Part II – Black-Box Composition Systems
20. Finding UML Business Components in a Component-Based Development Process

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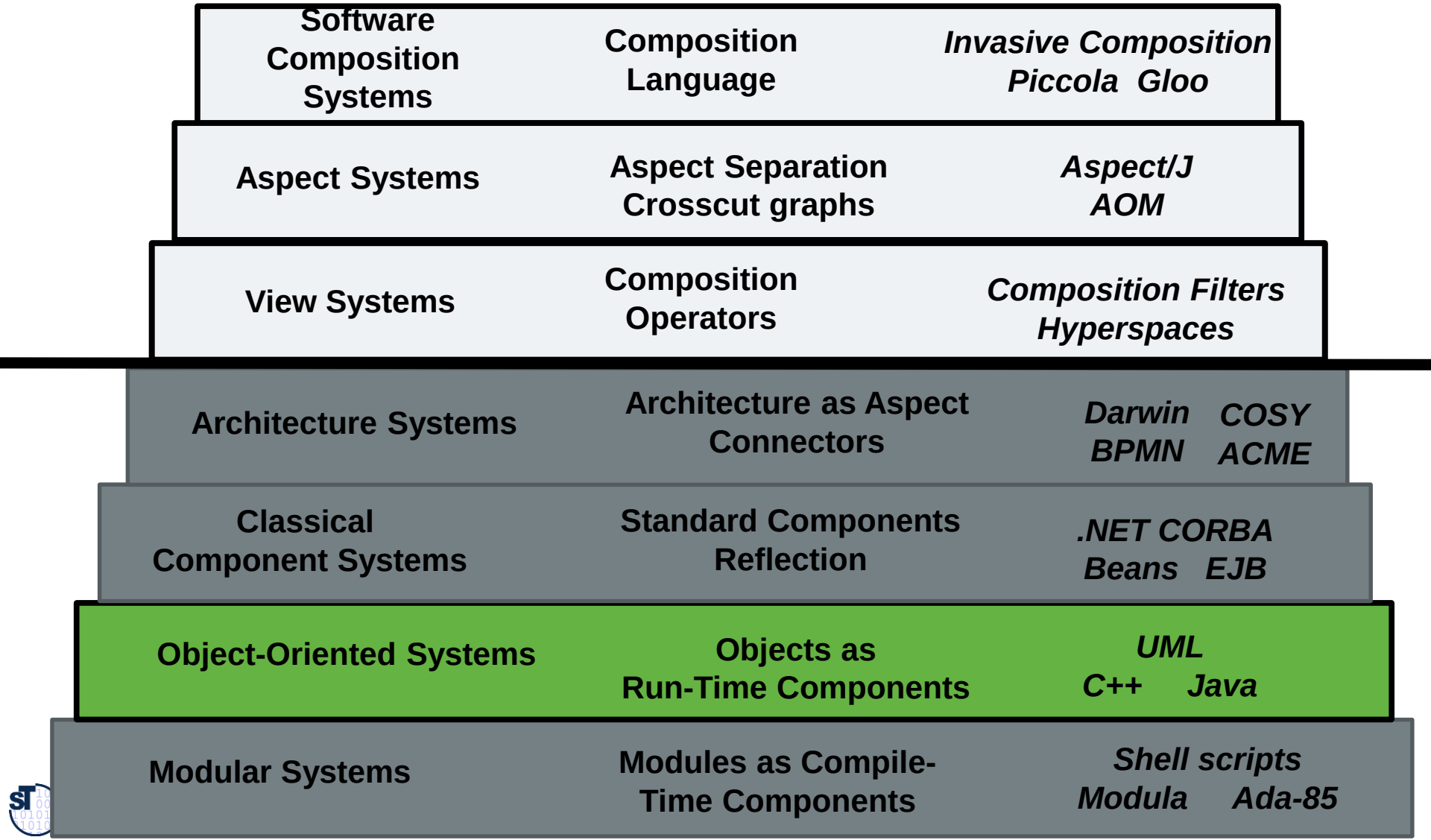
1. Business component model of the Cheesman/Daniels process
2. Identifying business components

Literature

- J. Cheesman, J. Daniels. UML Components. Addison-Wesley.

The Ladder of Composition Systems



20.1 The Cheesman-Daniels Business Component Model

- Problem: UML classes do not specify required interfaces, which is necessary for UML components

- The Cheesman-Daniels process to find components from UML class diagrams
- Using the “Business component model”

