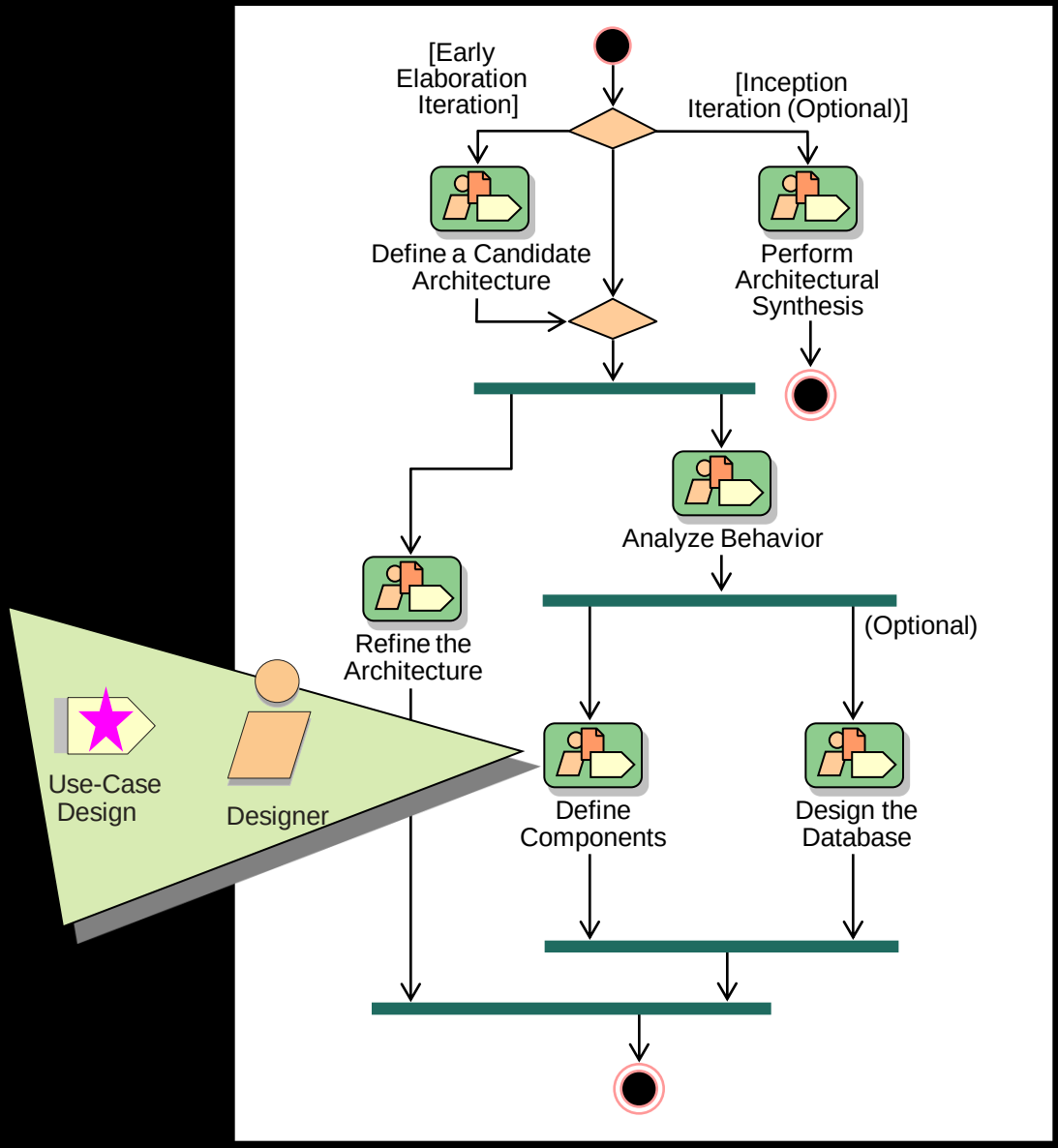
Object-Oriented Analysis and Design

Lecture 11: Use-Case Design

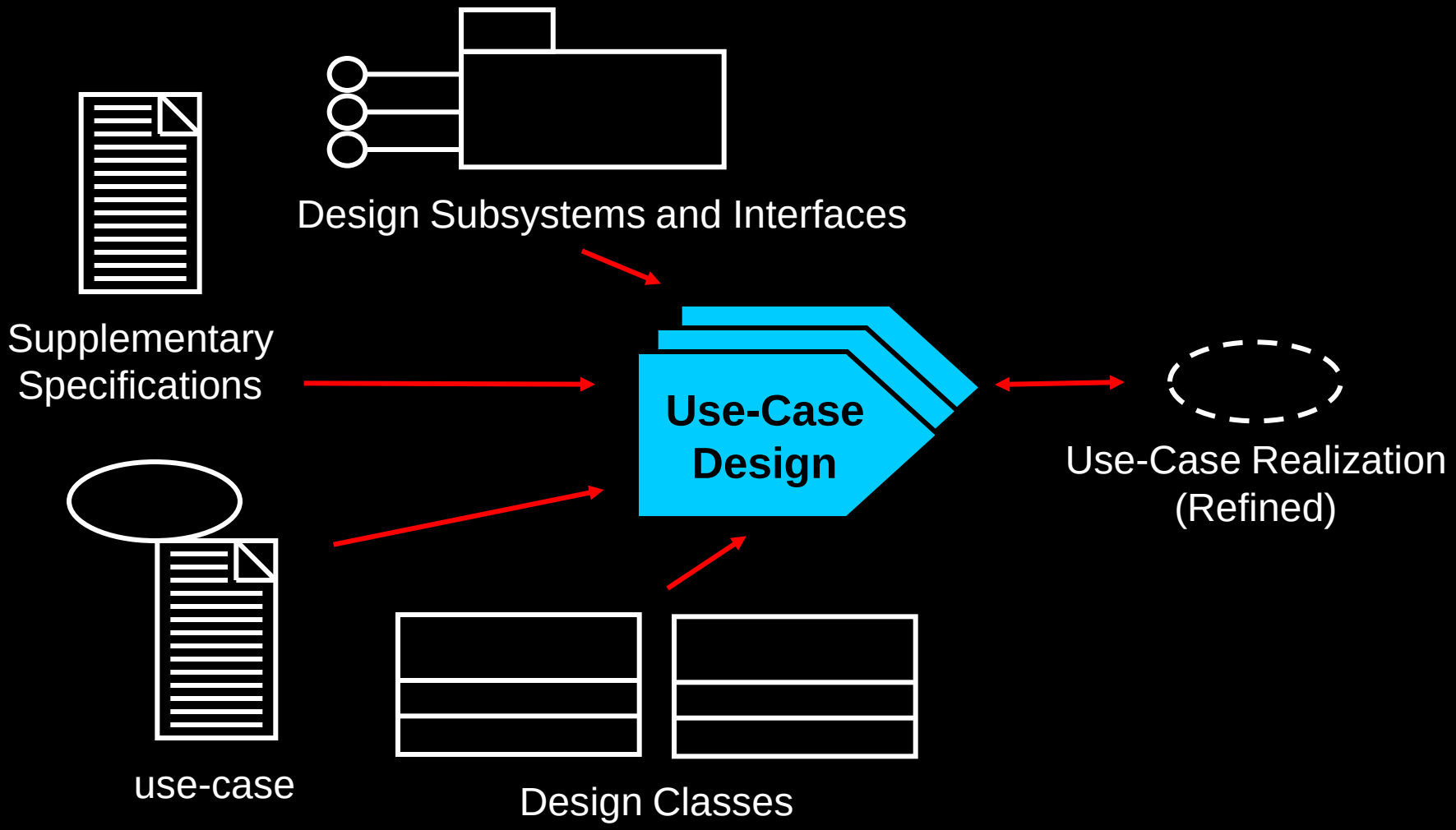
Objectives: Use-Case Design

- 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

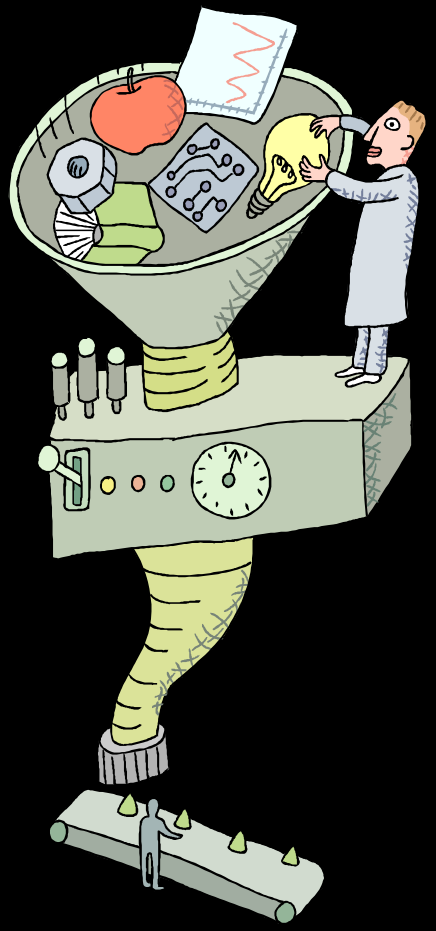


