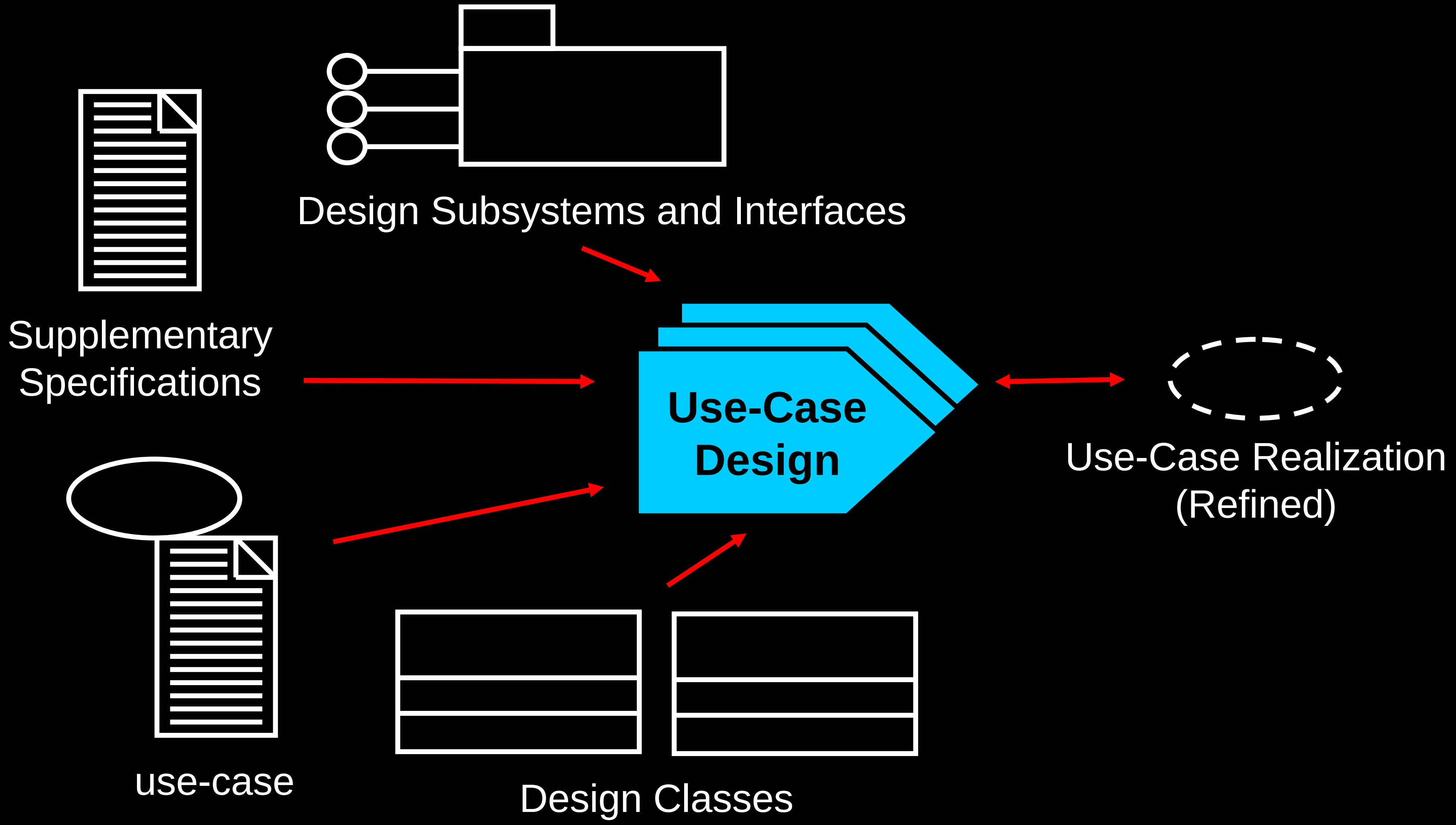
Objectives: Use-Case Design

- Define the purpose of Use-Case Design and when in the lifecycle it is performed
- Verify that there is consistency in the use-case implementation
- Refine the use-case realizations from Use-Case Analysis using defined Design Model elements

Use-Case Design in Context


[Early Elaboration Iteration]
[Inception Iteration (Optional)]
Define a Candidate Architecture
Perform Architectural Synthesis
Analyze Behavior
Refine the Architecture
(Optional)
Use-Case Design
Designer
Define Components
Design the Database

Use-Case Design Overview



Design Subsystems and Interfaces

Supplementary Specifications

Use-Case Design

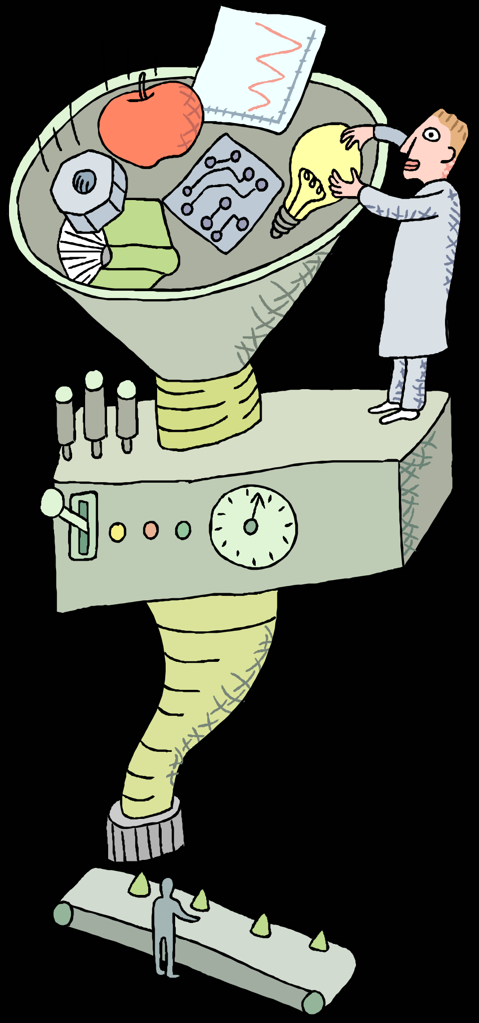
Use-Case Realization (Refined)

use-case

Design Classes

Use-Case Design Steps

- Describe interaction among design objects
- Simplify sequence diagrams using subsystems
- Describe persistence-related behavior
- Refine the flow of events description
- Unify classes and subsystems



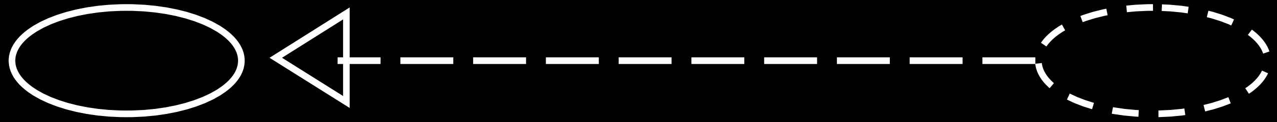
Use-Case Design Steps

- ★ Describe interaction among design objects
- Simplify sequence diagrams using subsystems
- Describe persistence-related behavior
- Refine the flow of events description
- Unify classes and subsystems