Business Objects are Complex Objects

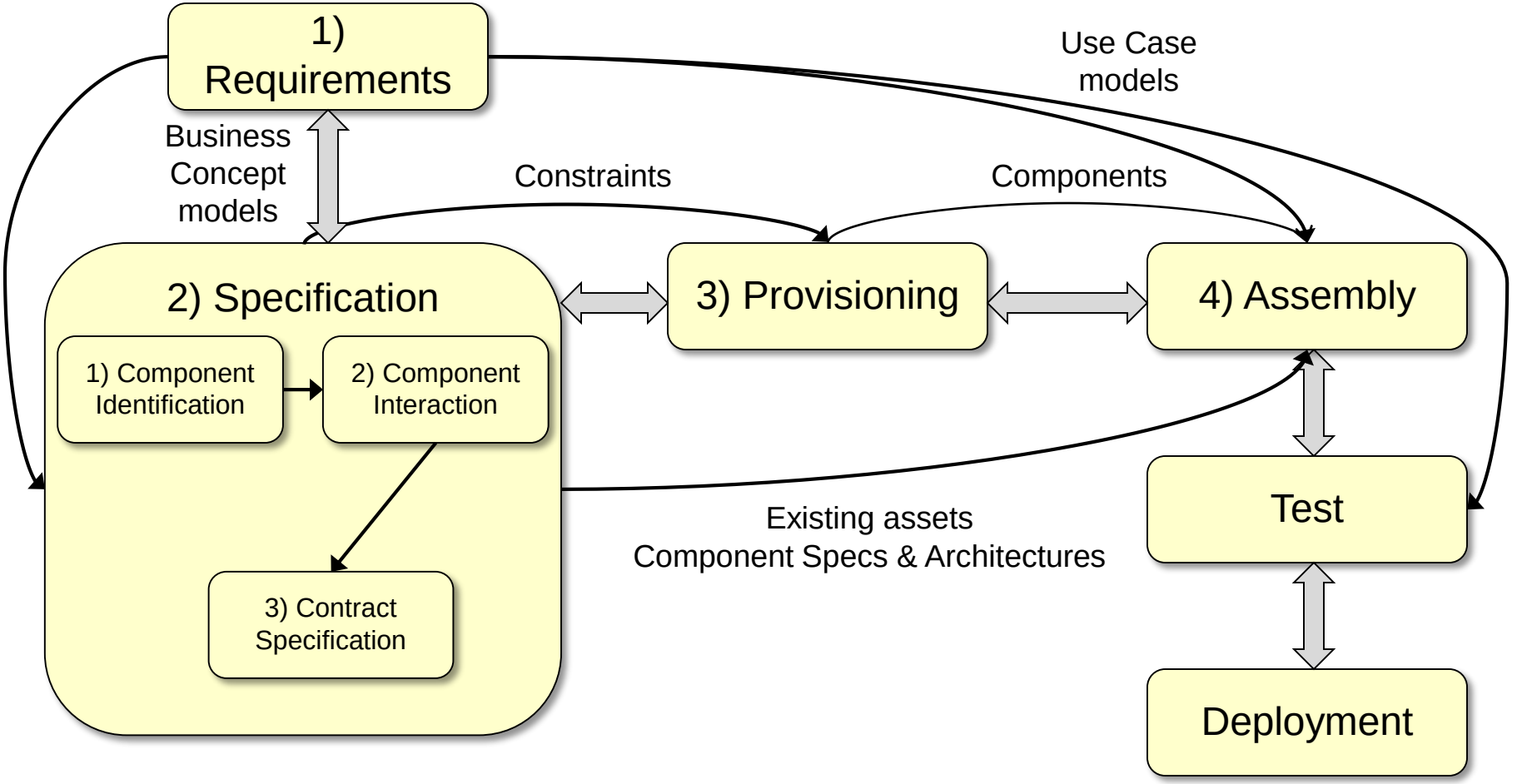
- In the Cheesman-Daniels component model, a **business component** consists of a set of business objects and other business components (part-of relation)
  - The smallest component is a *business object with several provided and required interfaces*
  - The business objects are the logical entities of an application
  - Their interfaces are re-grouped on system components for good information hiding and change-oriented design
- A business component has a specification containing all interfaces and contracts and an implementation
  - UML-CD are used (UML profile with stereotypes)

Goals of the Cheesman-Daniels Process

- The Cheesman-Daniels Process identifies UML components in UML class diagrams
  - It bridges *domain modelling* with *use case modelling* (functional requirements)
- Be aware: the Cheesman-Daniels Process can be employed also for many other component models of this course, such as
  - Black box component models, such as EJB, Corba, .NET
  - Grey-box component models:
    - Generics (e.g., class diagram templates)
    - Fragment component models (e.g., advice groups in aspects)
    - Class-role models

Identifying Business Components with the Cheesman-Daniels Process

- Overall development process



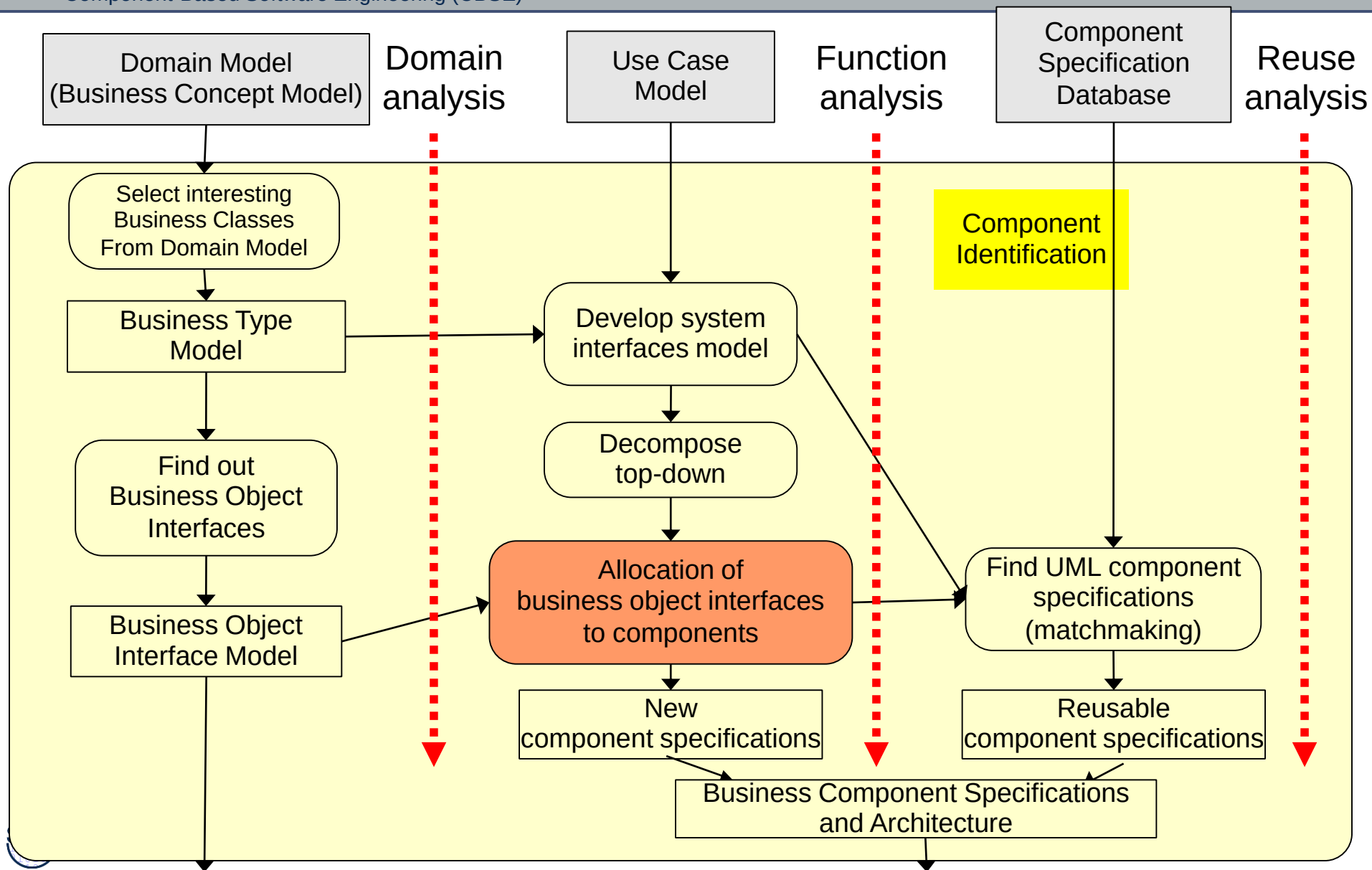
Simplified version of Fig. 2.1 from Cheesman/Daniels