Use-Case Design Overview



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
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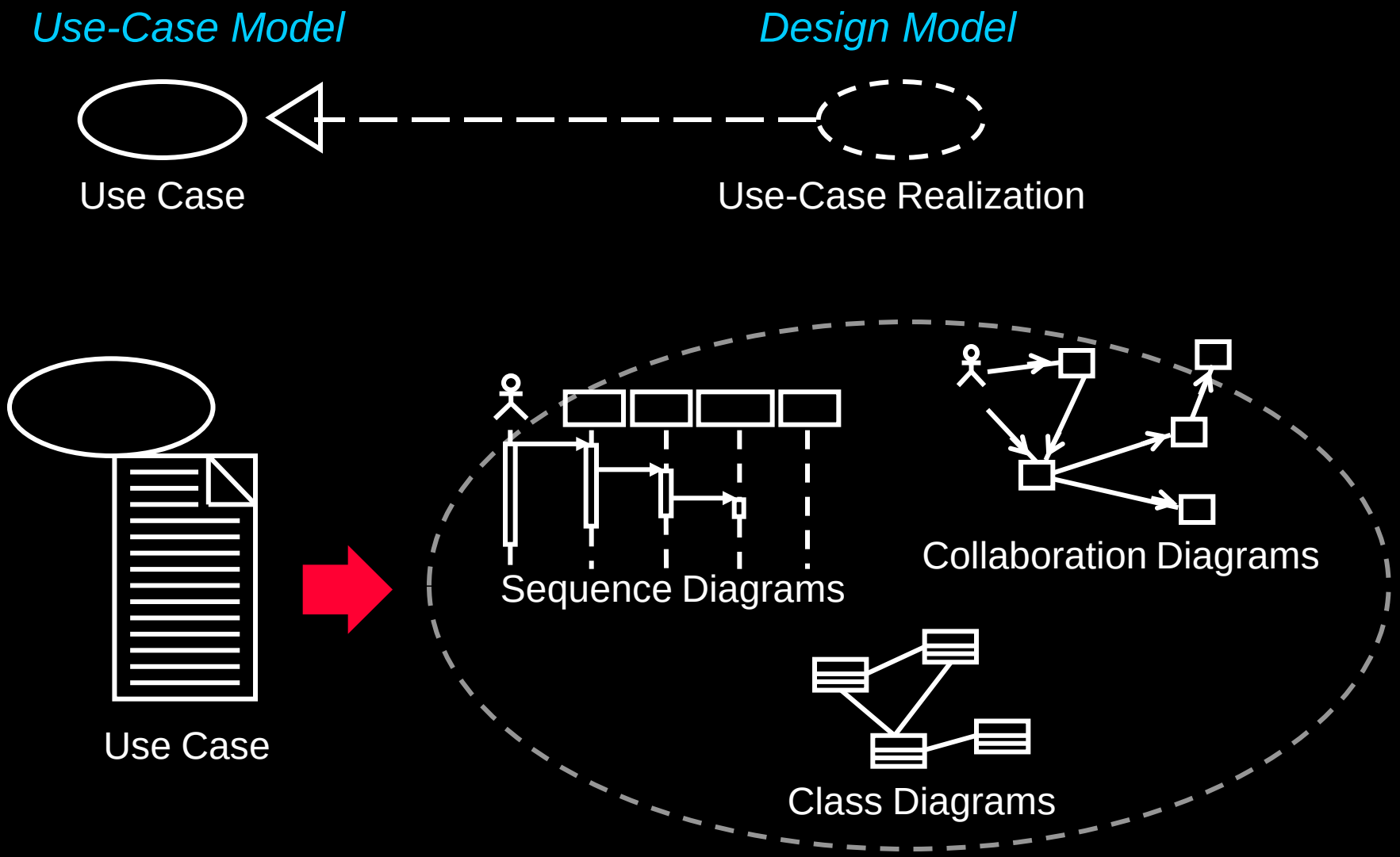
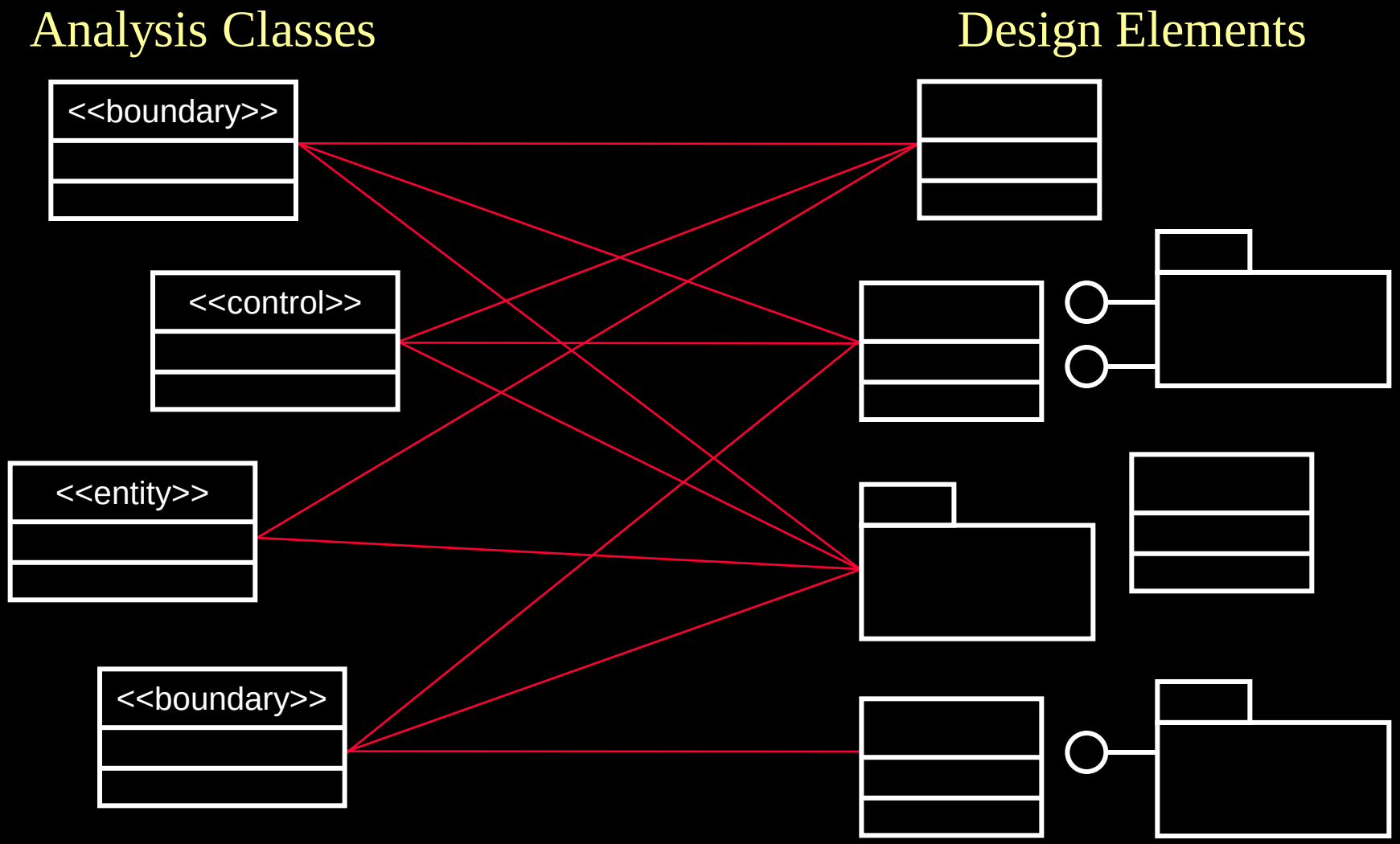
Review: Use-Case Realization