Review: Use-Case Realization

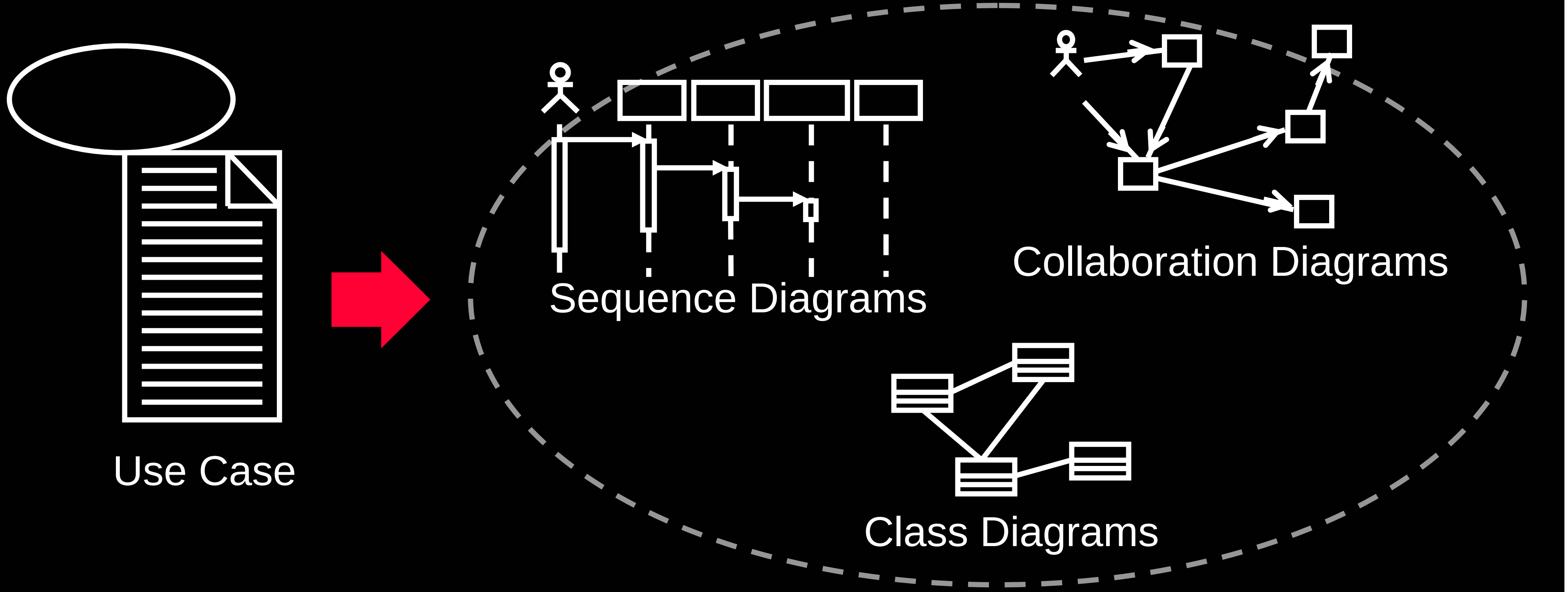
Use-Case Model

Design Model



Use Case

Use-Case Realization



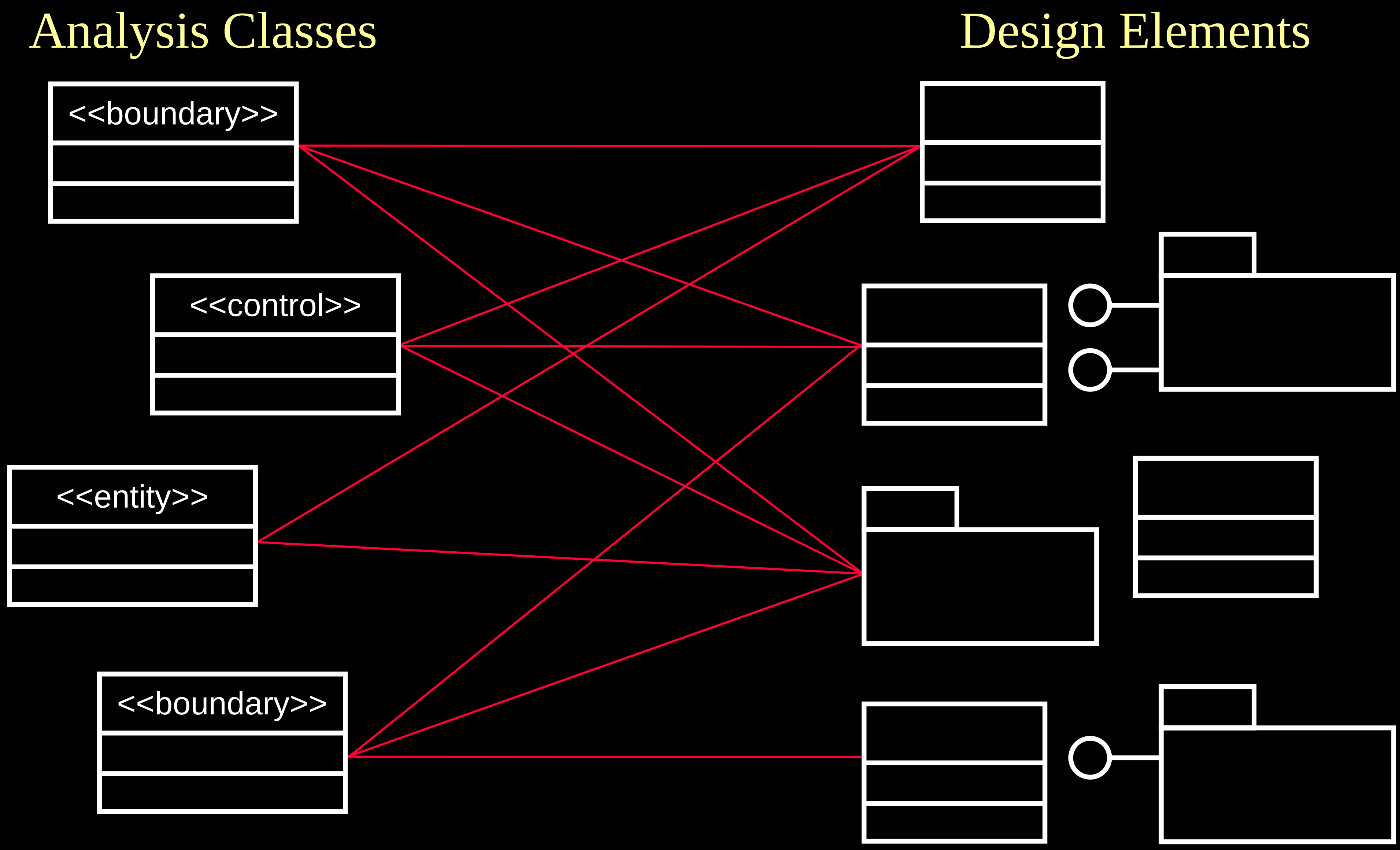
Sequence Diagrams

Collaboration Diagrams

Use Case

Class Diagrams

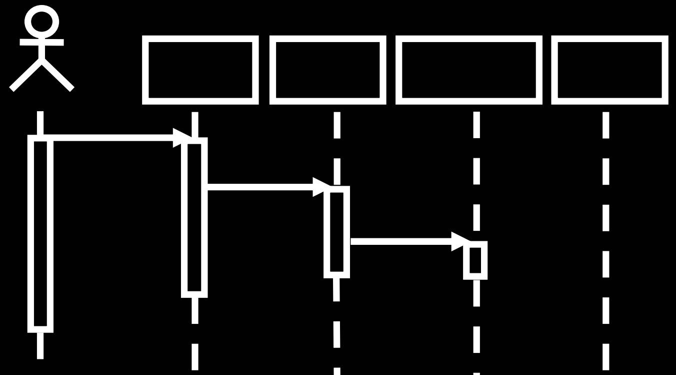
Review: From Analysis Classes to Design Elements