Artifacts of the Cheesman/Daniels Process

- Requirement artifacts:
  - *Domain model (business concept model):* describes the business domain (application domain)
  - *Use case model* (requirements model)
- System artifacts, derived from the business concept model:
  - *Business type model*, class diagram derived from domain model:
    - Represents the system's perspective on the outer world (more attributes, refined class structures from the system's perspective)
  - *Business object interface model*, identifies the business objects and all their interfaces
  - *Business object model*, derived from the business object interface model by adding additional operations
- System component artifacts
  - Component interface specifications: one contract with the client
  - Component interface information model (state-based model)
  - Component specifications: all interface specifications of a component plus constraints.
  - Component architecture: wiring (topology) of a component net.

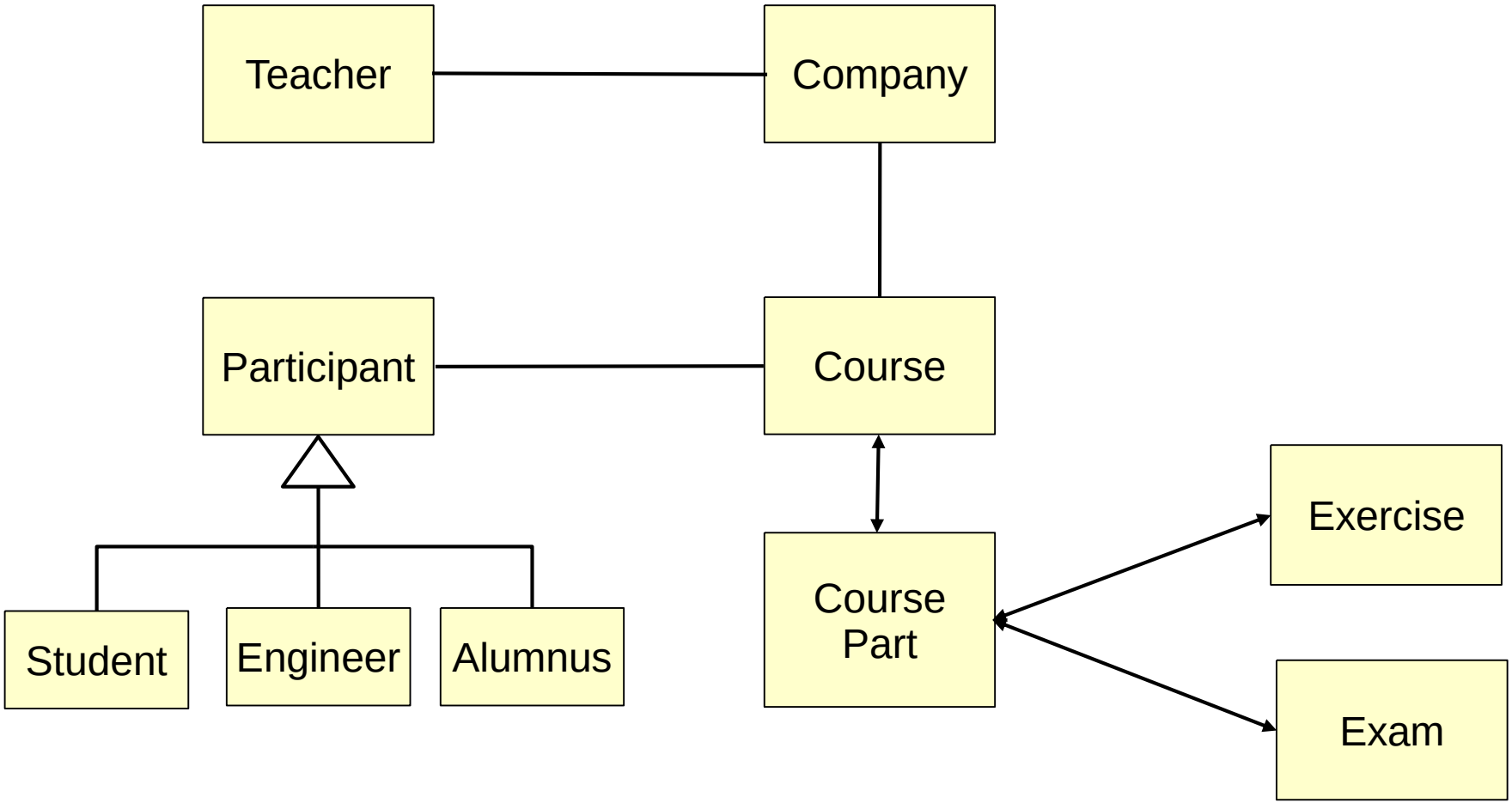
20.2. Identifying Business Components

Component Identification (Step 2.1)



