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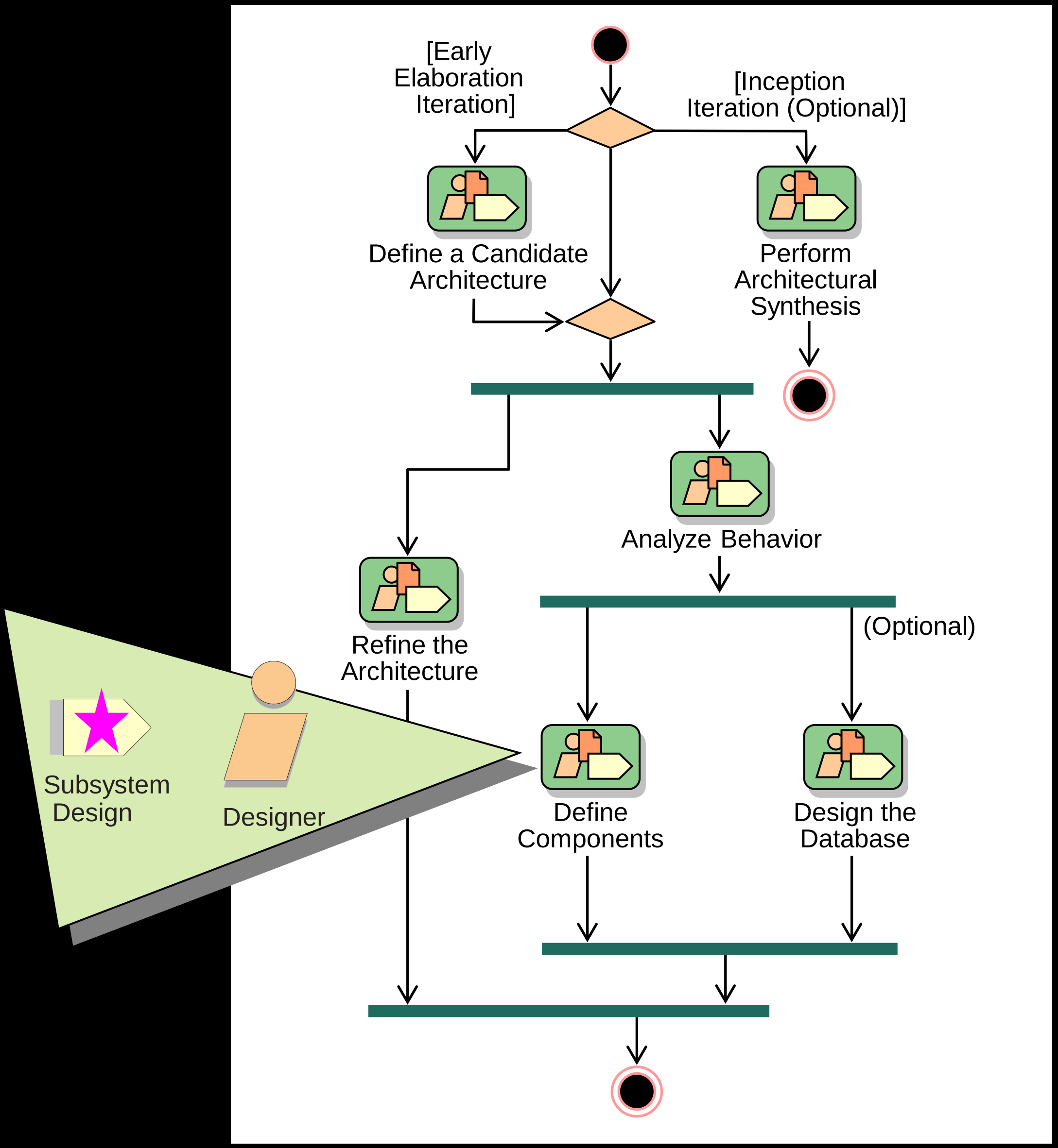
Mastering Object-Oriented Analysis and Design with UML

Module 12: Subsystem Design

Objectives: Subsystem Design

- Describe the purpose of Subsystem Design and where in the lifecycle it is performed
- Define the behaviors specified in the subsystem's interfaces in terms of collaborations of contained classes
- Document the internal structure of the subsystem
- Determine the dependencies upon elements external to the subsystem