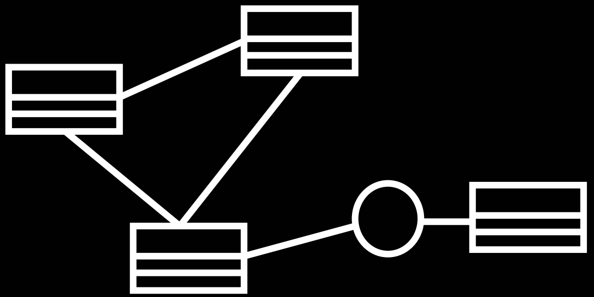
Many-to-Many Mapping

Use-Case Realization Refinement

- Identify participating objects
- Allocate responsibilities among objects
- Model messages between objects
- Describe processing resulting from messages
- Model associated class relationships



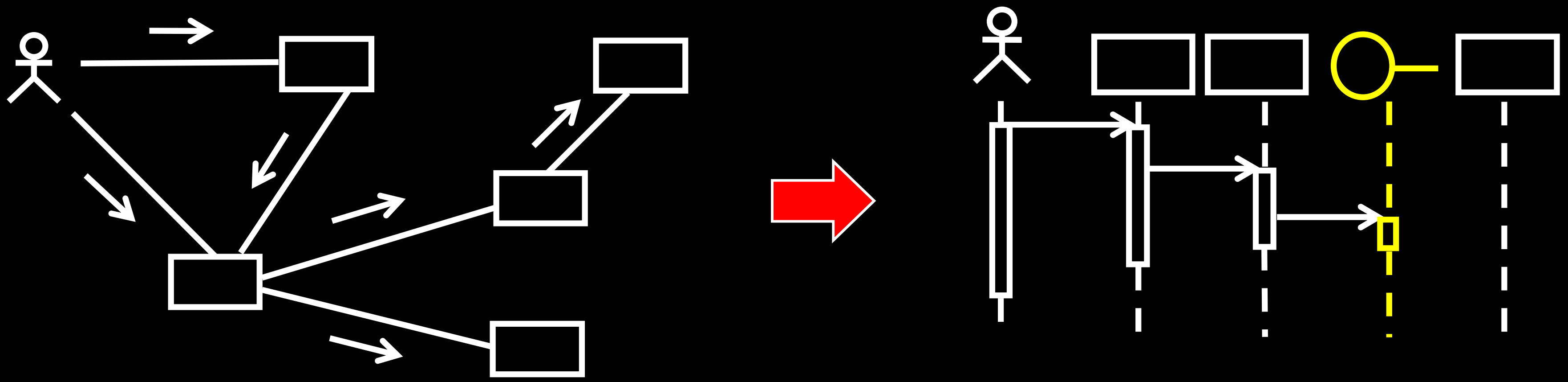
Sequence Diagrams



Class Diagrams

Use-Case Realization Refinement Steps

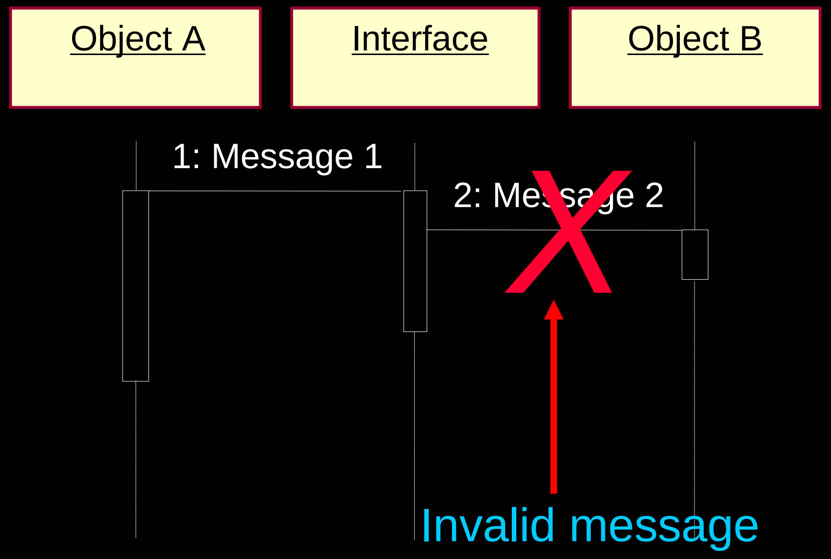
- Identify each object that participates in the flow of the use case
- Represent each participating object in a sequence diagram