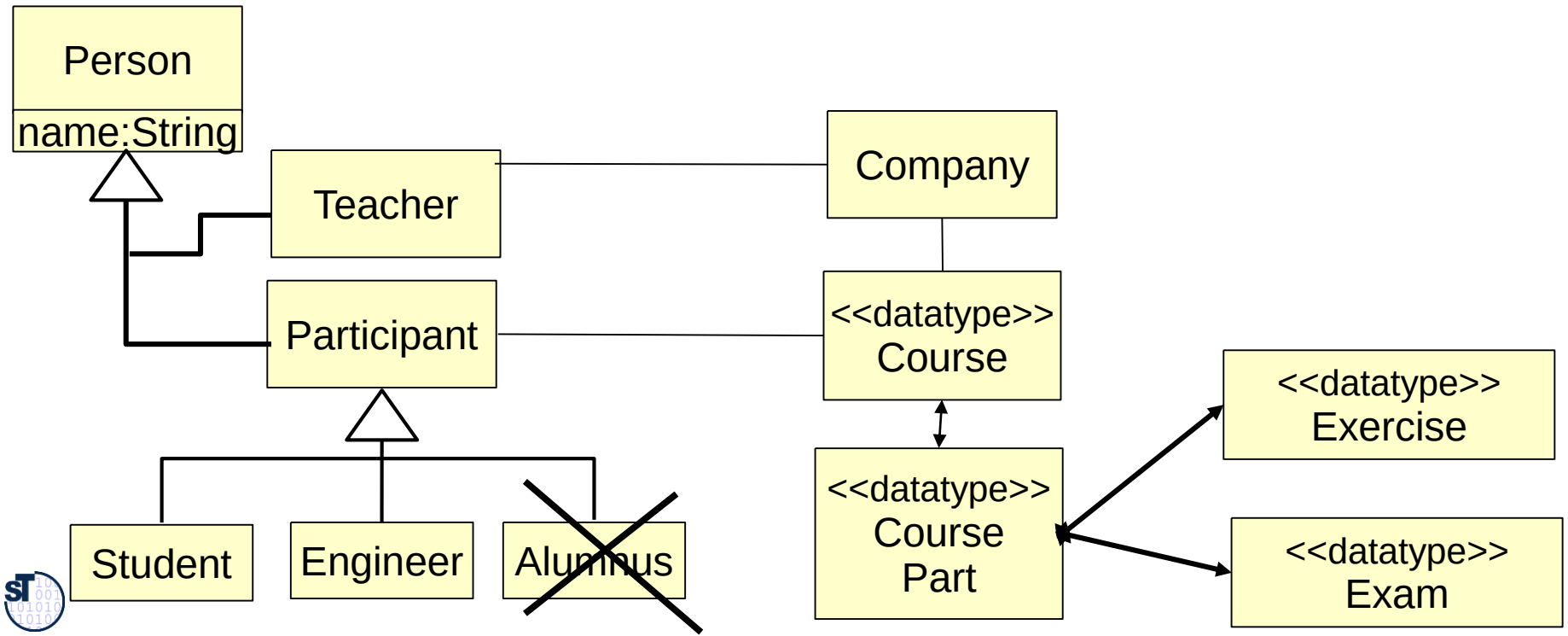
Ex.: Domain Model of a Course-Management System

- Collects all concepts of the domain (aka business concept model)