Subsystem Design in Context


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

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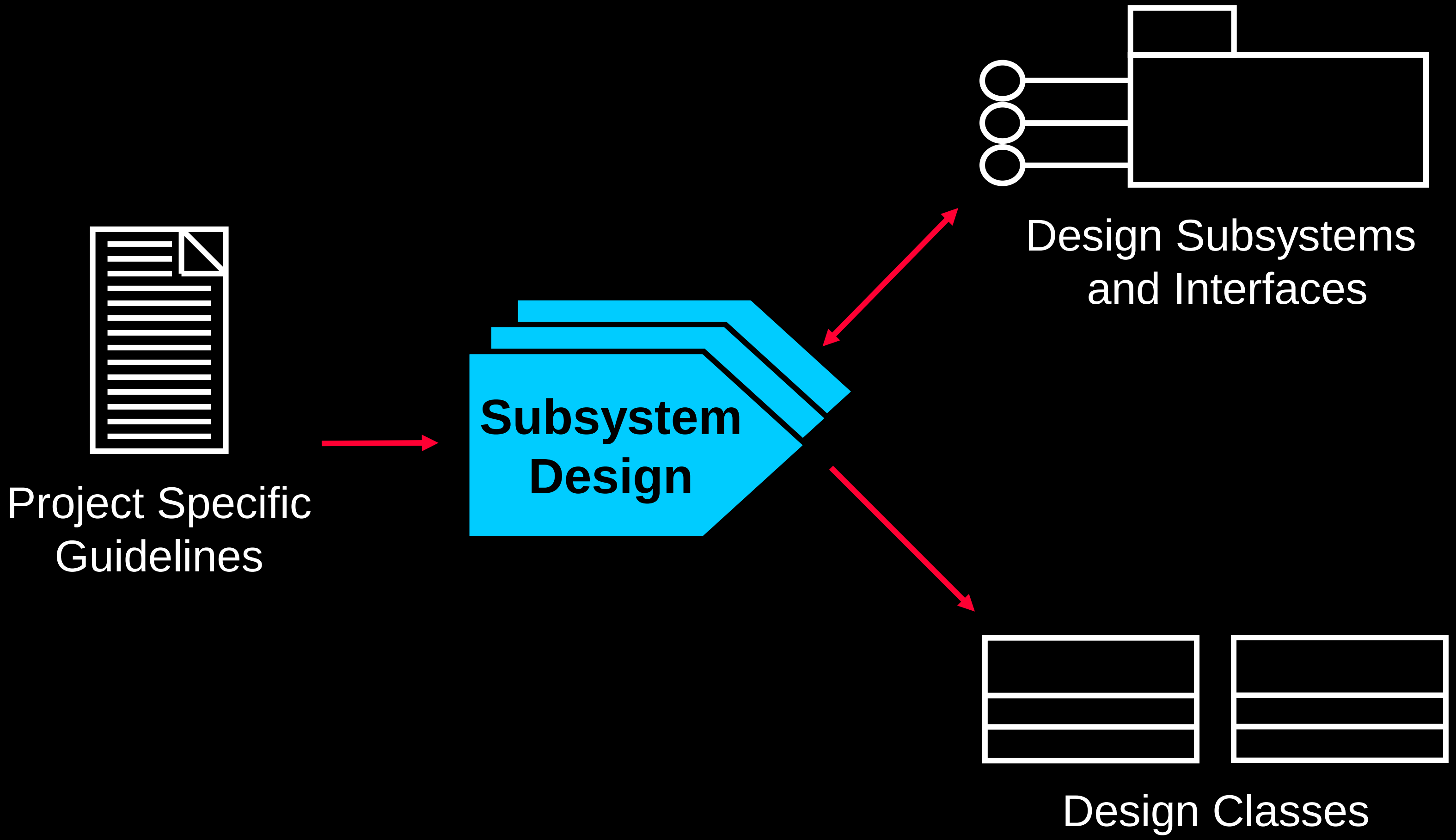
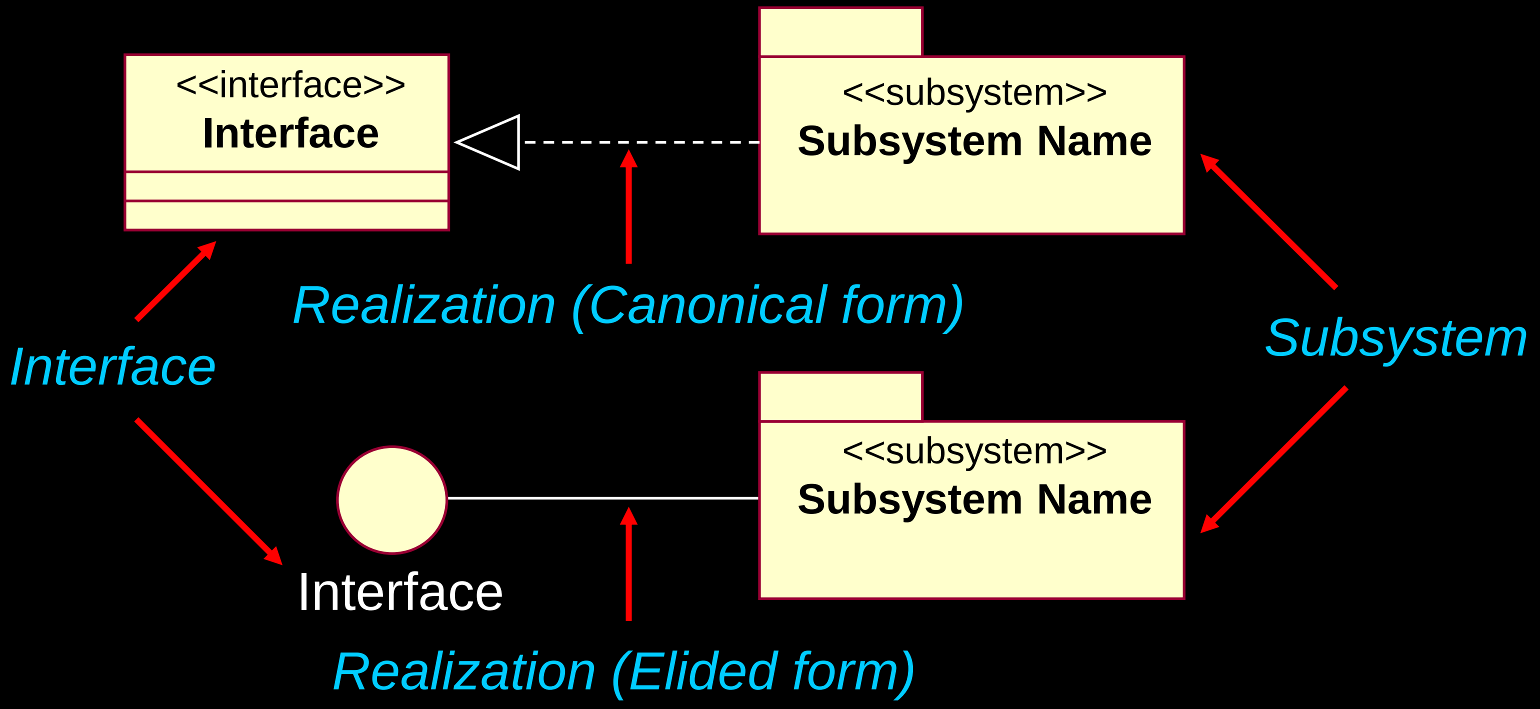
Subsystem Design Overview



Review: Subsystems and Interfaces

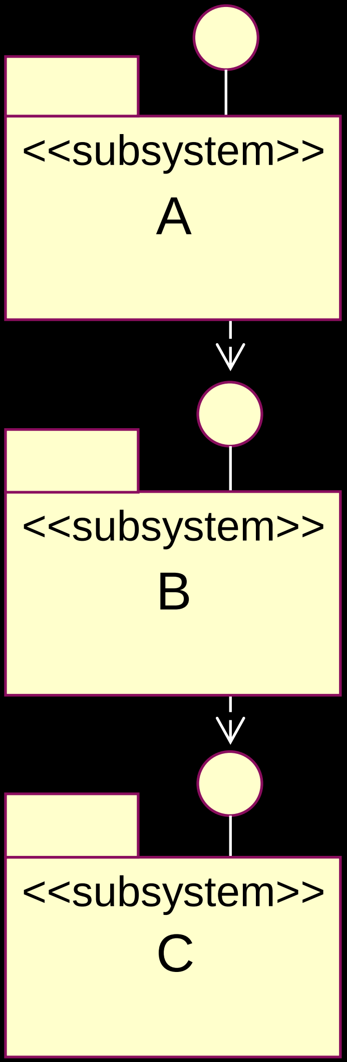
A Subsystem:

- Is a “cross between” a package and a class
- Realizes one or more interfaces that define its behavior