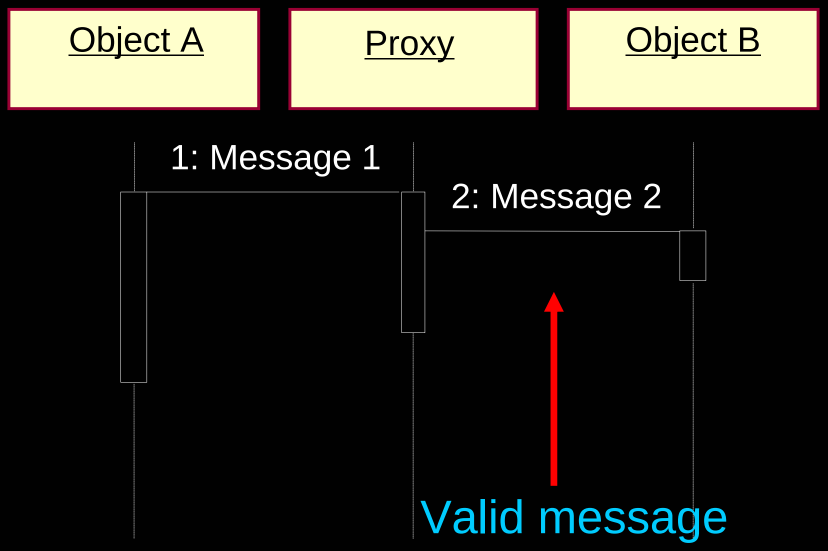


- Incrementally incorporate applicable architectural mechanisms

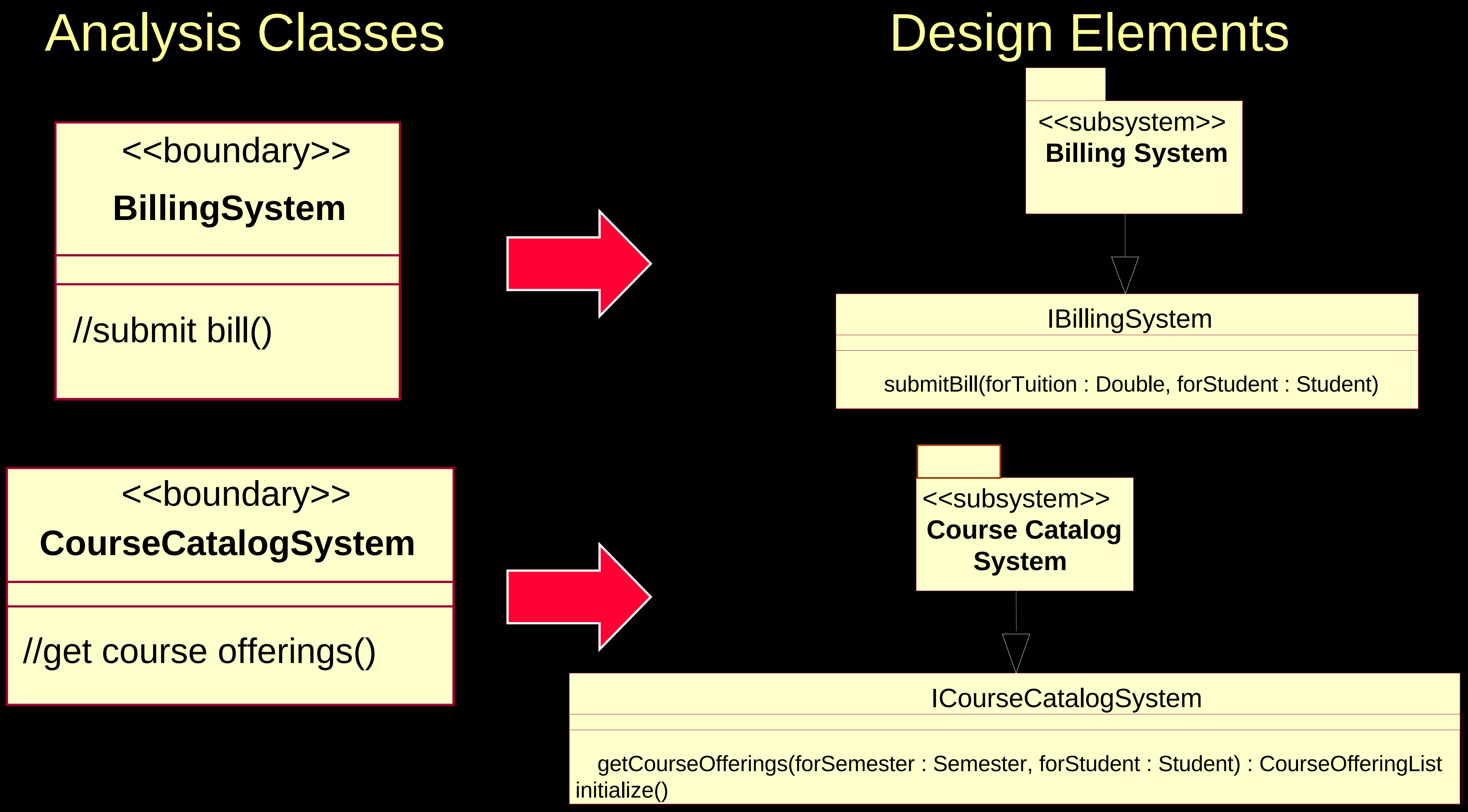
Representing Subsystems on a Sequence Diagram

- Interfaces
  - Represent any model element that realizes the interface
  - No message should be drawn from the interface
- Proxy class
  - Represents a specific subsystem
  - Messages can be drawn from the proxy



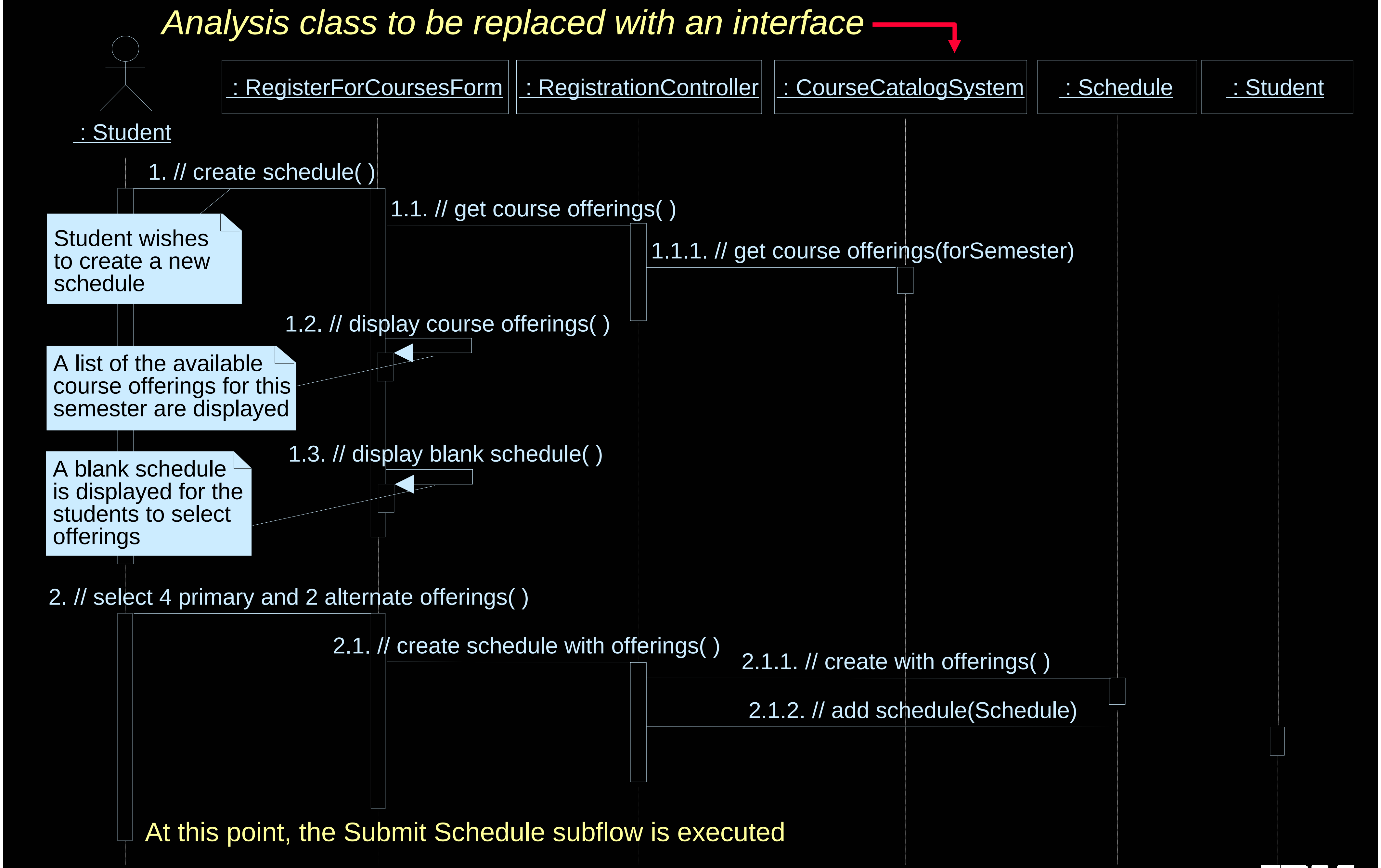


Example: Incorporating Subsystem Interfaces



Analysis classes are mapped directly to design classes.