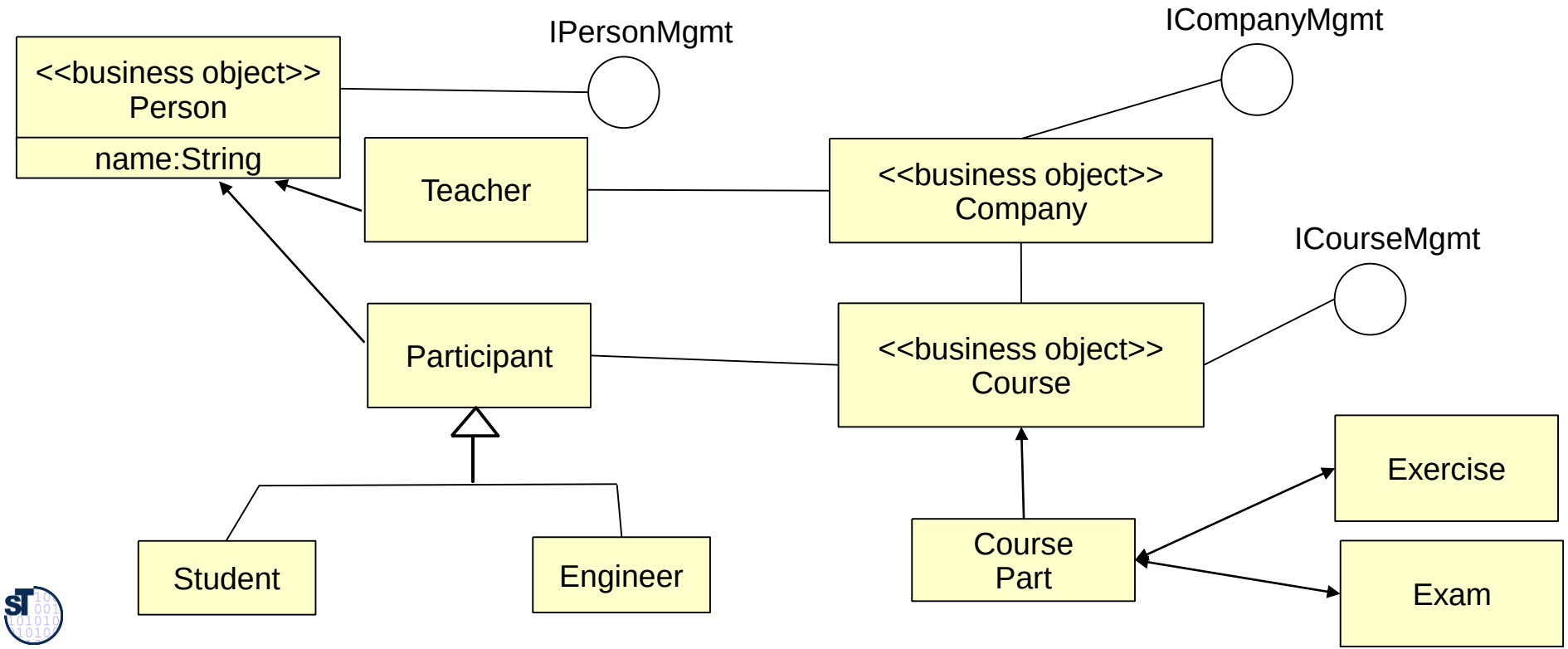
Step 2.1a) Business Type Model

- Shorten the domain model by selecting system types from the domain model
  - Eliminates superfluous concepts
  - Adds more details
  - Distinguish datatypes (passive objects, materials, persistent entities)



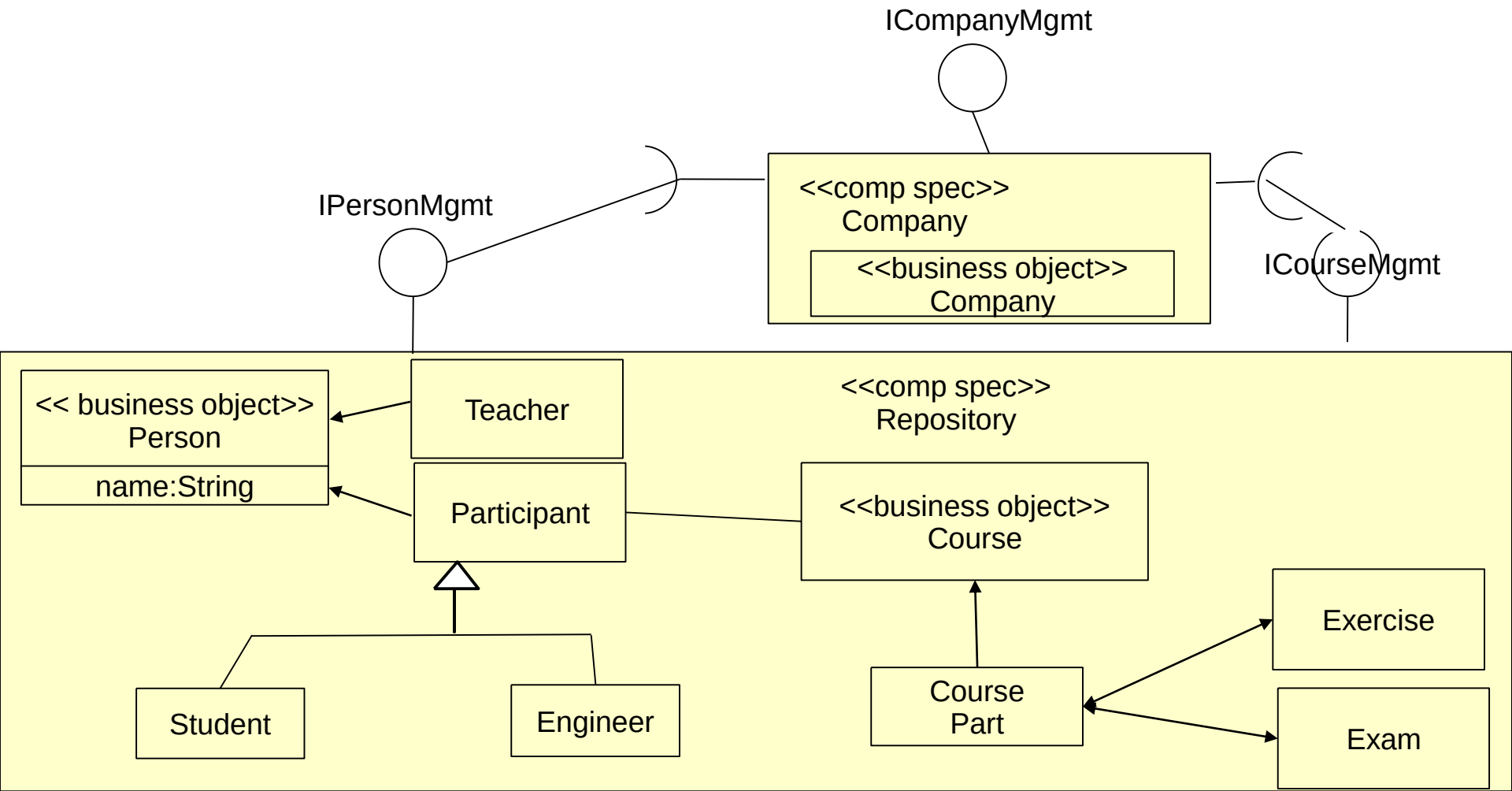
Step 2.1b) Identifying Business Object Interfaces

- Identifies business objects from the business type model
  - And defines *management interfaces* for them
  - Here, only Company, Course, Person are business objects, all others are dependent types