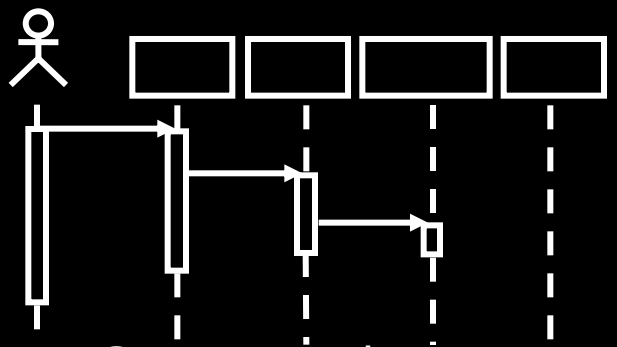


Review: From Analysis Classes to Design Elements

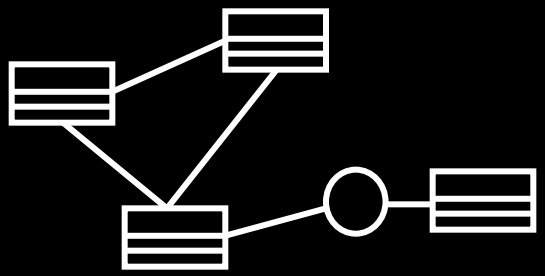


Use-Case Realization Refinement

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



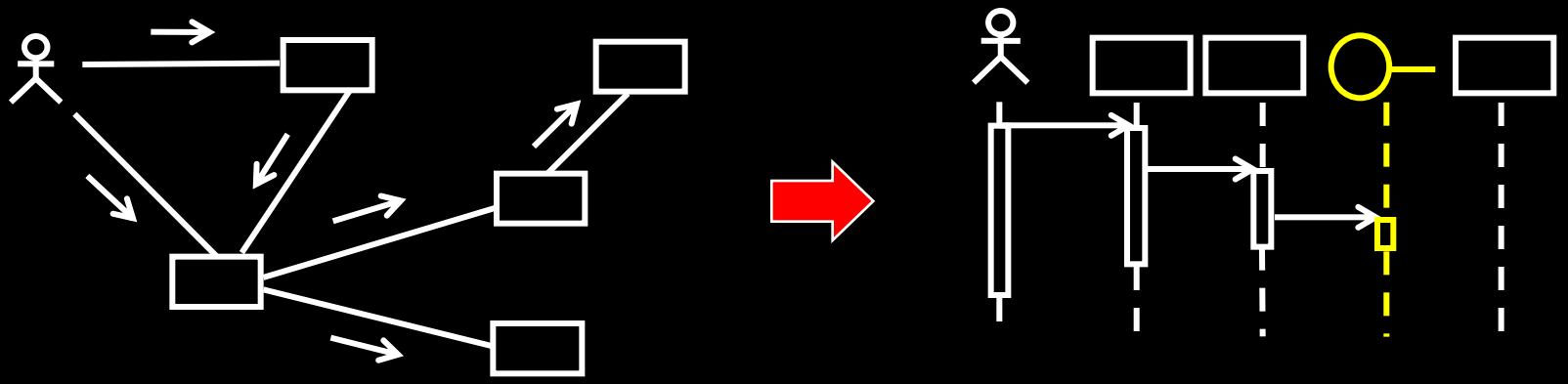
Sequence Diagrams



Class Diagrams

Use-Case Realization Refinement Steps

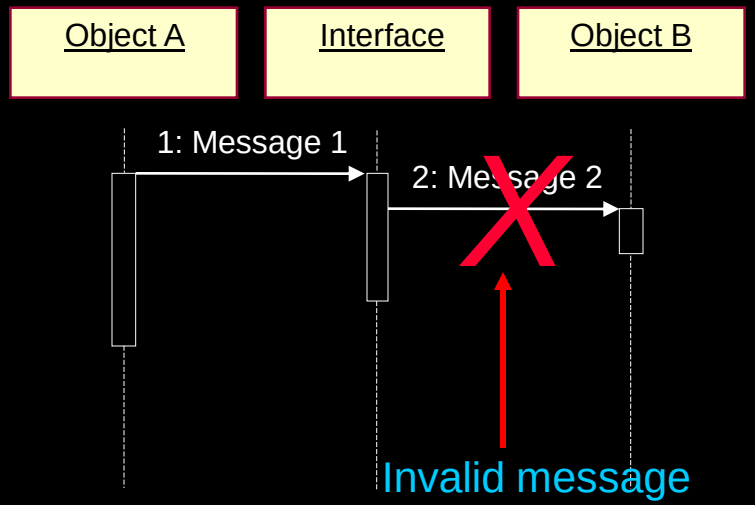
- Identify each object that participates in the flow of the use case
- Represent each participating object in a sequence diagram

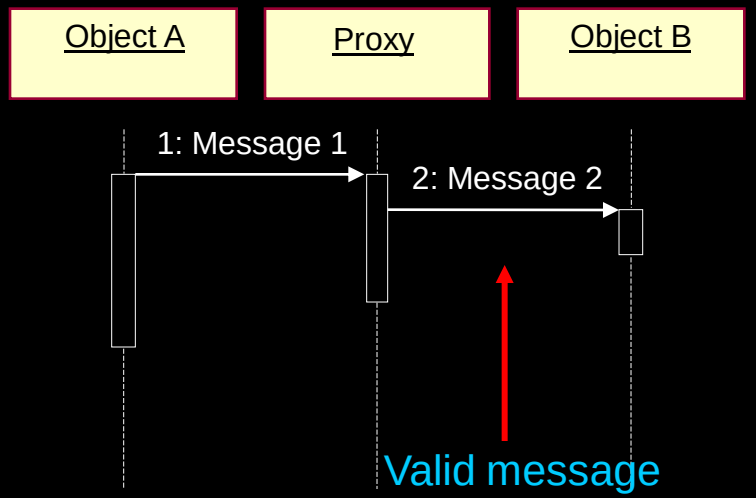


- Incrementally incorporate applicable architectural mechanisms

Representing Subsystems on a Sequence Diagram

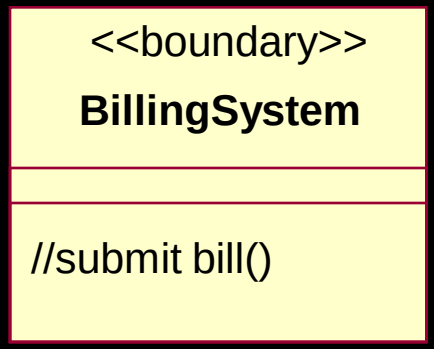
- Interfaces
  - Represent any model element that realizes the interface
  - No message should be drawn from the interface
- Proxy class
  - Represents a specific subsystem
  - Messages can be drawn from the proxy

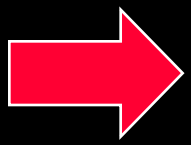




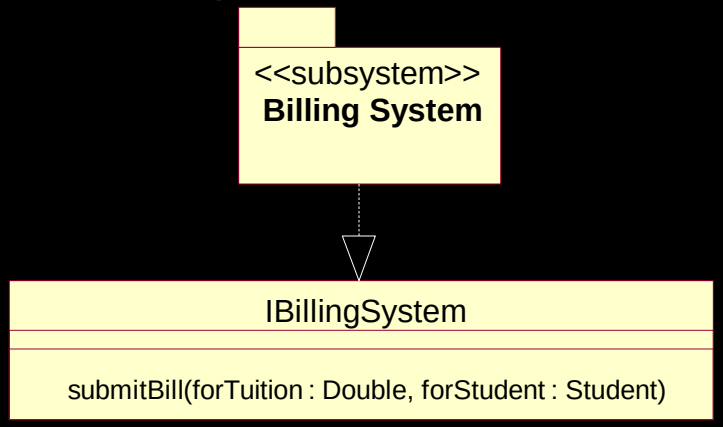
Example: Incorporating Subsystem Interfaces