Example: Incorporating Subsystem Interfaces (Before)



Analysis class to be replaced with an interface

: Student

: RegisterForCoursesForm

: RegistrationController

: CourseCatalogSystem

: Schedule

: Student

1. // create schedule( )

1.1. // get course offerings( )

1.1.1. // get course offerings(forSemester)

1.2. // display course offerings( )

1.3. // display blank schedule( )

2. // select 4 primary and 2 alternate offerings( )

2.1. // create schedule with offerings( )

2.1.1. // create with offerings( )

2.1.2. // add schedule(Schedule)

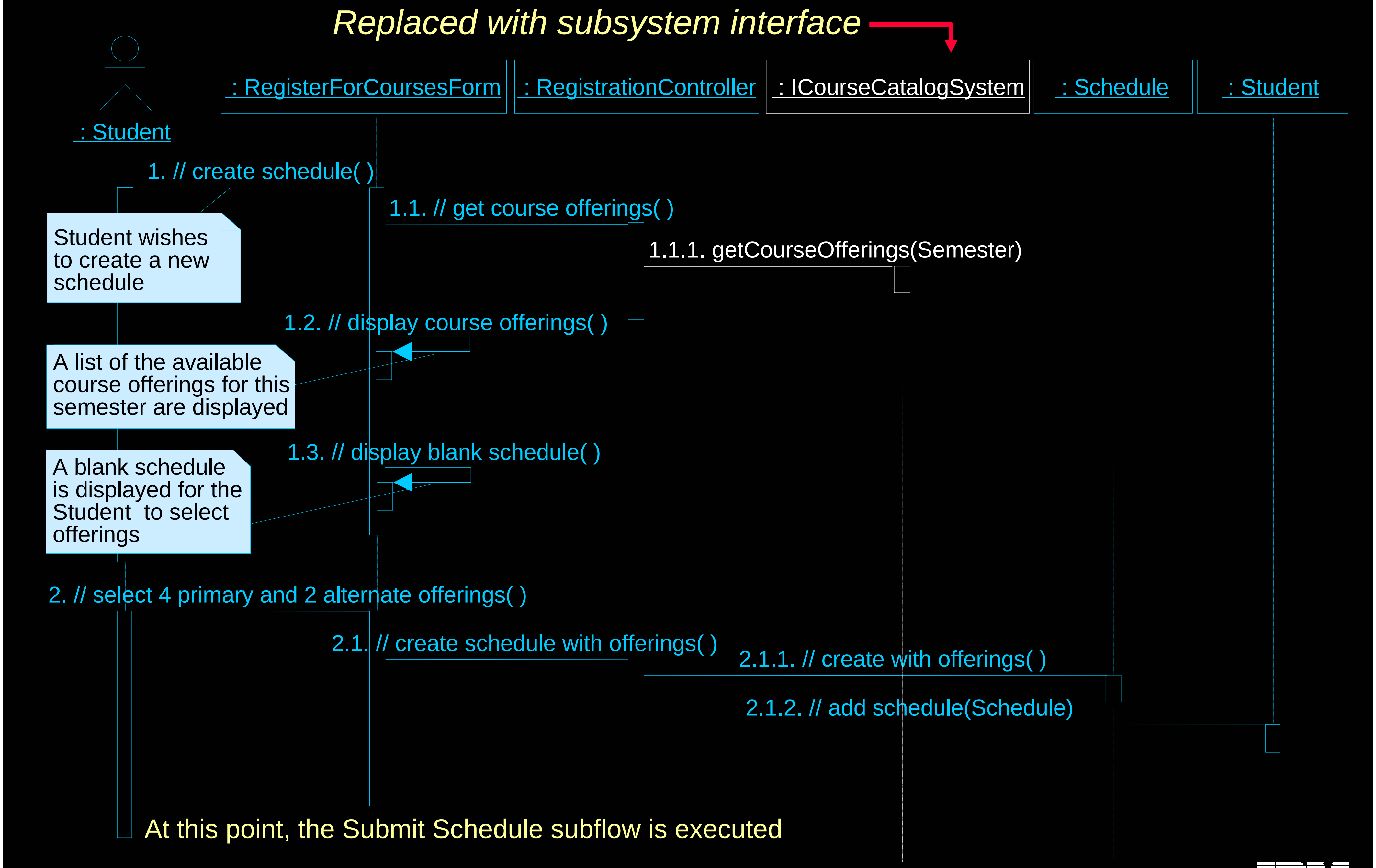
Student wishes to create a new schedule

A list of the available course offerings for this semester are displayed

A blank schedule is displayed for the students to select offerings

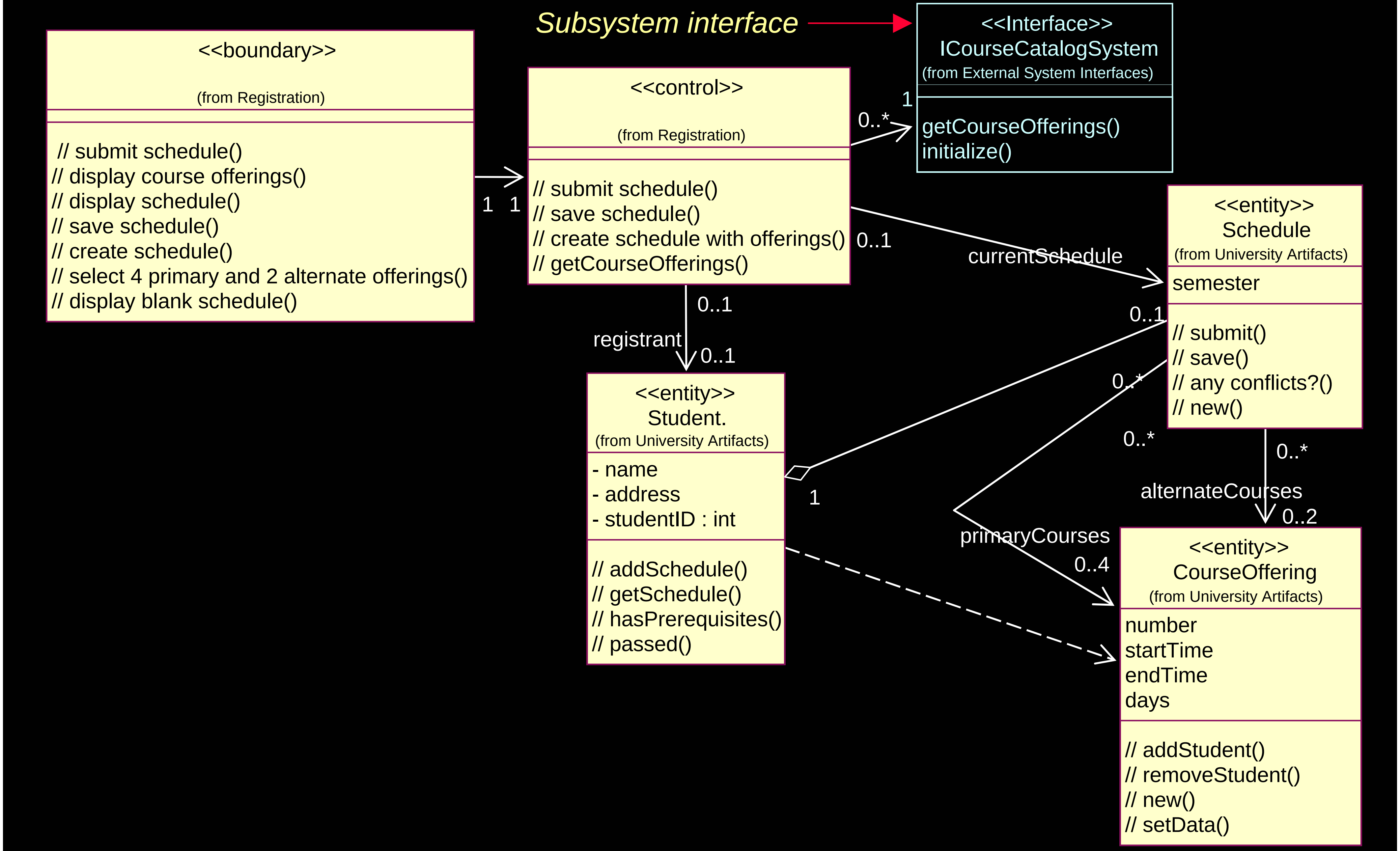
At this point, the Submit Schedule subflow is executed

Example: Incorporating Subsystem Interfaces (After)