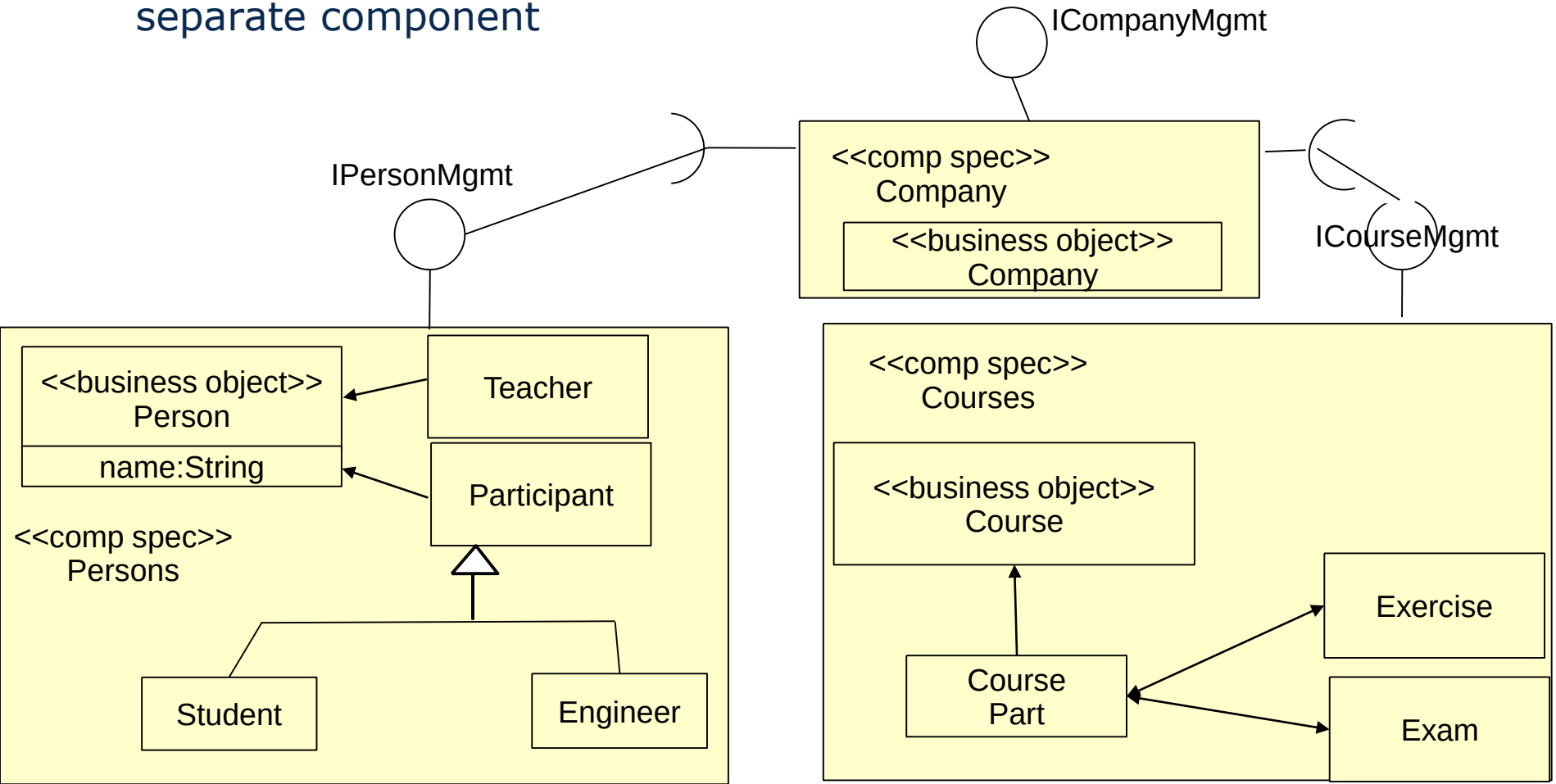
Step 2.1c) Component Grouping

- Group classes and interfaces into reusable components



Alternative Component Grouping (Version 0.2)

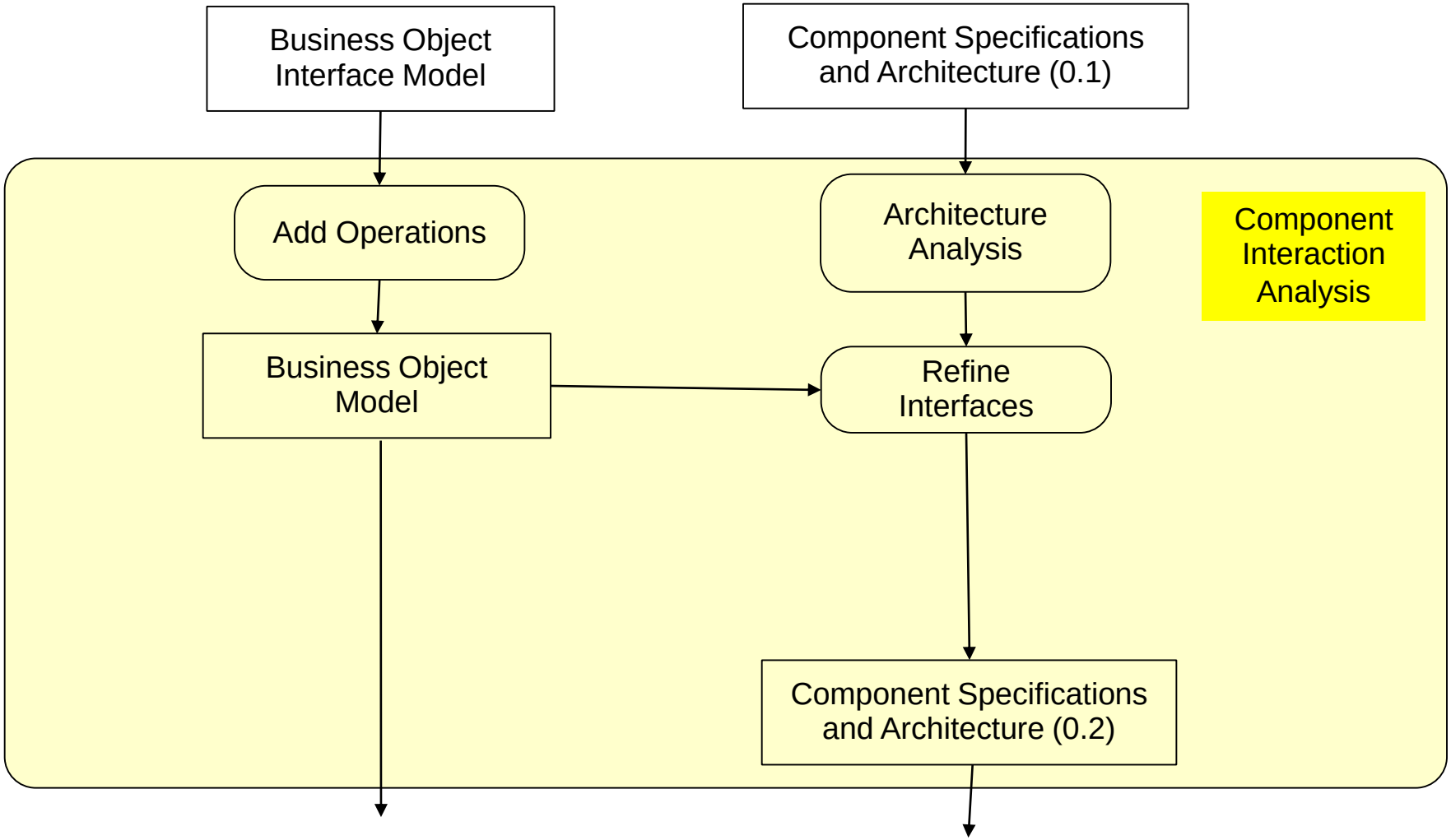
- Often, classes and interfaces can be grouped in several ways into components. Goal: think about what is reusable
- Here: Person management might be reuseable, so make it a separate component