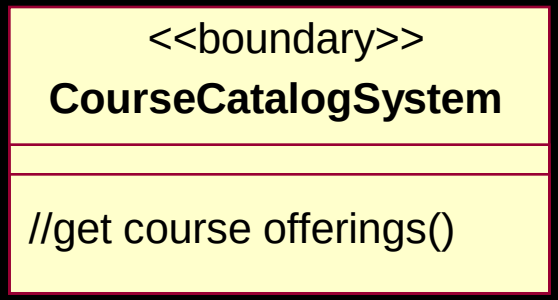
Analysis Classes

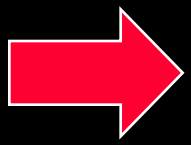




Design Elements

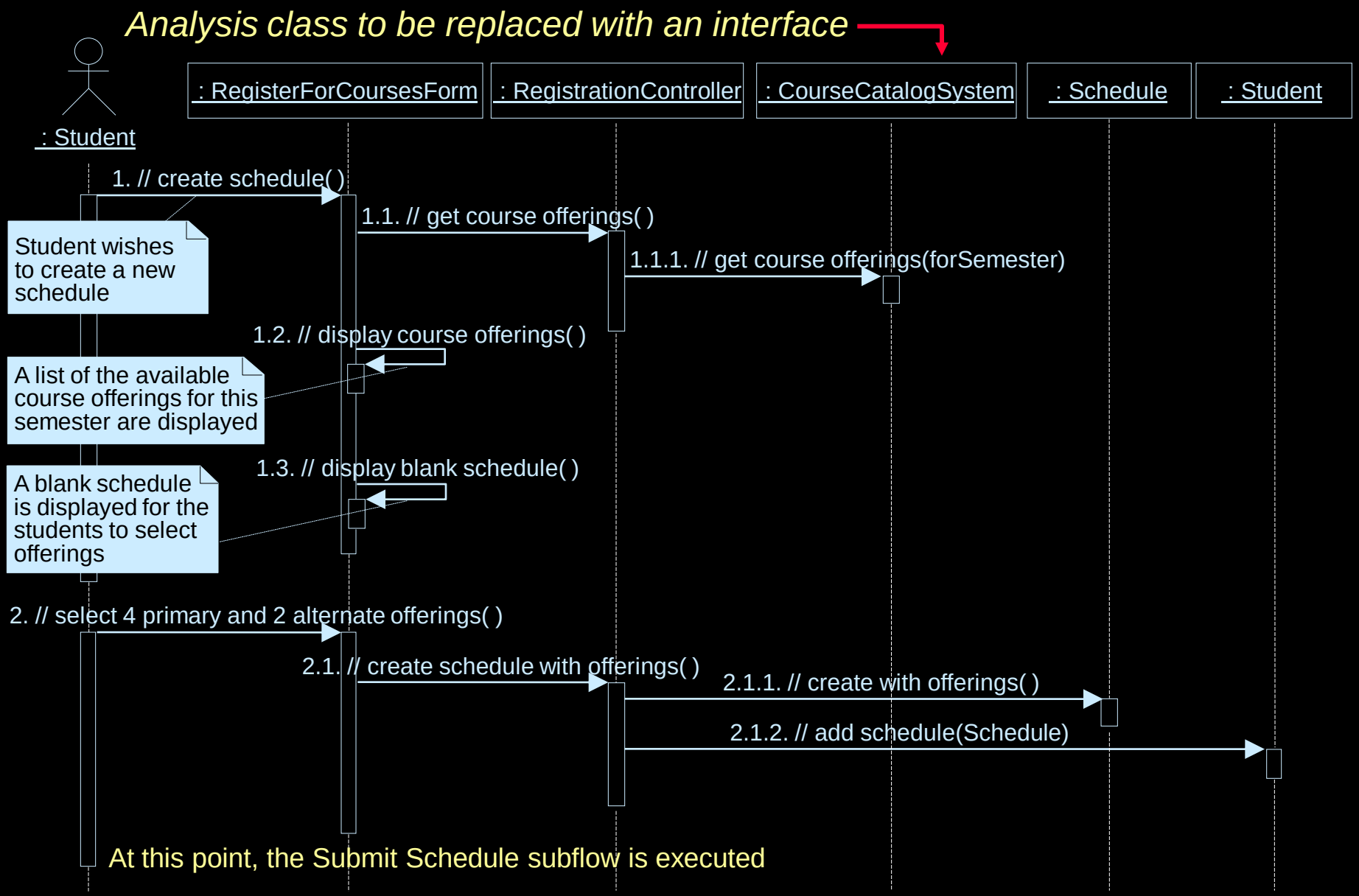




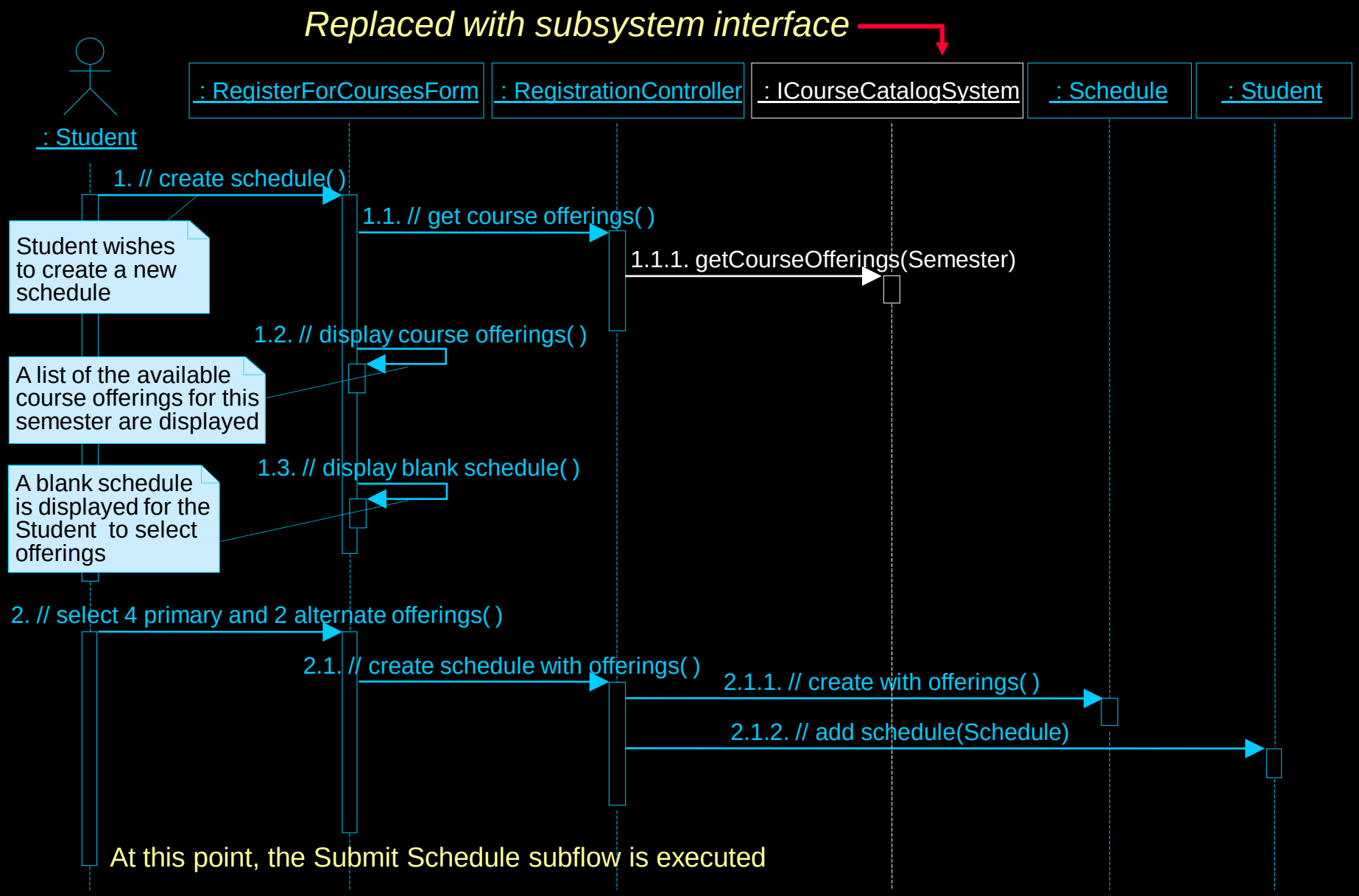


Analysis classes are mapped directly to design classes.