Replaced with subsystem interface
: Student
: RegisterForCoursesForm
: RegistrationController
: ICourseCatalogSystem
: Schedule
: Student
1. // create schedule( )
Student wishes to create a new schedule
1.1. // get course offerings( )
1.1.1. getCourseOfferings(Semester)
1.2. // display course offerings( )
A list of the available course offerings for this semester are displayed
1.3. // display blank schedule( )
A blank schedule is displayed for the Student to select offerings
2. // select 4 primary and 2 alternate offerings( )
2.1. // create schedule with offerings( )
2.1.1. // create with offerings( )
2.1.2. // add schedule(Schedule)
At this point, the Submit Schedule subflow is executed

Example: Incorporating Subsystem Interfaces (VOPC)



Subsystem interface

<<Interface>>
ICourseCatalogSystem
(from External System Interfaces)

getCourseOfferings()
initialize()

<<boundary>>

(from Registration)

// submit schedule()
// display course offerings()
// display schedule()
// save schedule()
// create schedule()
// select 4 primary and 2 alternate offerings()
// display blank schedule()

<<control>>

(from Registration)

// submit schedule()
// save schedule()
// create schedule with offerings()
// getCourseOfferings()

<<entity>>
Schedule
(from University Artifacts)

semester

// submit()
// save()
// any conflicts?()
// new()

<<entity>>
Student.
(from University Artifacts)

- name
- address
- studentID : int

// addSchedule()
// getSchedule()
// hasPrerequisites()
// passed()

<<entity>>
CourseOffering
(from University Artifacts)

number
startTime
endTime
days

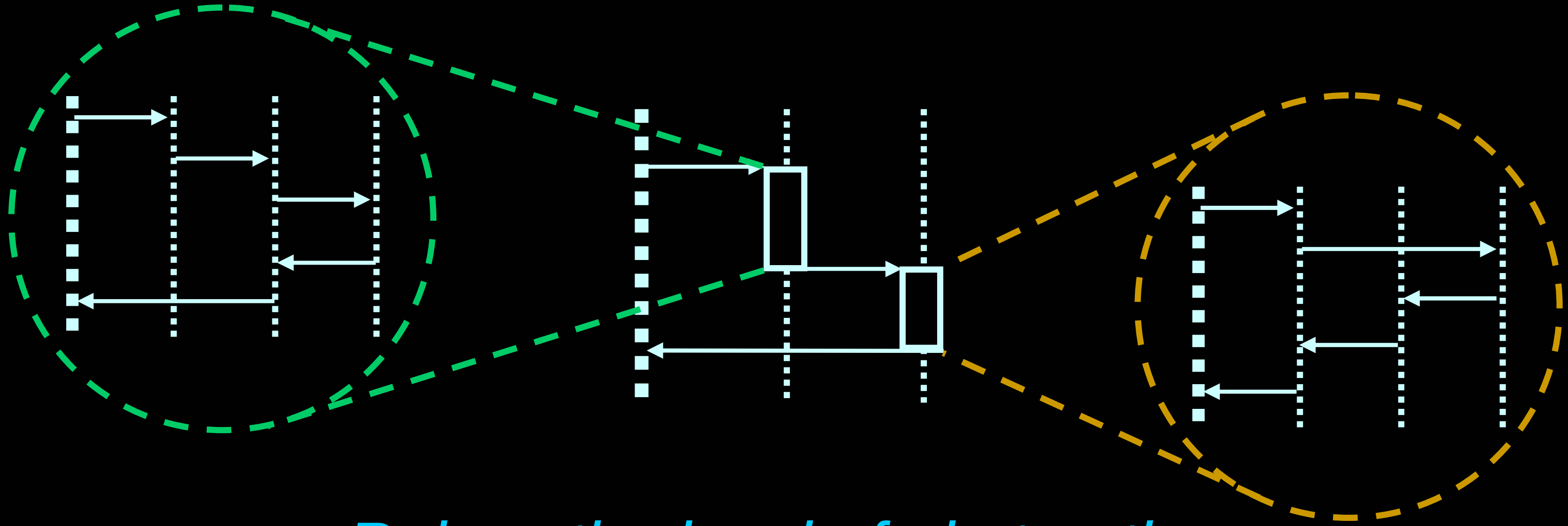
// addStudent()
// removeStudent()
// new()
// setData()

Use-Case Design Steps

- Describe interaction among design objects
- ★ Simplify sequence diagrams using subsystems
- Describe persistence-related behavior
- Refine the flow of events description
- Unify classes and subsystems

Encapsulating Subsystem Interactions

- Interactions can be described at several levels
- Subsystem interactions can be described in their own interaction diagrams

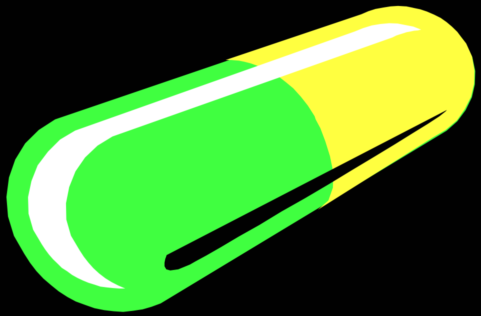


Raises the level of abstraction

When to Encapsulate Subflows in a Subsystem

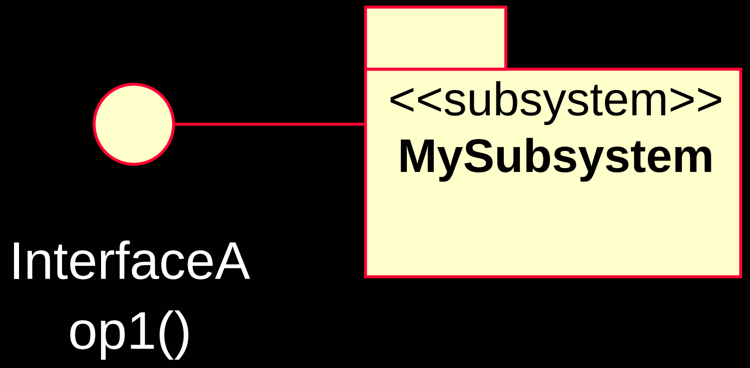
Encapsulate a Subflow when it:

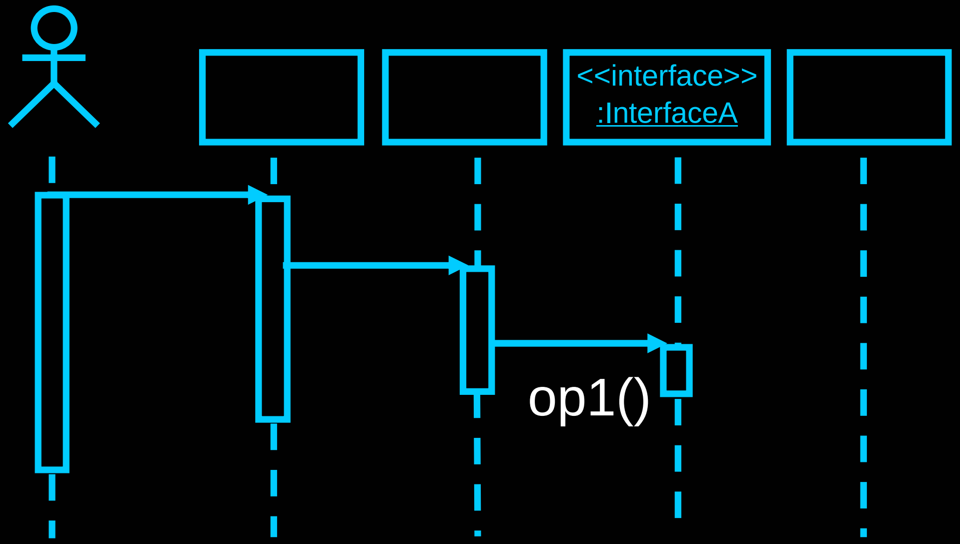
- Occurs in multiple use-case realizations
- Has reuse potential
- Is complex and easily encapsulated
- Is responsibility of one person or team
- Produces a well-defined result
- Is encapsulated within a single Implementation Model component



Guidelines: Encapsulating Subsystem Interactions

- Subsystems should be represented by their interfaces on interaction diagrams
- Messages to subsystems are modeled as messages to the subsystem interface
- Messages to subsystems correspond to operations of the subsystem interface
- Interactions within subsystems are modeled in Subsystem Design





Advantages of Encapsulating Subsystem Interactions

Use-case realizations:

- Are less cluttered
- Can be created before the internal designs of subsystems are created (parallel development)
- Are more generic and easier to change (Subsystems can be substituted.)