Component Identification

- The **component identification** subprocess attempts to
  - Create a business object interface model from the domain model (still without methods)
  - Attempts to group these interfaces to initial *system component specifications*
    - The grouping is done according to
      - *information hiding*: what should a component hide, so that it can easily be exchanged and the system can evolve?
      - *Reuse considerations:* which specifications of components are found in the component specification repository, so that they can be reused?
- There is a tension between business concepts, coming from the business domain (problem domain), and system components (solution domain). This gap should be bridged.

Step 2.2: Component Interaction Analysis for Refinement of Component Interfaces

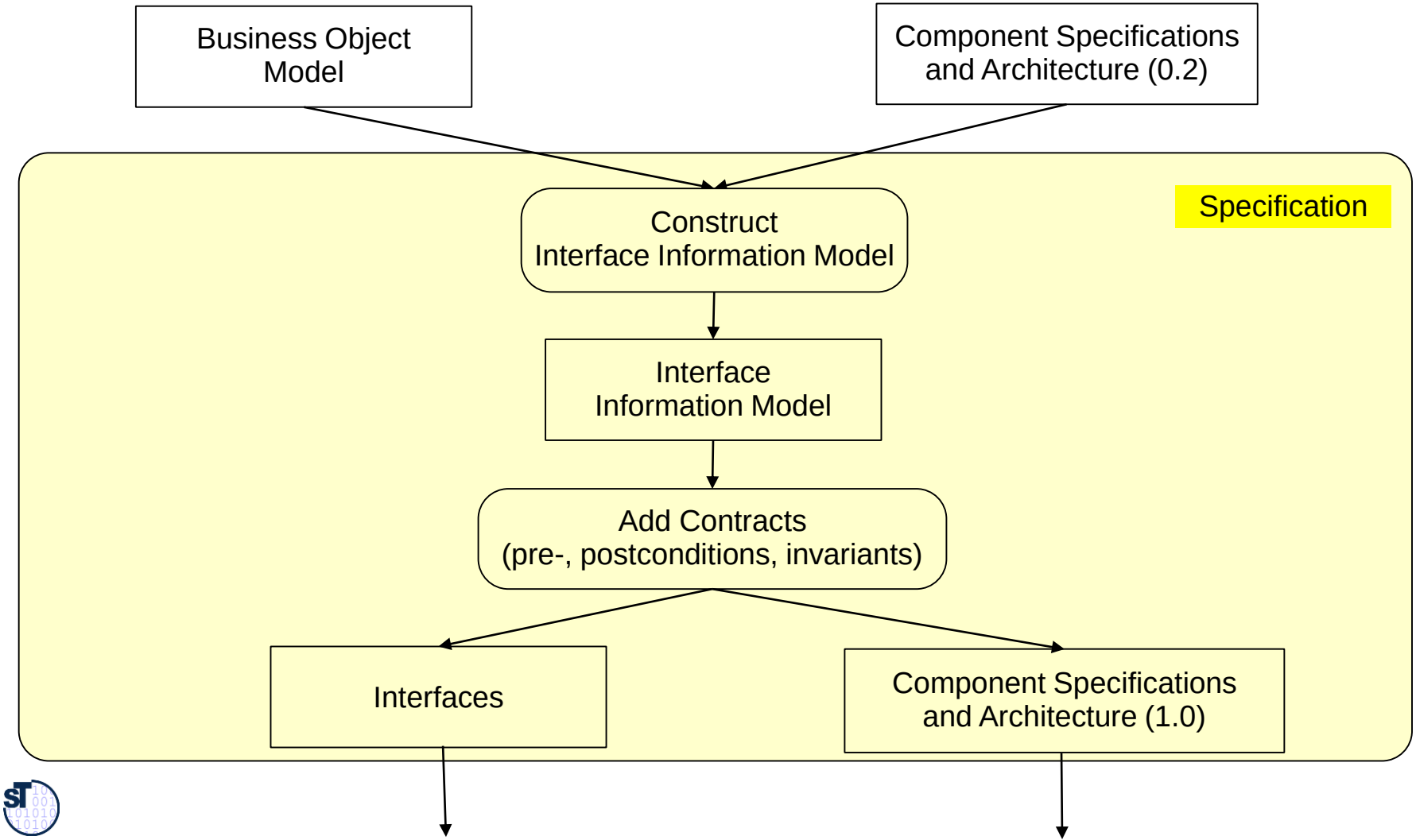


Component Interaction Analysis

- Component Interaction Analysis refines the results of the first stage
  - Removing,
  - Regrouping,
  - Augmenting,
  - Adding interfaces
  - Producing component specifications and wirings in a version 0.2
- Additionally, operations are added to business object interfaces
  - And mapped to internal types.