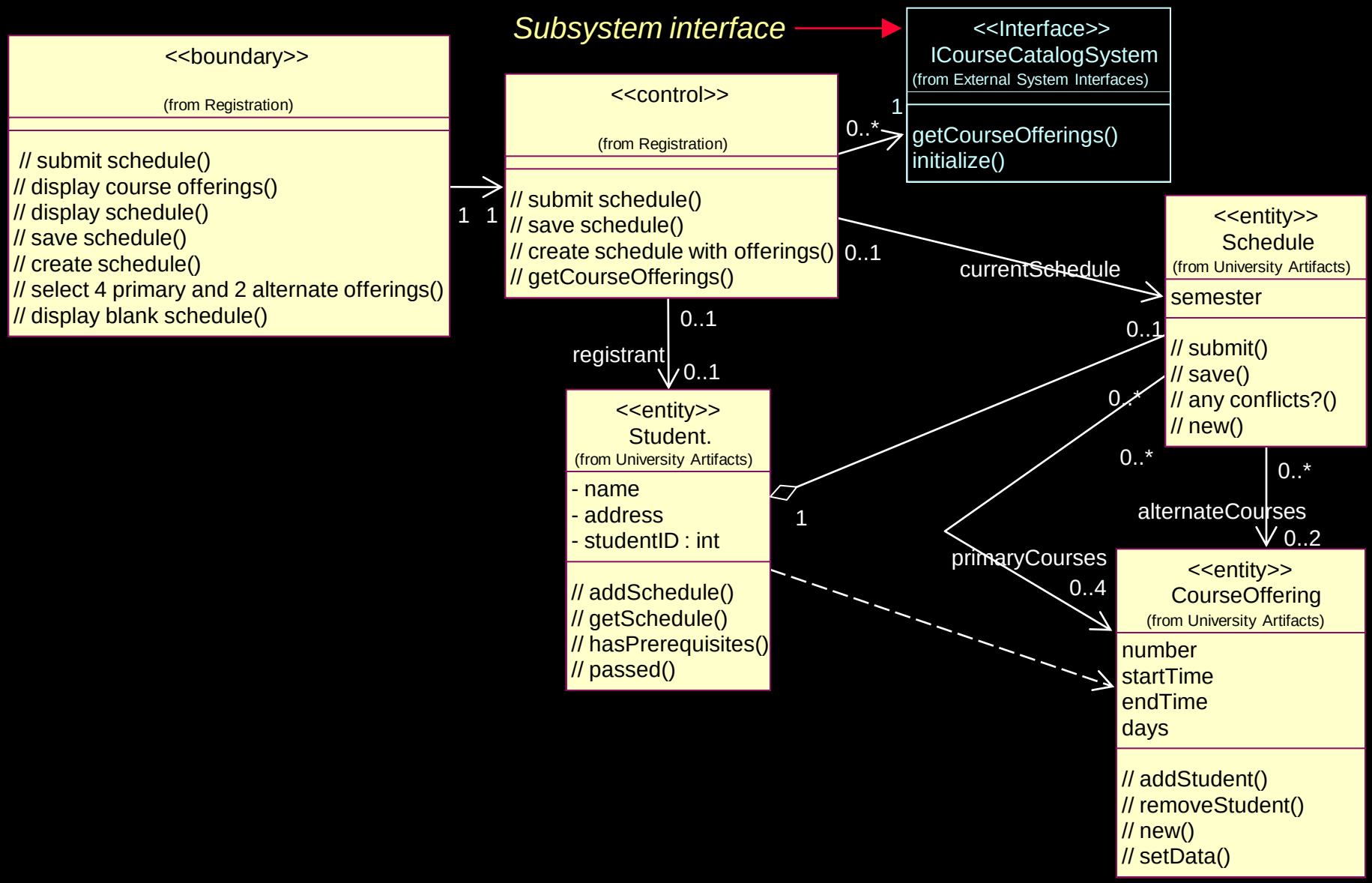
Example: Incorporating Subsystem Interfaces (Before)



Example: Incorporating Subsystem Interfaces (After)



Example: Incorporating Subsystem Interfaces (VOPC)



Incorporating Architectural Mechanisms: Security

- Analysis-Class-to-Architectural-Mechanism Map from Use-Case Analysis

Analysis Class	Analysis Mechanism(s)
Student	Persistency, *Security*
Schedule	Persistency, *Security*
CourseOffering	Persistency, Legacy Interface
Course	Persistency, Legacy Interface
RegistrationController	Distribution

Details are in the appendix.

Incorporating Architectural Mechanisms: Distribution

- Analysis-Class-to-Architectural-Mechanism Map from Use-Case Analysis

Analysis Class	Analysis Mechanism(s)
Student	Persistency, Security
Schedule	Persistency, Security
CourseOffering	Persistency, Legacy Interface
Course	Persistency, Legacy Interface
RegistrationController	*Distribution*

Review: Incorporating RMI: Steps

- Provide access to RMI support classes (e.g., Remote and Serializable interfaces, Naming Service)
  - √ *Use java.rmi and java.io package in Middleware layer*
- For each class to be distributed:
  - √ *Controllers to be distributed are in Application layer*
  - √ *Dependency from Application layer to Middleware layer is needed to access java packages*
  - Define interface for class that realizes Remote
  - Have class inherit from UnicastRemoteObject

√ - Done

Review: Incorporating RMI: Steps (cont.)

- Have classes for data passed to distributed objects realize the Serializable interface
  - √ *Core data types are in Business Services layer*
  - √ *Dependency from Business Services layer to Middleware layer is needed to get access to java.rmi*
  - Add the realization relationships
- Run pre-processor – out of scope

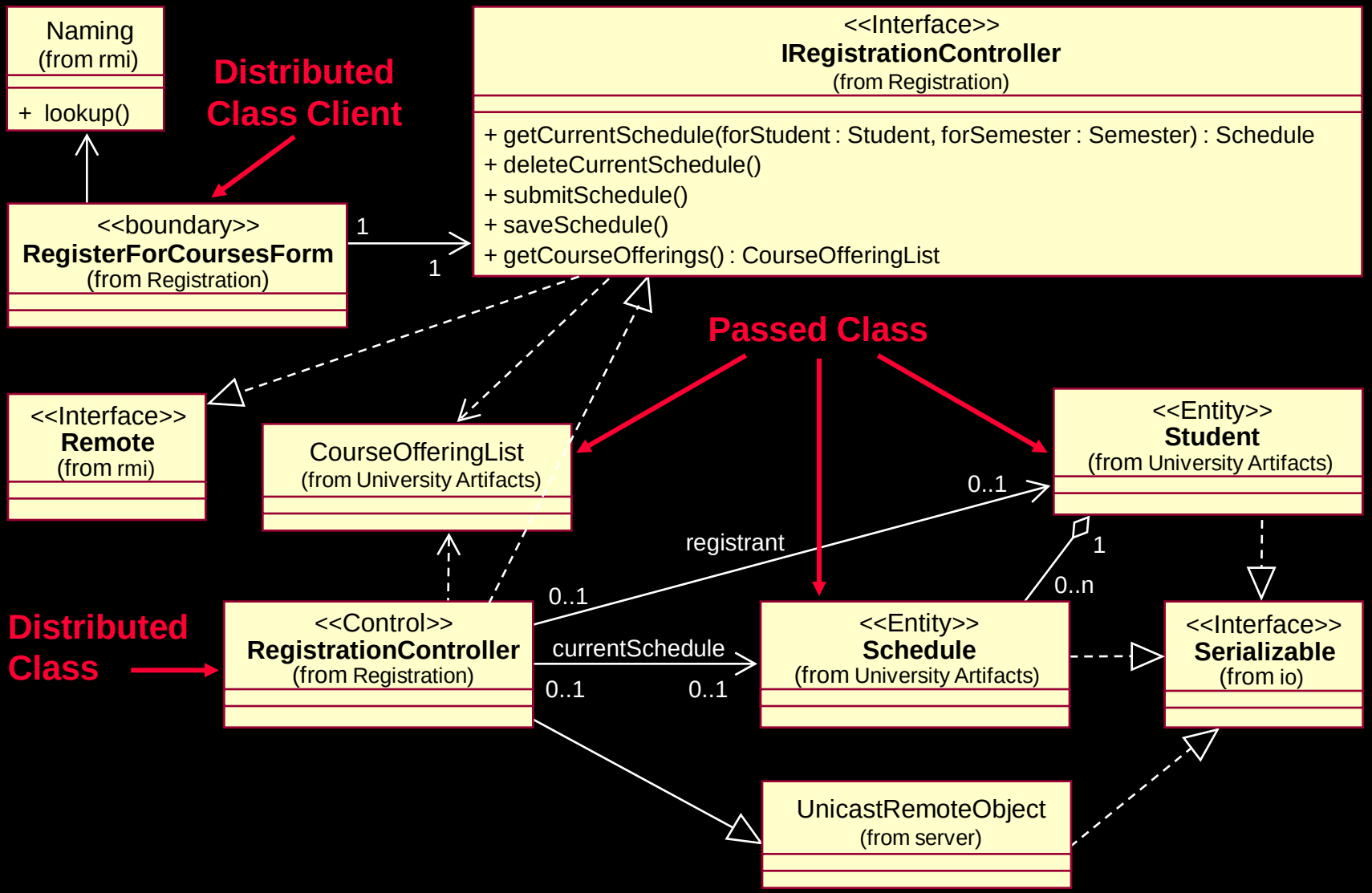
√ - Done

Review: Incorporating RMI: Steps (cont.)