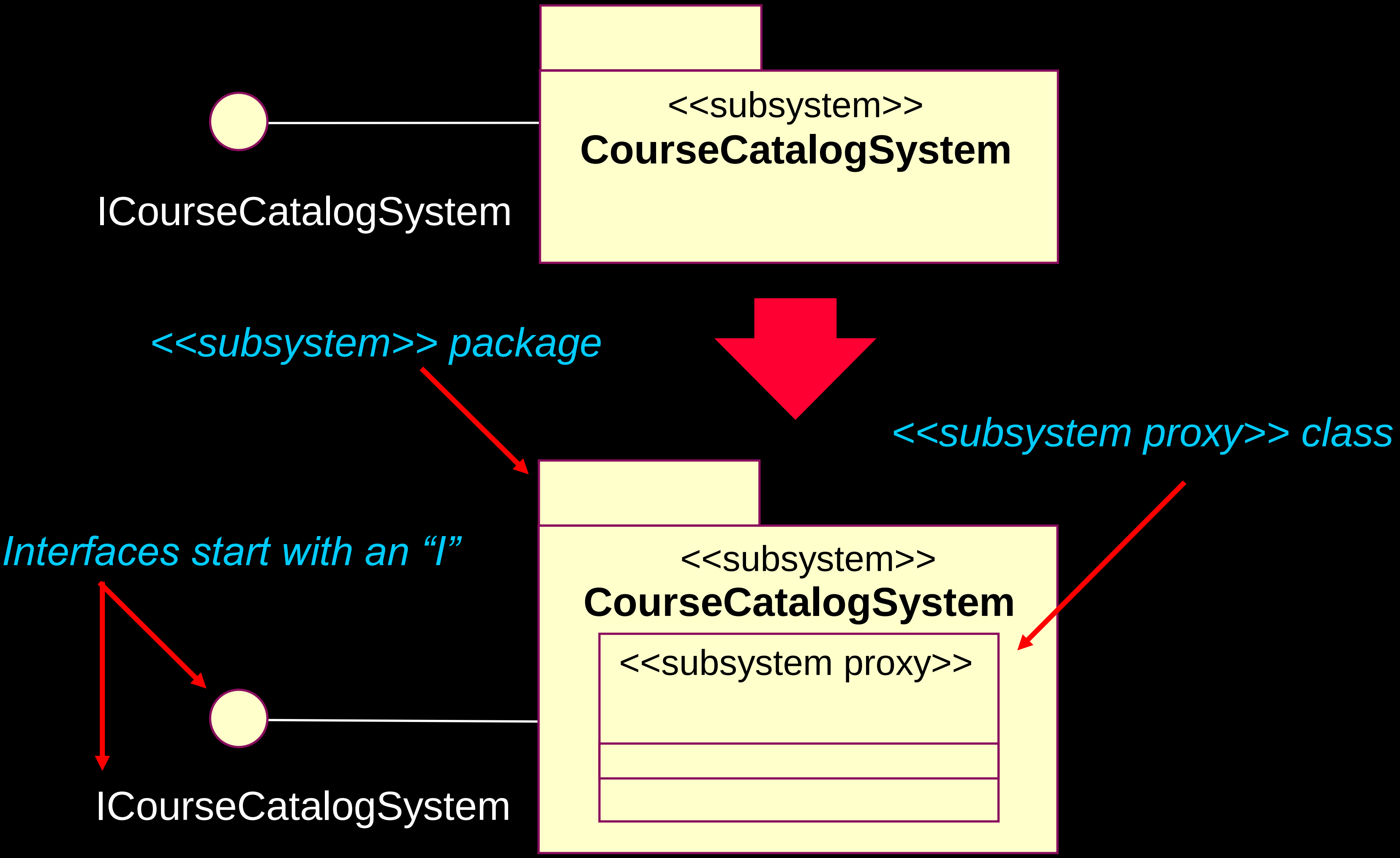
Subsystem Guidelines

- Goals
  - Loose coupling
  - Portability, plug-and-play compatibility
  - Insulation from change
  - Independent evolution
- Strong Suggestions
  - Do not expose details, only interfaces
  - Depend only on other interfaces



Key is abstraction and encapsulation

Review: Modeling Convention for Subsystems and Interfaces



<<subsystem>>
CourseCatalogSystem

ICourseCatalogSystem

<<subsystem>> package

<<subsystem proxy>> class

Interfaces start with an "I"

<<subsystem>>
CourseCatalogSystem

<<subsystem proxy>>

ICourseCatalogSystem

Interfaces are EXTERNAL to the subsystem.

Subsystem Design Steps

- Distribute subsystem behavior to subsystem elements
- Document subsystem elements
- Describe subsystem dependencies
- Checkpoints

Subsystem Design Steps

- ★ Distribute subsystem behavior to subsystem elements
- Document subsystem elements
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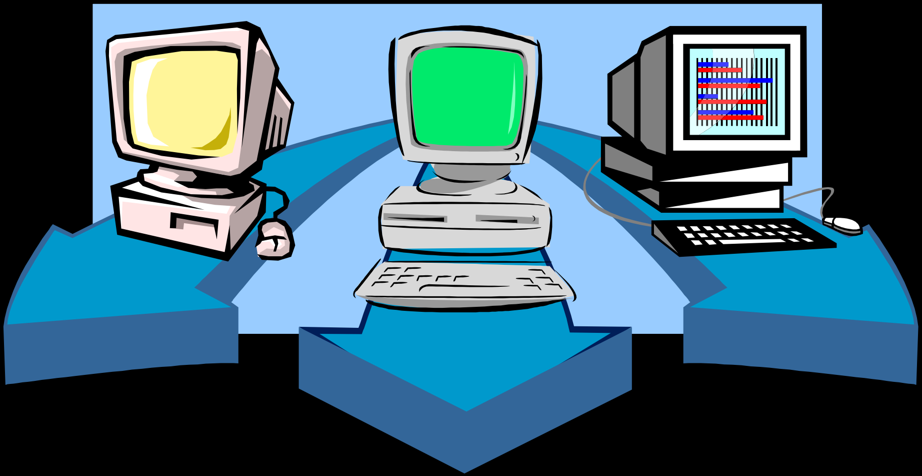
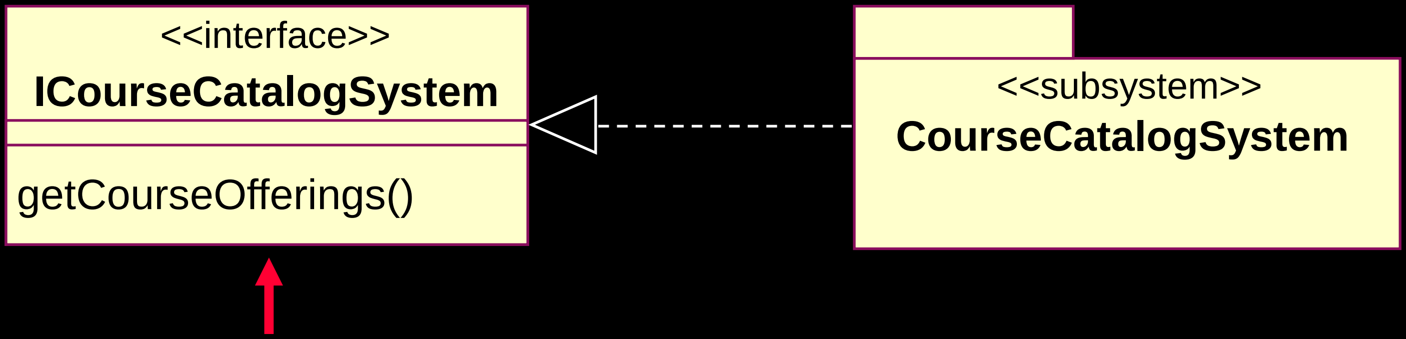


Subsystem Responsibilities

- Subsystem responsibilities defined by interface operations
  - Model interface realizations
- Interface operations may be realized by
  - Internal class operations
  - Internal subsystem operations