Parallel Subsystem Development

- Concentrate on requirements that affect subsystem interfaces
- Outline required interfaces
- Model messages that cross subsystem boundaries
- Draw interaction diagrams in terms of subsystem interfaces for each use case
- Refine the interfaces needed to provide messages
- Develop each subsystem in parallel

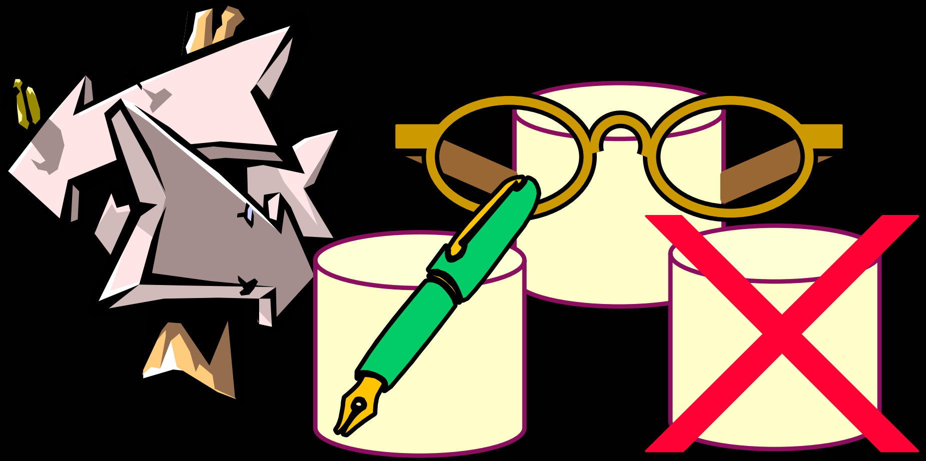
Use subsystem interfaces as synchronization points

Use-Case Design Steps

- Describe interaction among design objects
- Simplify sequence diagrams using subsystems
- ★ Describe persistence-related behavior
- Refine the flow of events description
- Unify classes and subsystems

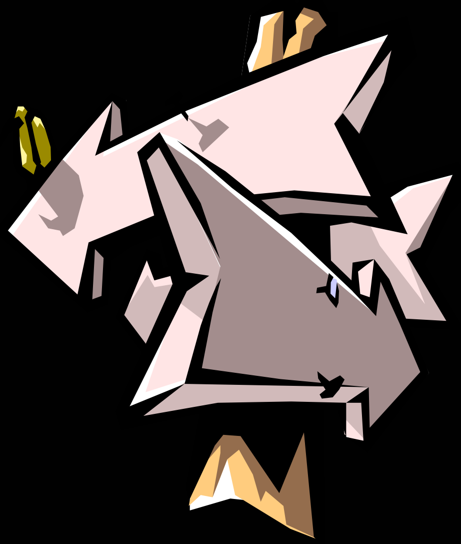
Use-Case Design Steps: Describe Persistence-Related Behavior

- Describe Persistence-Related Behavior
  - Modeling Transactions
  - Writing Persistent Objects
  - Reading Persistent Objects
  - Deleting Persistent Objects



Modeling Transactions

- What is a transaction?
  - Atomic operation invocations
  - “All or nothing”
  - Provide consistency
- Modeling options
  - Textually (scripts)
  - Explicit messages
- Error conditions
  - Rollback
  - Failure modes
  - May require separate interaction diagrams

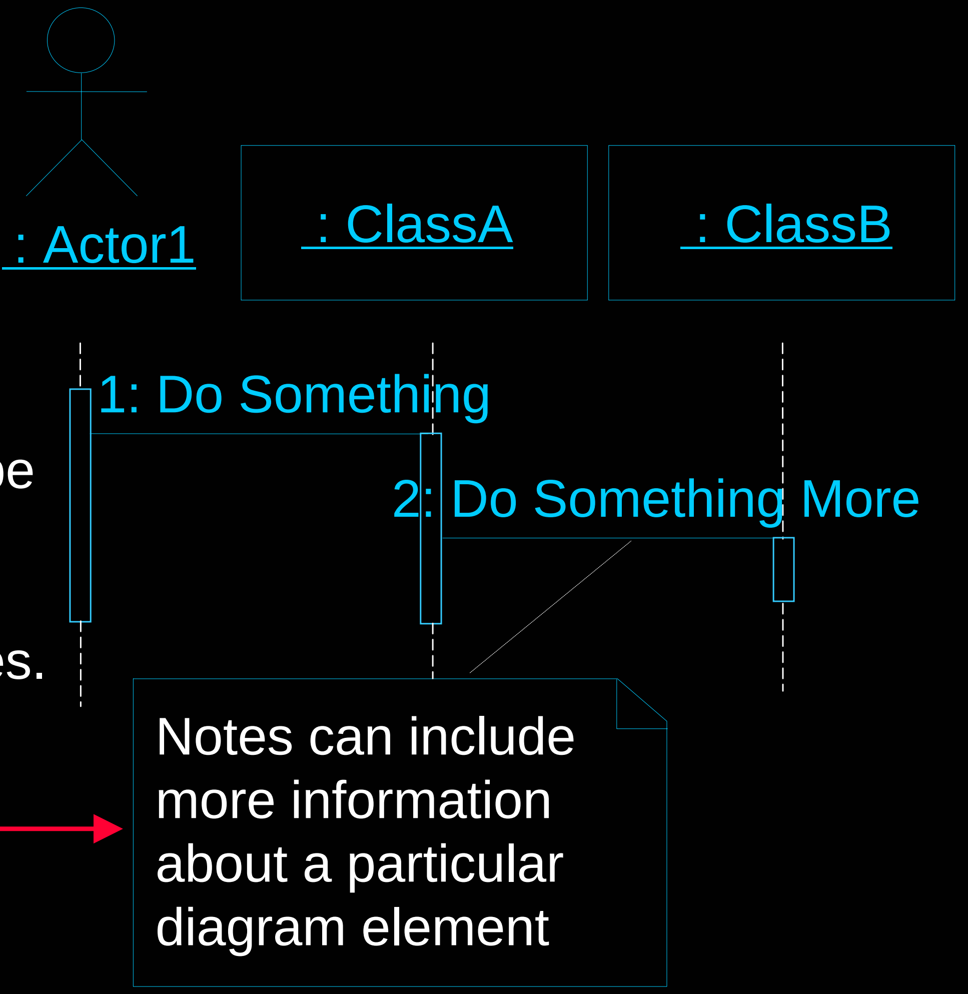


Use-Case Design Steps

- Describe interaction among design objects
- Simplify sequence diagrams using subsystems
- Describe persistence-related behavior
- ★ Refine the flow of events description
- Unify classes and subsystems

Detailed Flow of Events Description Options

- Annotate the interaction diagrams



Script → Scripts can be used to describe the details surrounding these messages.