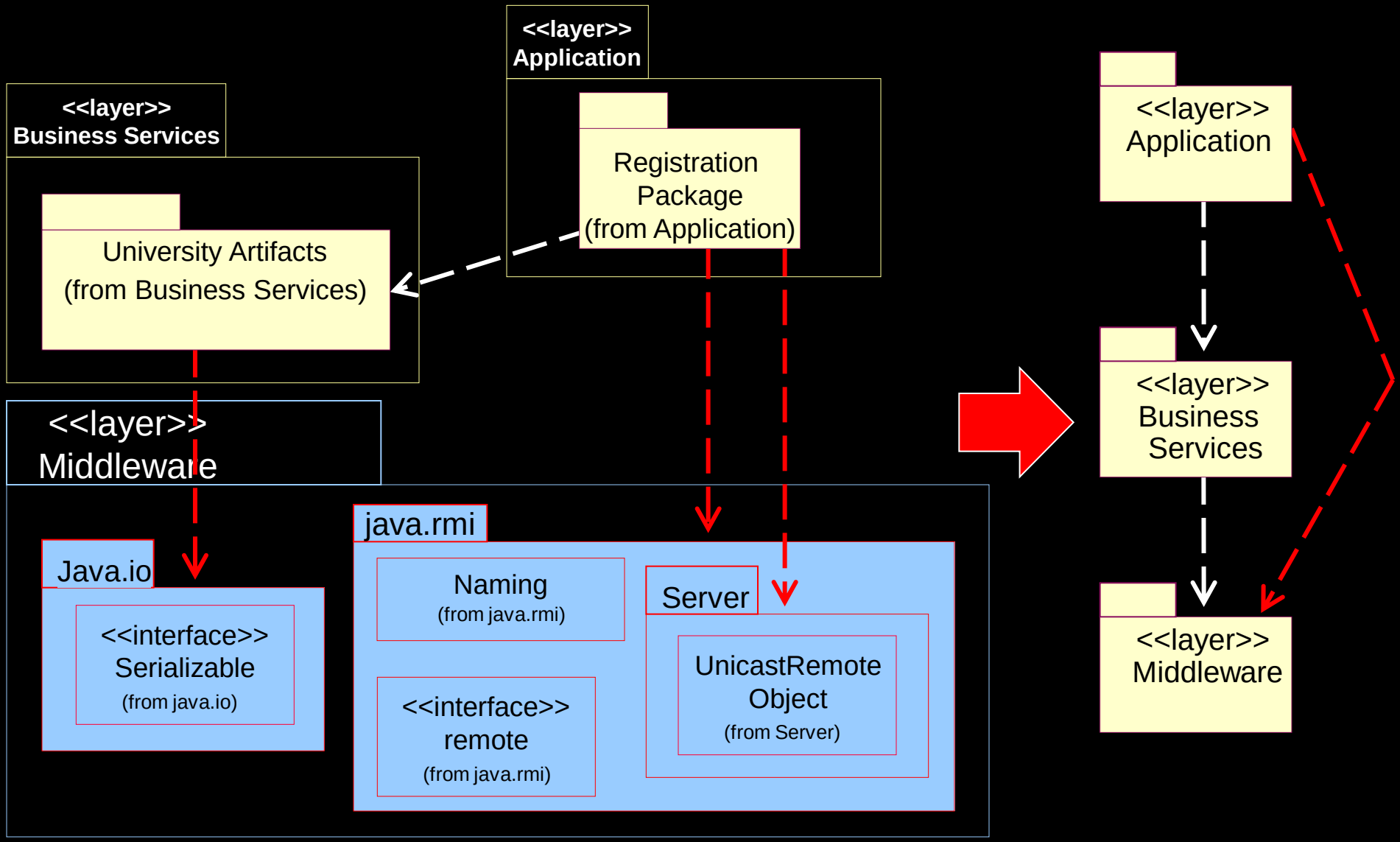
- Have distributed class clients look up the remote objects using the Naming service
  - √ *Most Distributed Class Clients are forms*
  - √ *Forms are in Application layer*
  - √ *Dependency from Application layer to Middleware layer is needed to get access to java.rmi*
  - Add relationship from Distributed Class Clients to Naming Service
- Create/update interaction diagrams with distribution processing (optional)

√ - Done

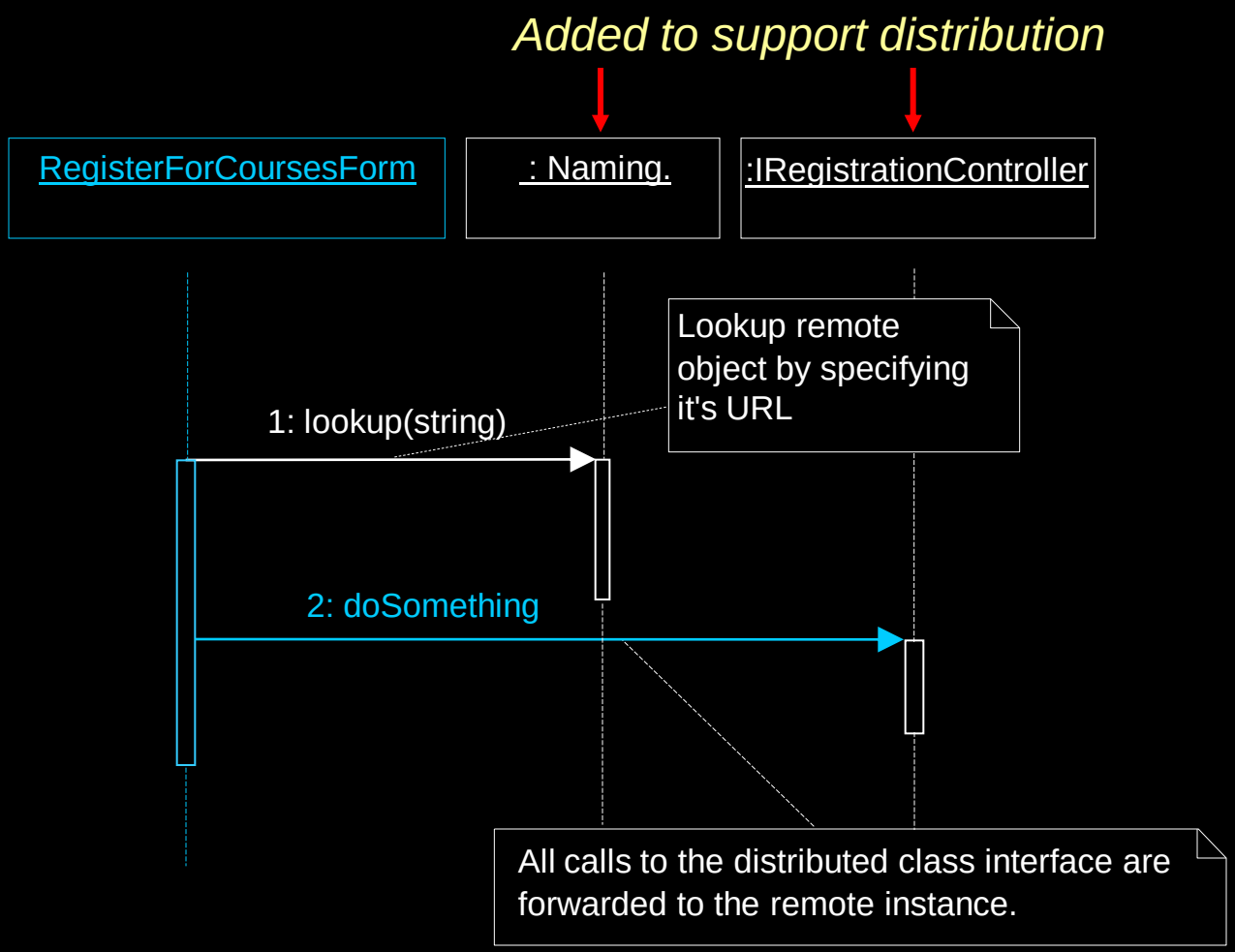
Example: Incorporating RMI



Example: Incorporating RMI (cont.)