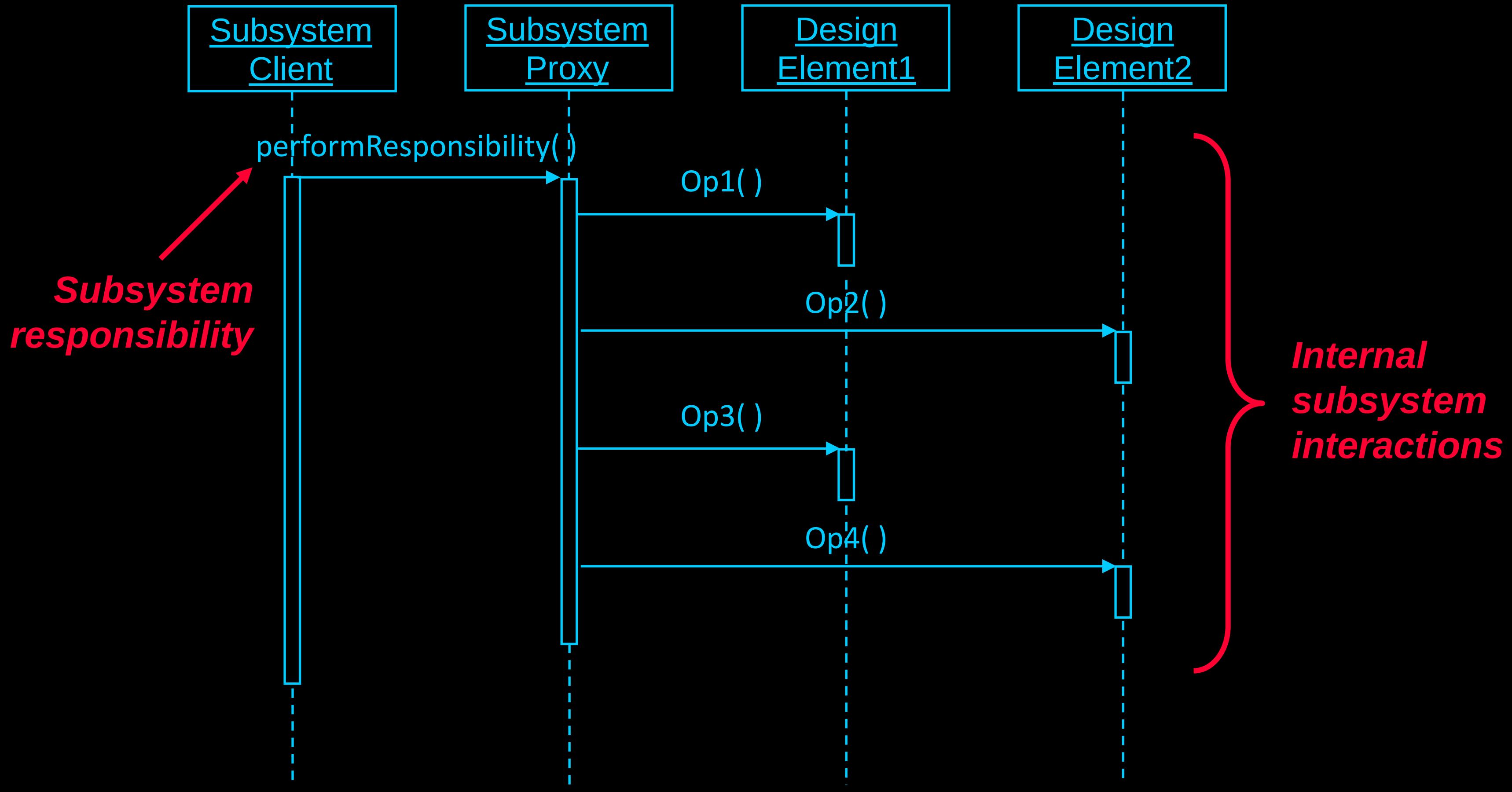


subsystem responsibility

Distributing Subsystem Responsibilities

- Identify new, or reuse existing, design elements (for example, classes and/or subsystems)
- Allocate subsystem responsibilities to design elements
- Incorporate applicable mechanisms (for example, persistence, distribution)
- Document design element collaborations in "interface realizations"
  - One or more interaction diagrams per interface operation
  - Class diagram(s) containing the required design element relationships
- Revisit "*Identify Design Elements*"
  - Adjust subsystem boundaries and dependencies, as needed

Modeling Convention: Subsystem Interaction Diagrams

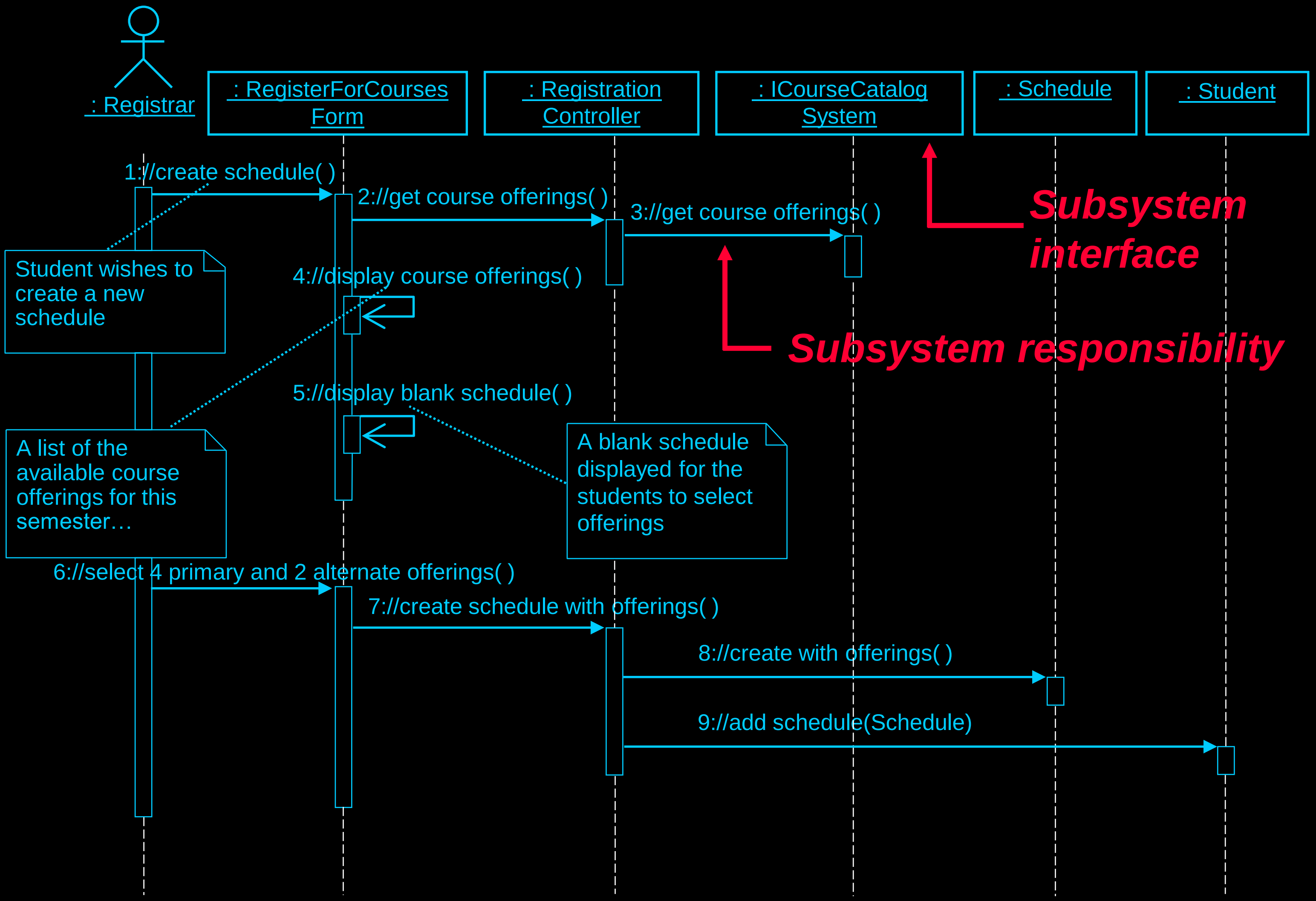


Subsystem responsibility

Internal subsystem interactions

Subsystem interface not shown

Example: CourseCatalogSystem Subsystem in Context


: Registrar
: RegisterForCourses Form
: Registration Controller
: ICourseCatalog System
: Schedule
: Student
1://create schedule( )
2://get course offerings( )
3://get course offerings( )
4://display course offerings( )
5://display blank schedule( )
6://select 4 primary and 2 alternate offerings( )
7://create schedule with offerings( )
8://create with offerings( )
9://add schedule(Schedule)
Student wishes to create a new schedule
A list of the available course offerings for this semester…
A blank schedule displayed for the students to select offerings