Step 2.3: Contract Specification

- Enrich the interfaces with contracts



Contract Specification in OCL (Step 2.3)

- Specification of declarative contracts for UML classes in OCL
- **Invariants**:
  - Evaluate business domain rules and integrity constraints
  - Example:

```
context r: Course
-- a course can only be booked if it has been allocated in the
   company
inv:  r.bookable = r.allocation->notEmpty
```

- **Pre**- and **Postconditions** for operations (**assumptions** and **guarantees**)
  - Can only be run on some state-based representation of the component
  - Hence, the component must be modeled in an *interface information model*
  - Or: be translated to implementation code (e.g. Java using an OCL2Java Compiler)

```
context Course::book(cert:Certification)
-- a course can only be booked if the booker has an A-level
   certificate
pre:  cert.instanceOf A-level
```

Step 3: Provisioning (Realization, Implementation, Publishing)

- Provisioning selects component implementations for the specifications
  - Choosing a concrete implementation platform (EJB, CORBA, COM+, ...)
  - Look up component implementations in implementation repositories
    - Write adapters if they don't fit exactly
  - Program missing components
- And makes them available in component repositories
  - Store component implementations and specifications in database for future reuse

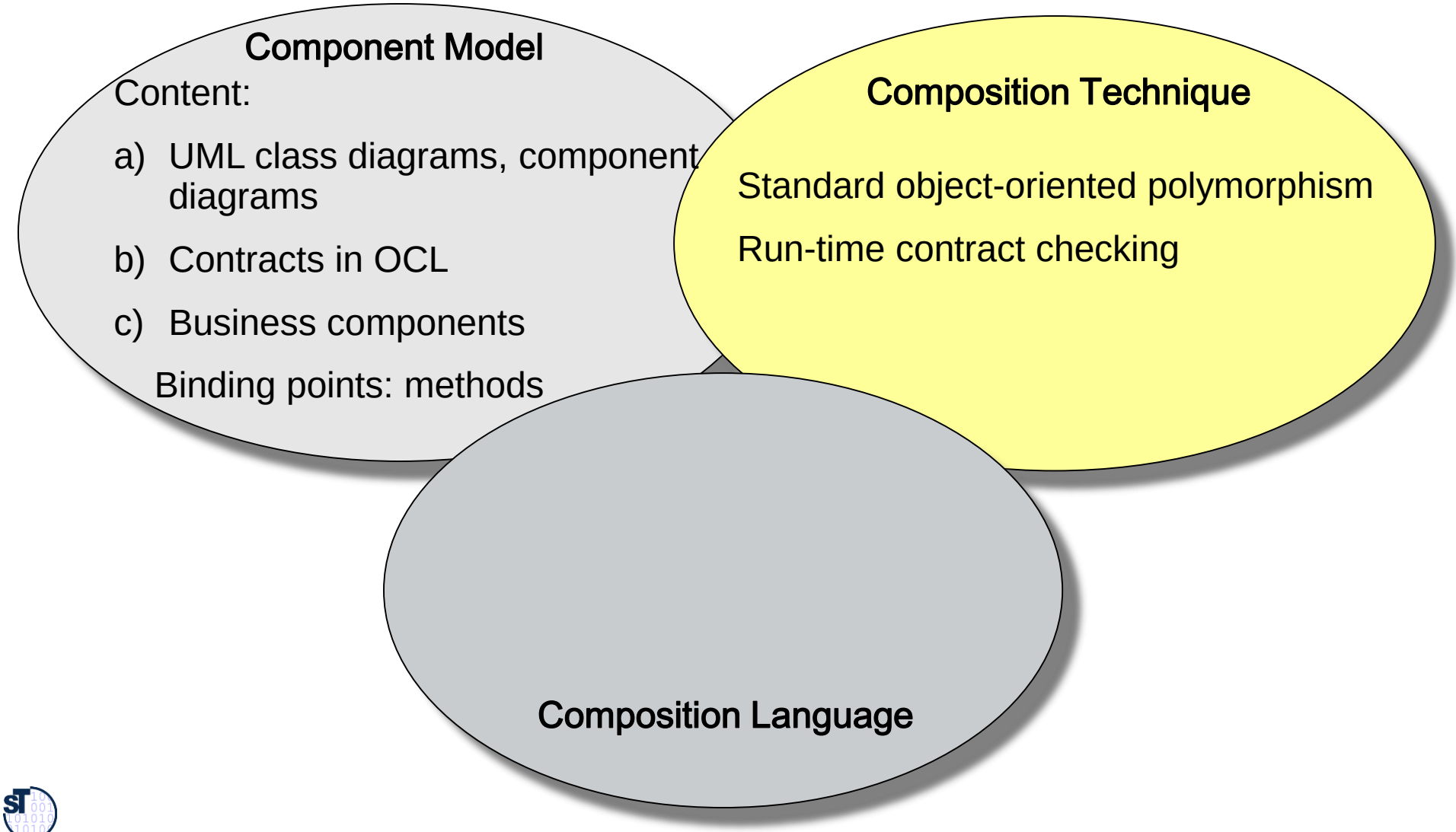
Step 4: Assembly

- Puts together architecture, component specifications and implementations, existing components
  - We will see more in the next lectures

20.3 Evaluation of Cheesman-Daniels Business Components

- No top-down decomposition of components, only bottom-up grouping from class diagrams
  - part-of relationship is not really supported
- Reuse of components is attempted, but
  - Finding components is not supported
    1. Metadata
    2. Facet-based classification

Cheesman-Daniels' Business Component Model as Composition System



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