Example: Incorporating RMI (cont.)



Use-Case Design Steps

- Describe interaction among design objects
- ★ Simplify sequence diagrams using subsystems
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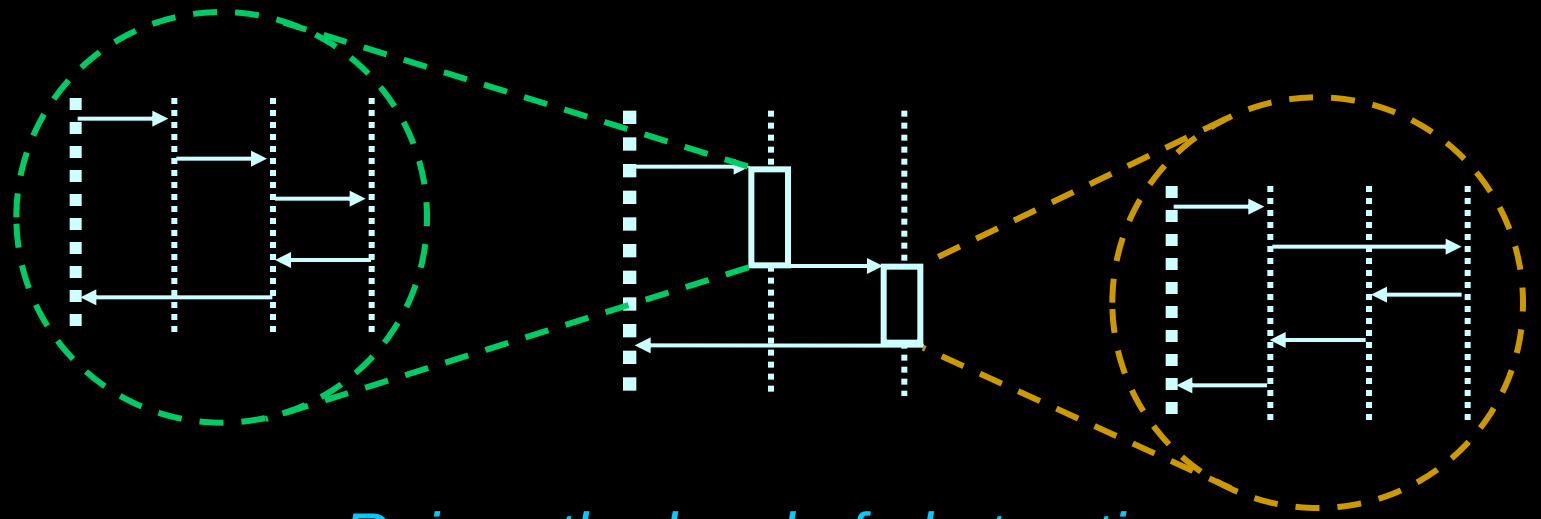
- Unify classes and subsystems

Encapsulating Subsystem Interactions

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

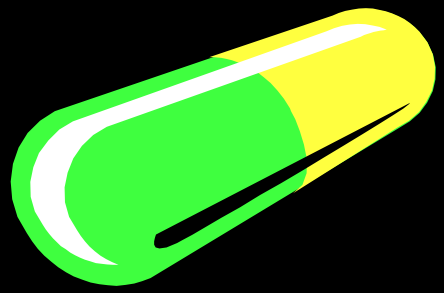


Raises the level of abstraction

When to Encapsulate Subflows in a Subsystem

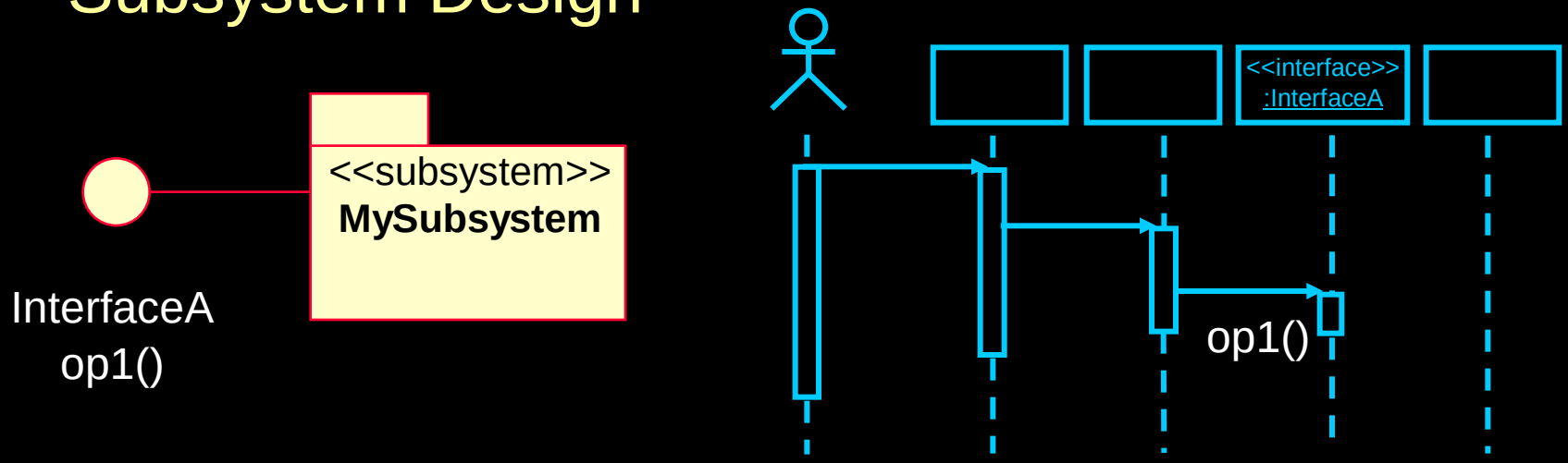
Encapsulate a Subflow when it:

- 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
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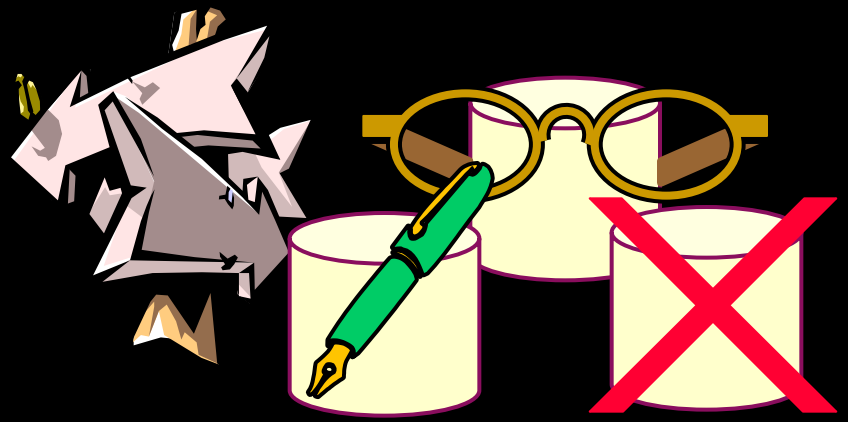
Use-Case Design Steps: Describe Persistence-Related Behavior

- 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

Incorporating the Architectural Mechanisms: Persistency

- Analysis-Class-to-Architectural-Mechanism Map from Use-Case Analysis

Analysis Class	Analysis Mechanism(s)
Student	*Persistency*, Security
Schedule	*Persistency*, Security
CourseOffering	Persistency, Legacy Interface
Course	Persistency, Legacy Interface
RegistrationController	Distribution

OODBMS Persistency

RDBMS Persistency

Legacy persistency (RDBMS) is deferred to Subsystem Design.