Subsystem interface

Subsystem responsibility

Legacy RDBMS Database Access

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

OODBMS Persistency was discussed in Use-Case Design

Review: Incorporating JDBC: Steps

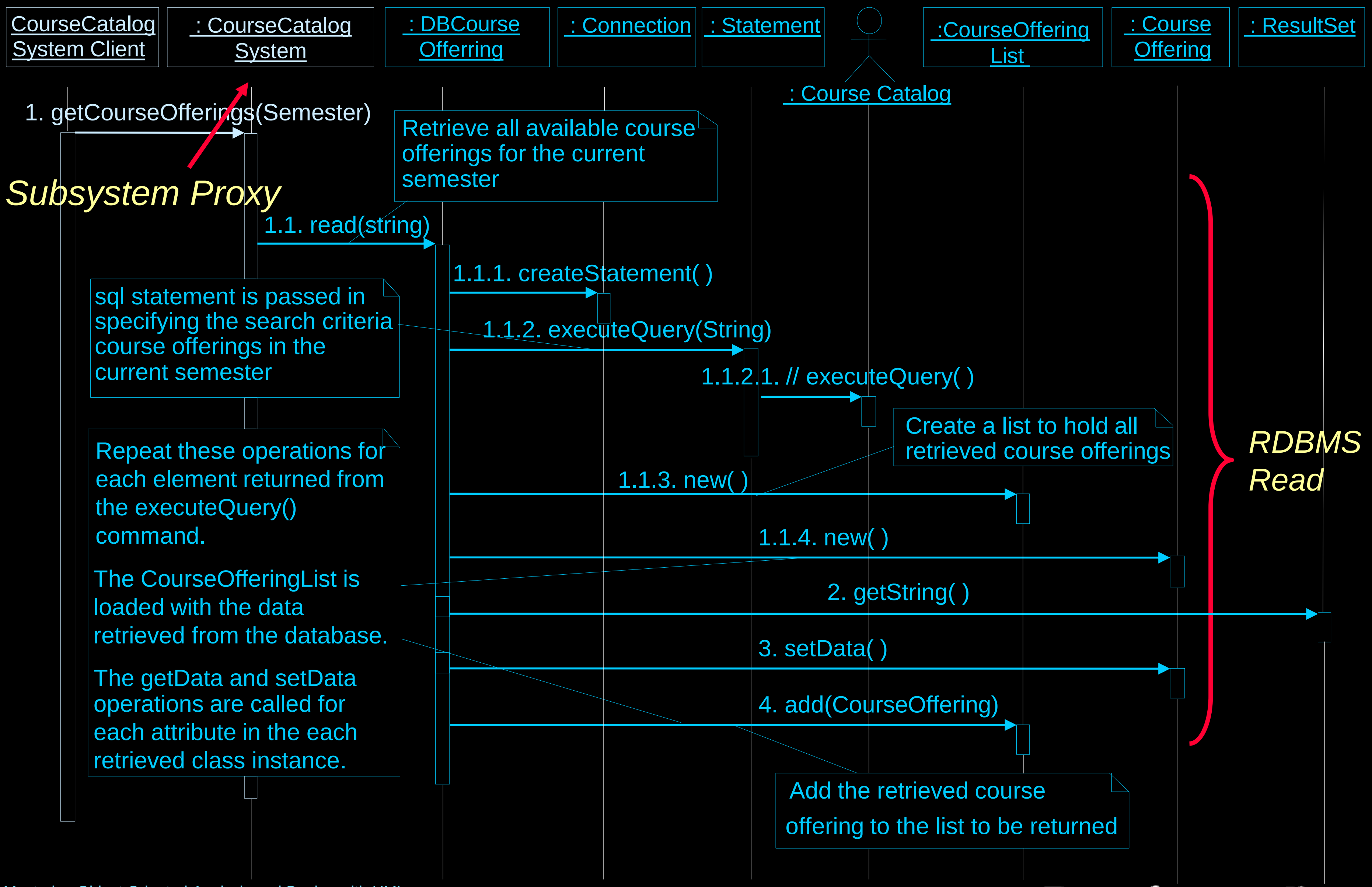
- Provide access to the class libraries needed to implement JDBC
  - √ *Provide java.sql package*
- Create the necessary DBClasses
  - One DBClass per persistent class
  - Course Offering persistent class => DBCourseOffering

√ - Done

Review: Incorporating JDBC: Steps (cont.)

- Incorporate DBClasses into the design
  - Allocate to package/layer
    - *DBCourseOffering placed in CourseCatalogSystem subsystem*
  - Add relationships from persistency clients
    - *Persistency clients are the CourseCatalogSystem subsystem clients*
- Create/Update interaction diagrams that describe:
  - Database initialization
  - Persistent class access: Create, Read, Update, Delete

Example: Local CourseCatalogSystem Subsystem Interaction



Retrieve all available course offerings for the current semester

sql statement is passed in specifying the search criteria course offerings in the current semester

Create a list to hold all retrieved course offerings

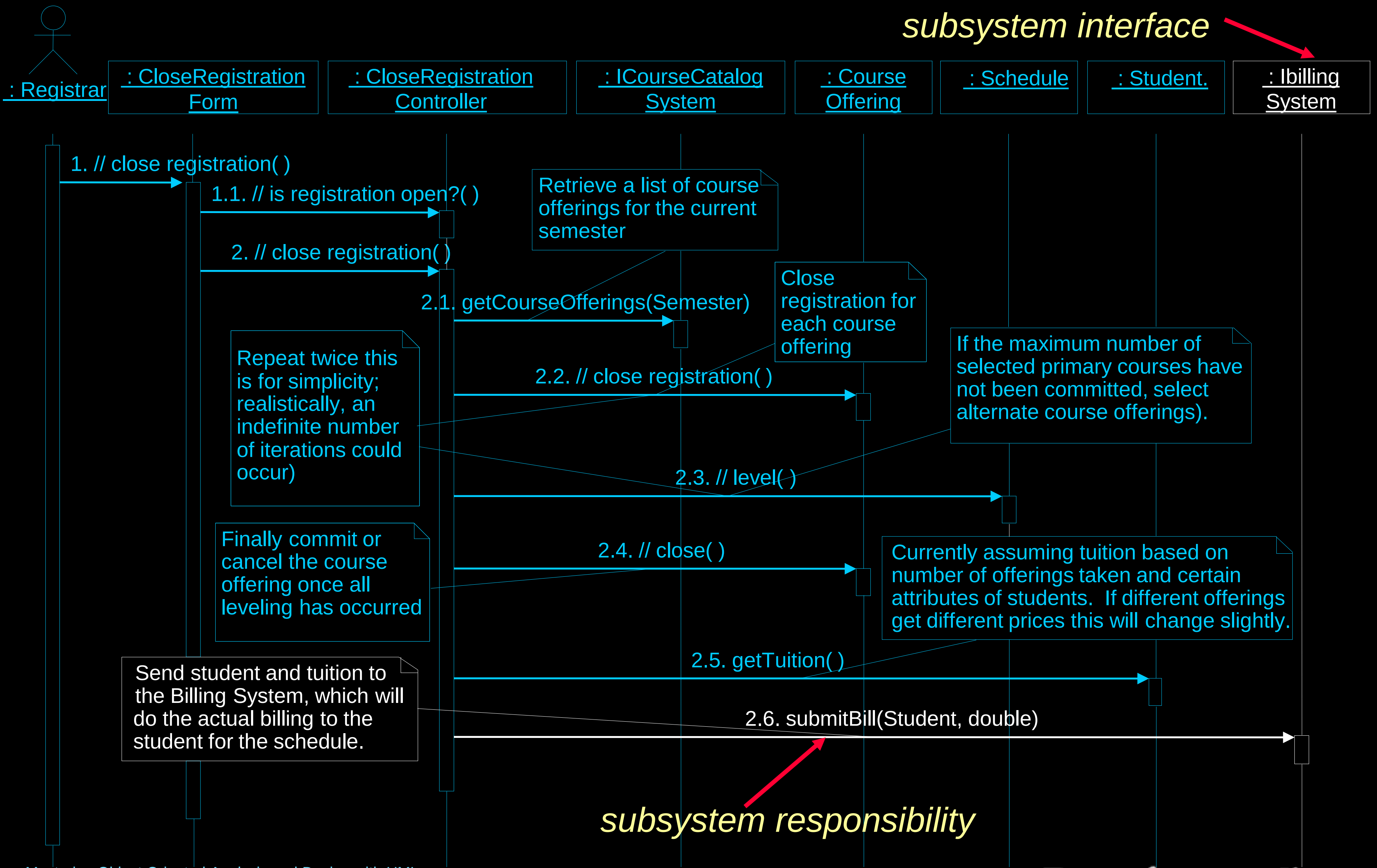
Repeat these operations for each element returned from the executeQuery() command.

The CourseOfferingList is loaded with the data retrieved from the database.

The getData and setData operations are called for each attribute in the each retrieved class instance.