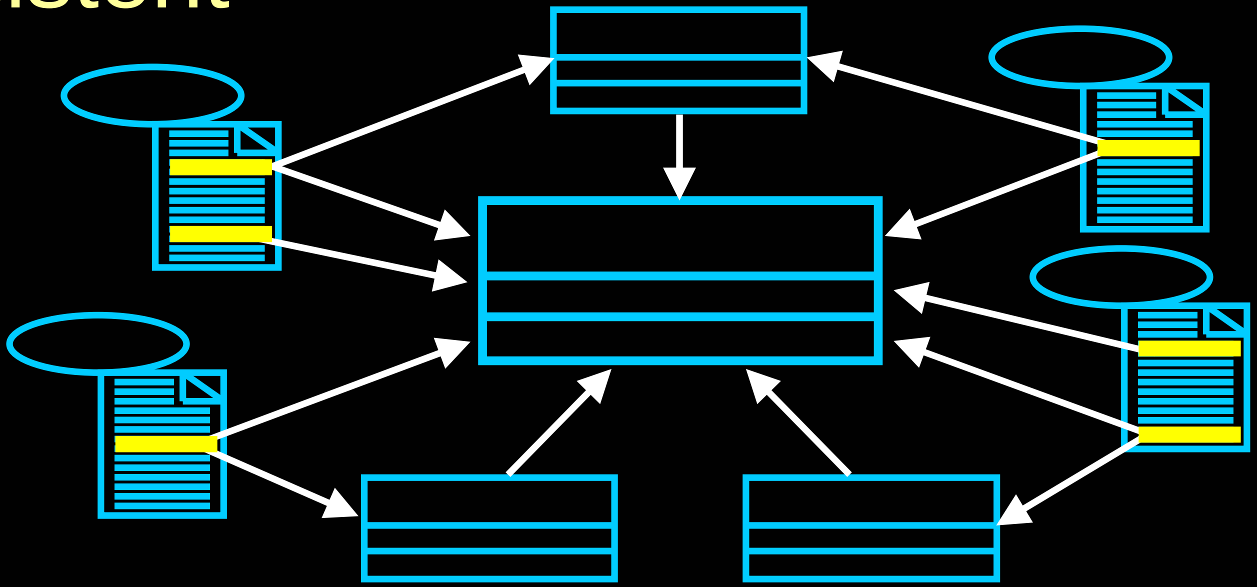
Note → Notes can include more information about a particular diagram element

Use-Case Design Steps

- Describe interaction among design objects
- Simplify sequence diagrams using subsystems
- Describe persistence-related behavior
- Refine the flow of events description
- ★ Unify classes and subsystems

Design Model Unification Considerations

- Model element names should describe their function
- Merge similar model elements
- Use inheritance to abstract model elements
- Keep model elements and flows of events consistent



Checkpoints: Use-Case Design

- Is package/subsystem partitioning logical and consistent?
- Are the names of the packages/subsystems descriptive?
- Do the public package classes and subsystem interfaces provide a single, logically consistent set of services?
- Do the package/subsystem dependencies correspond to the relationships between the contained classes?
- Do the classes contained in a package belong there according to the criteria for the package division?
- Are there classes or collaborations of classes that can be separated into an independent package/subsystem?

Checkpoints: Use-Case Design

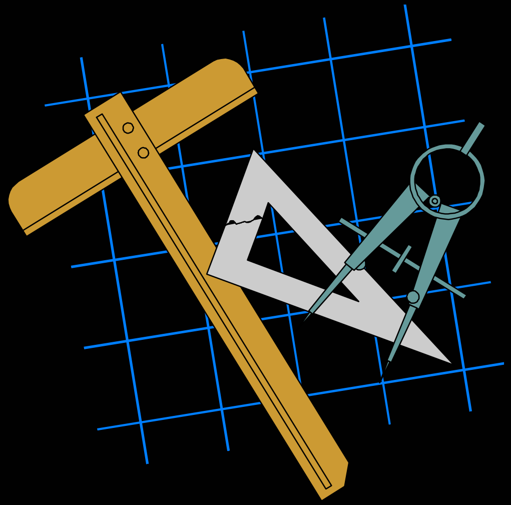
- Have all the main and/or subflow for this iteration been handled?
- Has all behavior been distributed among the participating design elements?
- Has behavior been distributed to the right design elements?
- If there are several interaction diagrams for the use-case realization, is it easy to understand which collaboration diagrams relate to which flow of events?

Review: Use-Case Design

- What is the purpose of Use-Case Design?
- What is meant by encapsulating subsystem interactions? Why is it a good thing to do?

Exercise: Use-Case Design

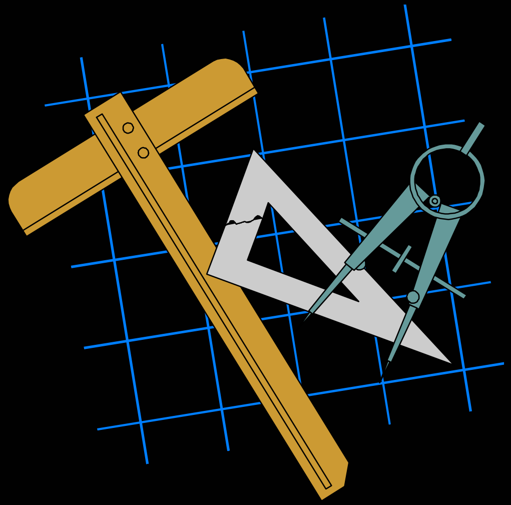
- Given the following:
  - Analysis use-case realizations (VOPCs and interaction diagrams)
  - The analysis-class-to-design-element map



(continued)

Exercise: Use-Case Design (cont.)

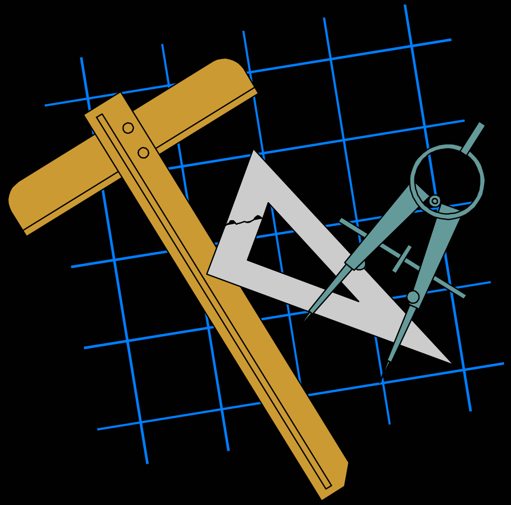
- Identify the following:
  - The design elements that replaced the analysis classes in the analysis use-case realizations
  - The design element collaborations needed to implement the use case
  - The relationships between the design elements needed to support the collaborations



(continued)

Exercise: Use-Case Design (cont.)

- Produce the following:
  - Design use-case realization
    - Interaction diagram(s) per use-case flow of events that describes the design element collaborations required to implement the use case
    - Class diagram (VOPC) that includes the design elements that must collaborate to perform the use case, and their relationships



(continued)

Exercise: Review

- Compare your use-case realizations
  - Have all the main and subflows for this iteration been handled?
  - Has all behavior been distributed among the participating design elements?
  - Has behavior been distributed to the right design elements?
  - Are there any messages coming from the interfaces?