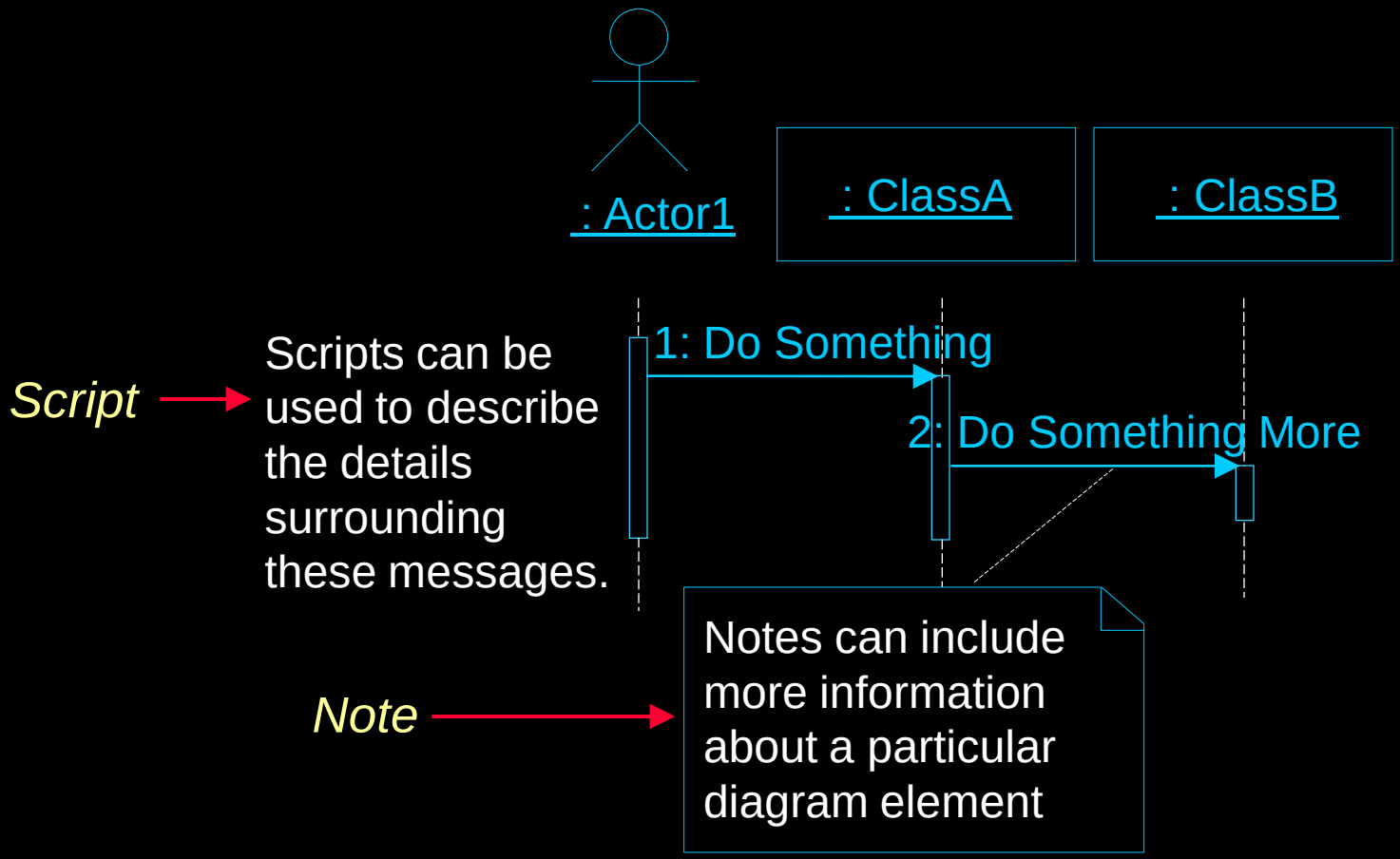
Details in Appendix

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

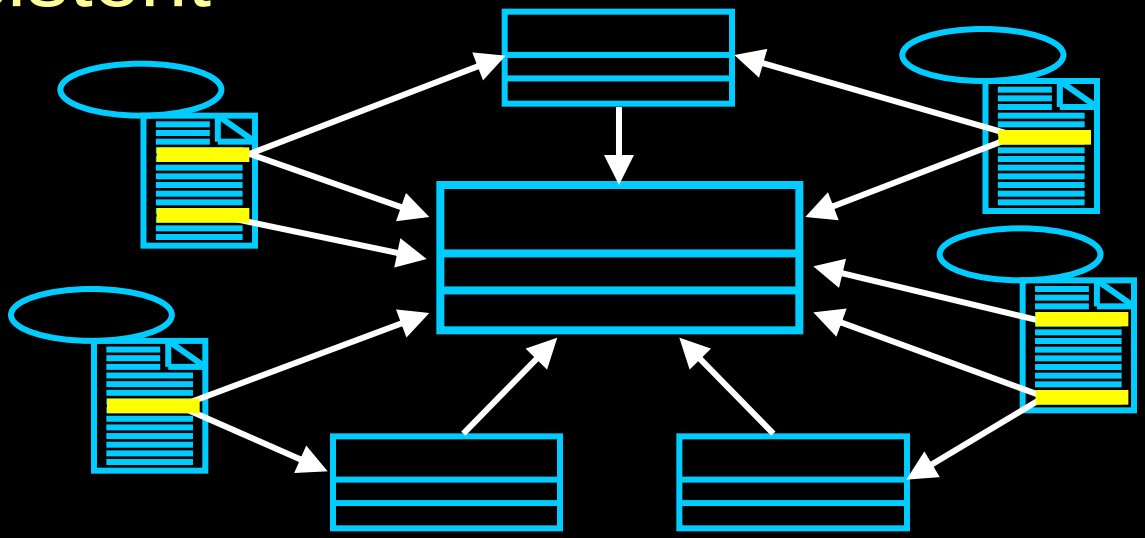


Use-Case Design Steps

- 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

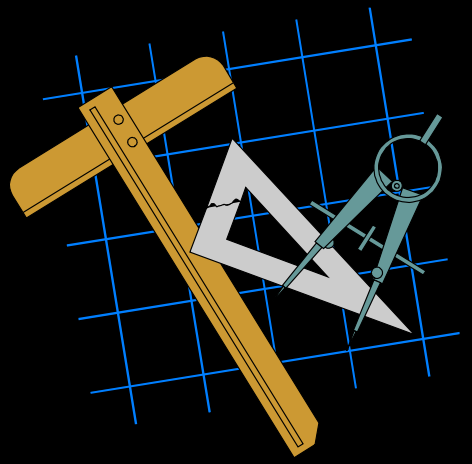
- Have all the main and/or subflow for this iteration been handled?
- Has all behavior been distributed among the participating design elements?
- Has behavior been distributed to the right design elements?
- If there are several interaction diagrams for the use-case realization, is it easy to understand 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
  - The analysis-class-to-analysis-mechanism map
  - Analysis-to-design-mechanism map
  - Patterns of use for the architectural mechanisms



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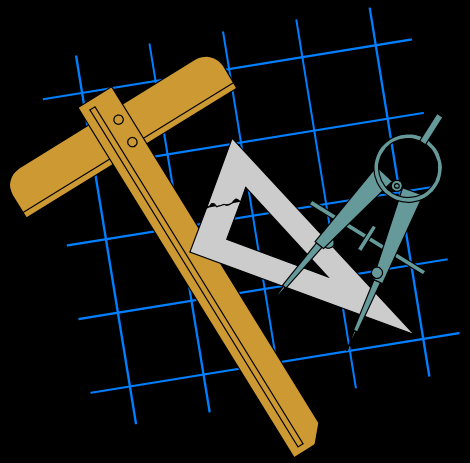
Exercise: Use-Case Design (cont.)

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



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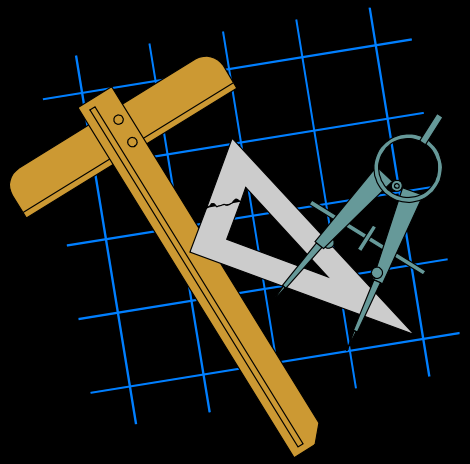
Exercise: Use-Case Design (cont.)

- 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



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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?