Add the retrieved course offering to the list to be returned

Example: Billing System Subsystem In Context


subsystem interface
: Registrar
: CloseRegistration Form
: CloseRegistration Controller
: ICourseCatalog System
: Course Offering
: Schedule
: Student.
: Ibilling System
1. // close registration( )
1.1. // is registration open?( )
2. // close registration( )
2.1. getCourseOfferings(Semester)
2.2. // close registration( )
2.3. // level( )
2.4. // close( )
2.5. getTuition( )
2.6. submitBill(Student, double)
subsystem responsibility

Retrieve a list of course offerings for the current semester

Close registration for each course offering

Repeat twice this is for simplicity; realistically, an indefinite number of iterations could occur)

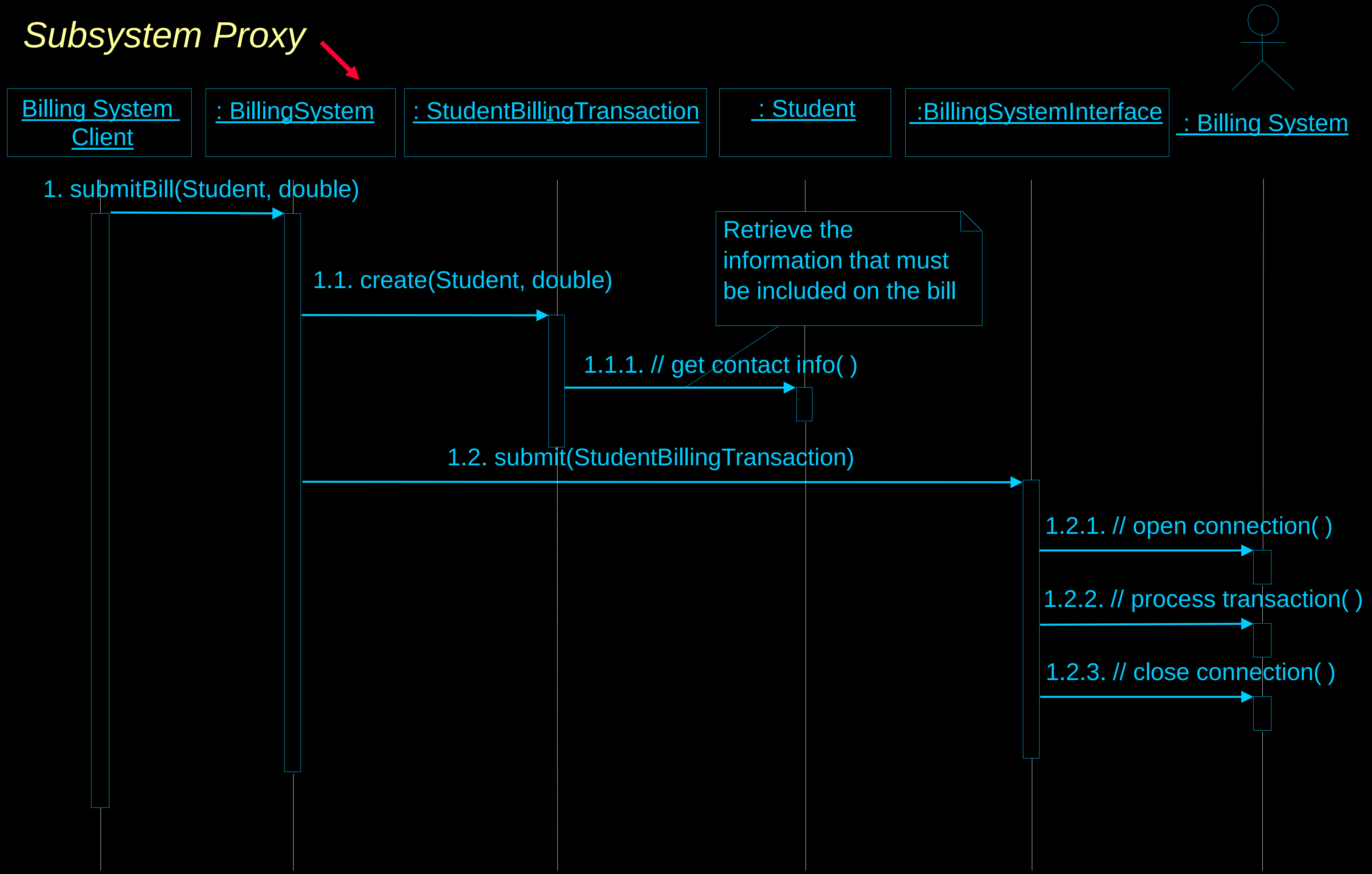
If the maximum number of selected primary courses have not been committed, select alternate course offerings).

Finally commit or cancel the course offering once all leveling has occurred

Currently assuming tuition based on number of offerings taken and certain attributes of students. If different offerings get different prices this will change slightly.

Send student and tuition to the Billing System, which will do the actual billing to the student for the schedule.

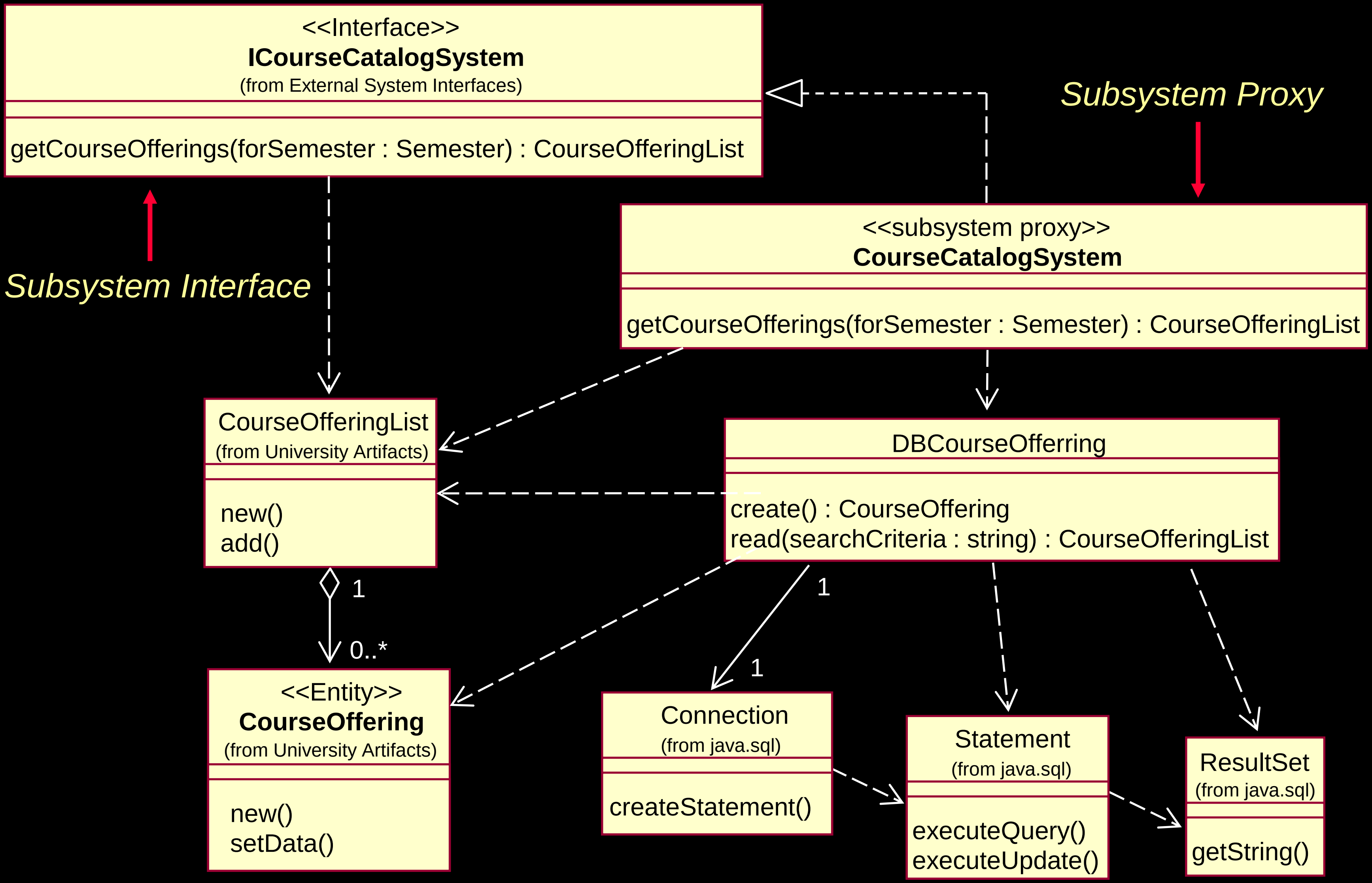
Example: Local BillingSystem Subsystem Interaction


Subsystem Proxy
Billing System Client
: BillingSystem
: StudentBillingTransaction
: Student
:BillingSystemInterface
: Billing System
1. submitBill(Student, double)
1.1. create(Student, double)
Retrieve the information that must be included on the bill
1.1.1. // get contact info( )
1.2. submit(StudentBillingTransaction)
1.2.1. // open connection( )
1.2.2. // process transaction( )
1.2.3. // close connection( )

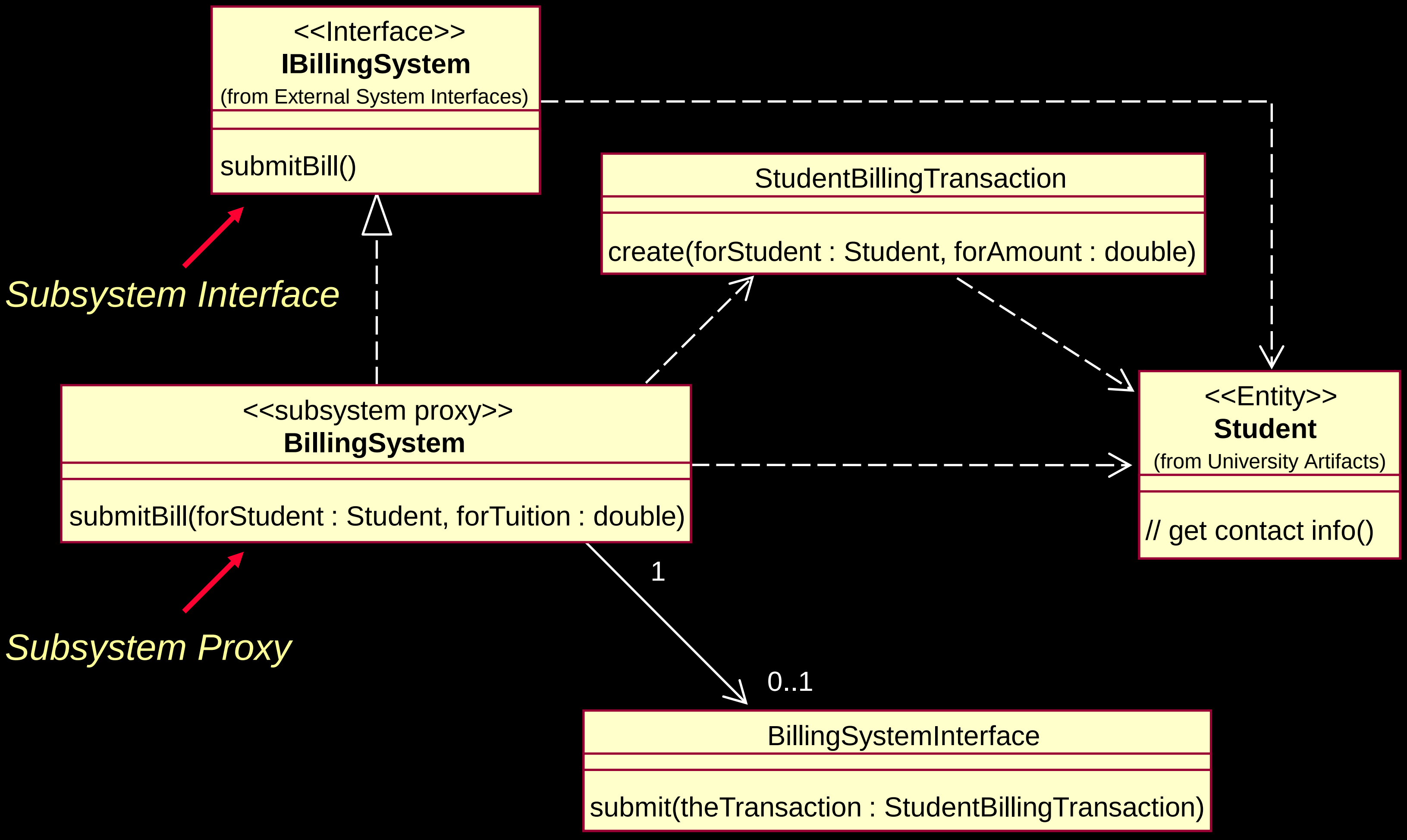
Subsystem Design Steps

- Distribute subsystem behavior to subsystem elements
- ★ Document subsystem elements
- Describe subsystem dependencies
- Checkpoints

Example: CourseCatalogSystem Subsystem Elements



Example: Billing System Subsystem Elements



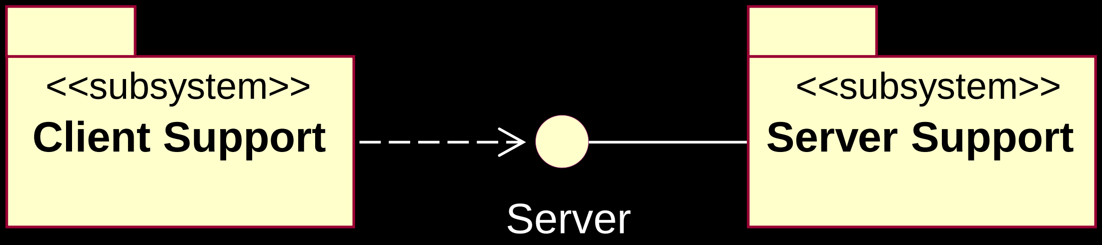
<<Interface>>
IBillingSystem
(from External System Interfaces)
submitBill()
StudentBillingTransaction
create(forStudent : Student, forAmount : double)
Subsystem Interface
<<subsystem proxy>>
BillingSystem
submitBill(forStudent : Student, forTuition : double)
<<Entity>>
Student
(from University Artifacts)
// get contact info()
1
Subsystem Proxy
0..1
BillingSystemInterface
submit(theTransaction : StudentBillingTransaction)

Subsystem Design Steps

- Distribute subsystem behavior to subsystem elements
- Document subsystem elements
- ★ Describe subsystem dependencies
- Checkpoints

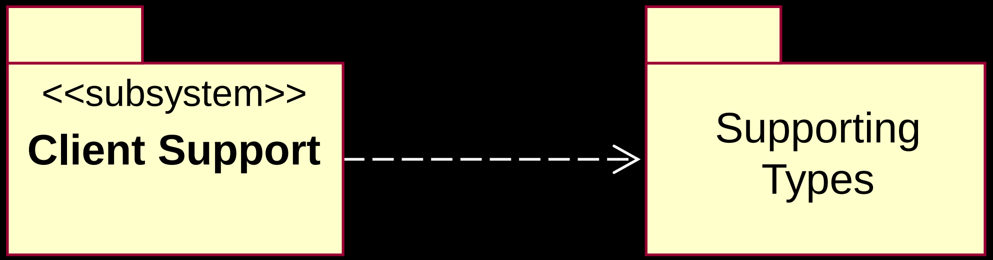
Subsystem Dependencies: Guidelines

- Subsystem dependency on a subsystem



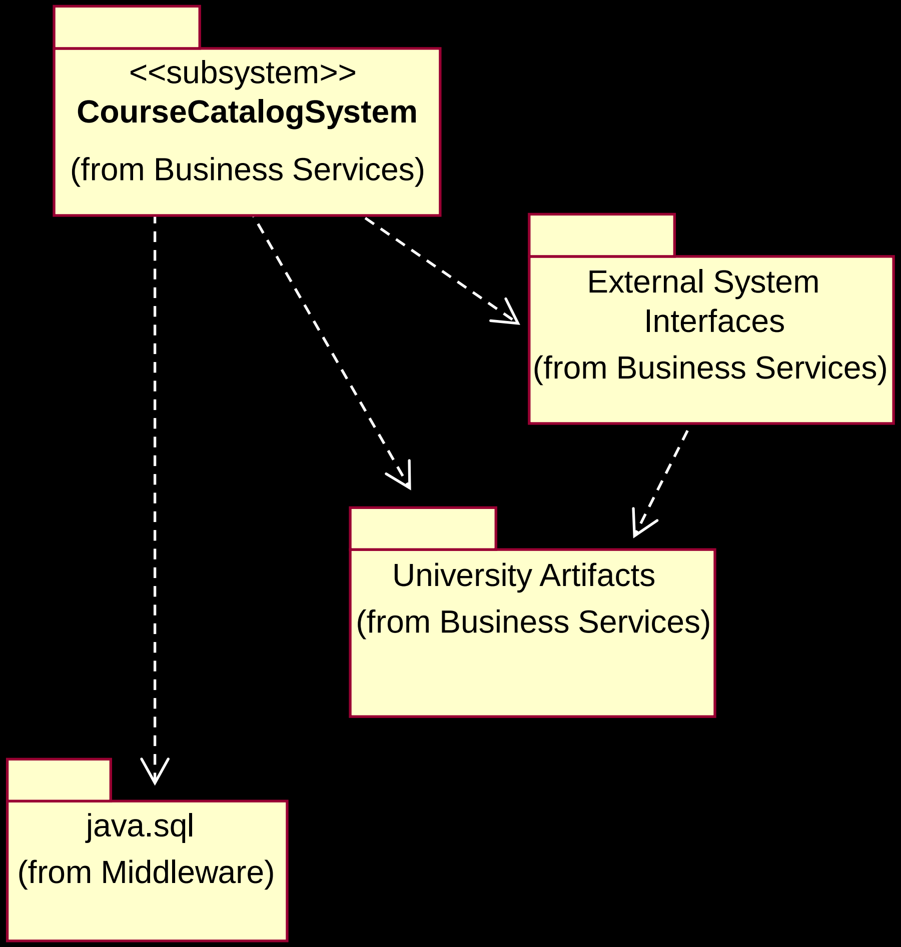
Flexible, Preferred

- Subsystem dependency on a package

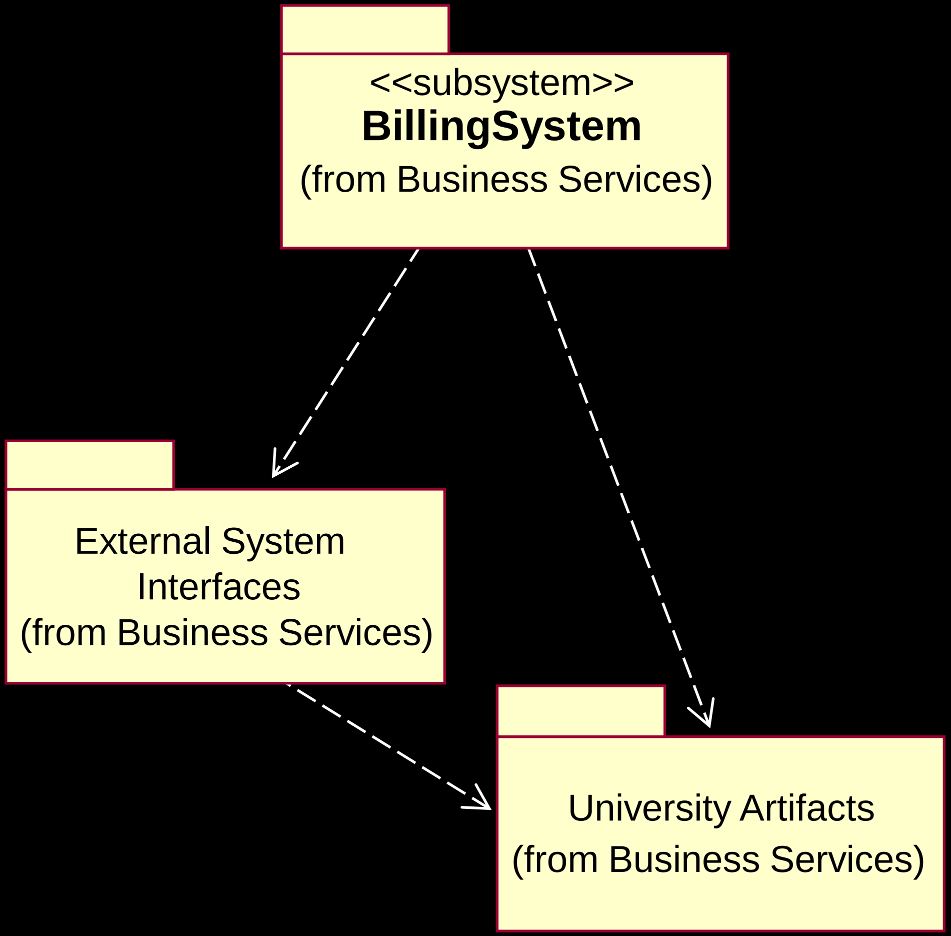


Use with care

Example: CourseCatalogSystem Subsystem Dependencies



Example: BillingSystem Subsystem Dependencies



<<subsystem>>
BillingSystem
(from Business Services)

External System Interfaces
(from Business Services)

University Artifacts
(from Business Services)

Subsystem Design Steps

- Distribute subsystem behavior to subsystem elements
- Document subsystem elements
- Describe subsystem dependencies
- ★ Checkpoints

Checkpoints: Design Subsystems

- Is a realization association defined for each interface offered by the subsystem?
- Is a dependency association defined for each interface used by the subsystem?
- Are you sure that none of the elements within the subsystem have public visibility?
- Is each operation on an interface realized by the subsystem documented in a interaction diagram? If not, is the operation realized by a single class, so that it is easy to see that there is a simple 1:1 mapping between the class operation and the interface operation?

Review: Subsystem Design

- What is the purpose of Subsystem Design?
- How many interaction diagrams should be produced during Subsystem Design?
- Why should dependencies on a subsystem be on the subsystem interface?

Exercise: Subsystem Design

- Given the following:
  - The defined subsystems, their interfaces and their relationships with other design elements (the subsystem context diagrams)
  - Patterns of use for the architectural mechanisms

(continued)

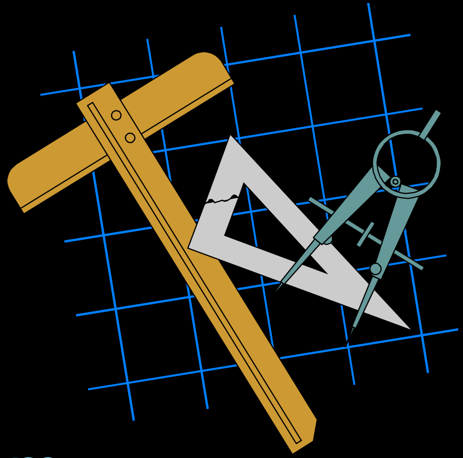
Exercise: Subsystem Design (cont.)

- Identify the following for a particular subsystem(s):
  - The design elements contained within the subsystem and their relationships
  - The applicable architectural mechanisms
  - The interactions needed to implement the subsystem interface operations

(continued)

Exercise: Subsystem Design (cont.)

- Produce the following diagrams for a particular subsystem(s):
  - “Interface realizations”
    - Interaction diagram for each interface operation
    - Class diagram containing the subsystem design elements that realize the interface responsibilities and their relationships
  - Class diagram that shows the subsystem and any dependencies on external package(s) and/or subsystem(s) (subsystem dependencies class diagram)



Exercise: Review

- Compare your Subsystem Interface Realizations
  - Have all the main and/or subflows for the interface operations 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?