Software Design and Architecture

System Decomposition

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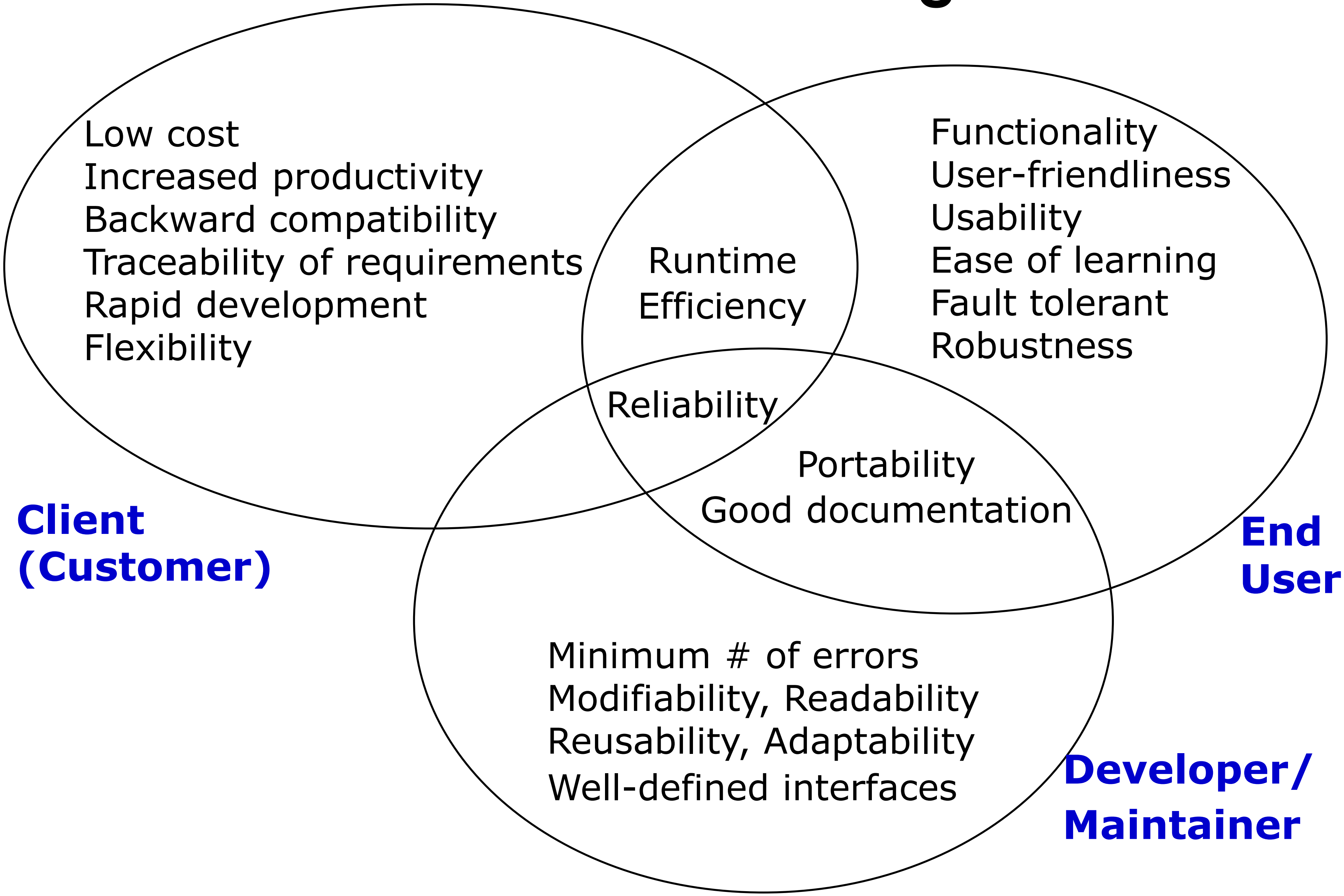
Example of Design Goals

- Reliability
- Modifiability
- Maintainability
- Understandability
- Adaptability
- Reusability
- Efficiency
- Portability
- Traceability of requirements
- Fault tolerance
- Backward-compatibility
- Cost-effectiveness
- Robustness
- High-performance

- Good documentation
- Well-defined interfaces
- User-friendliness
- Reuse of components
- Rapid development
- Minimum number of errors
- Readability
- Ease of learning
- Ease of remembering
- Ease of use
- Increased productivity
- Low-cost
- Flexibility

Stakeholders have different Design Goals



Low cost
Increased productivity
Backward compatibility
Traceability of requirements
Rapid development
Flexibility

Runtime
Efficiency

Functionality
User-friendliness
Usability
Ease of learning
Fault tolerant
Robustness

Reliability

Portability
Good documentation

Client (Customer)

End User

Minimum # of errors
Modifiability, Readability
Reusability, Adaptability
Well-defined interfaces

Developer/ Maintainer

Typical Design Trade-offs

- Functionality v. Usability
- Cost v. Robustness
- Efficiency v. Portability
- Rapid development v. Functionality

System Design Concepts

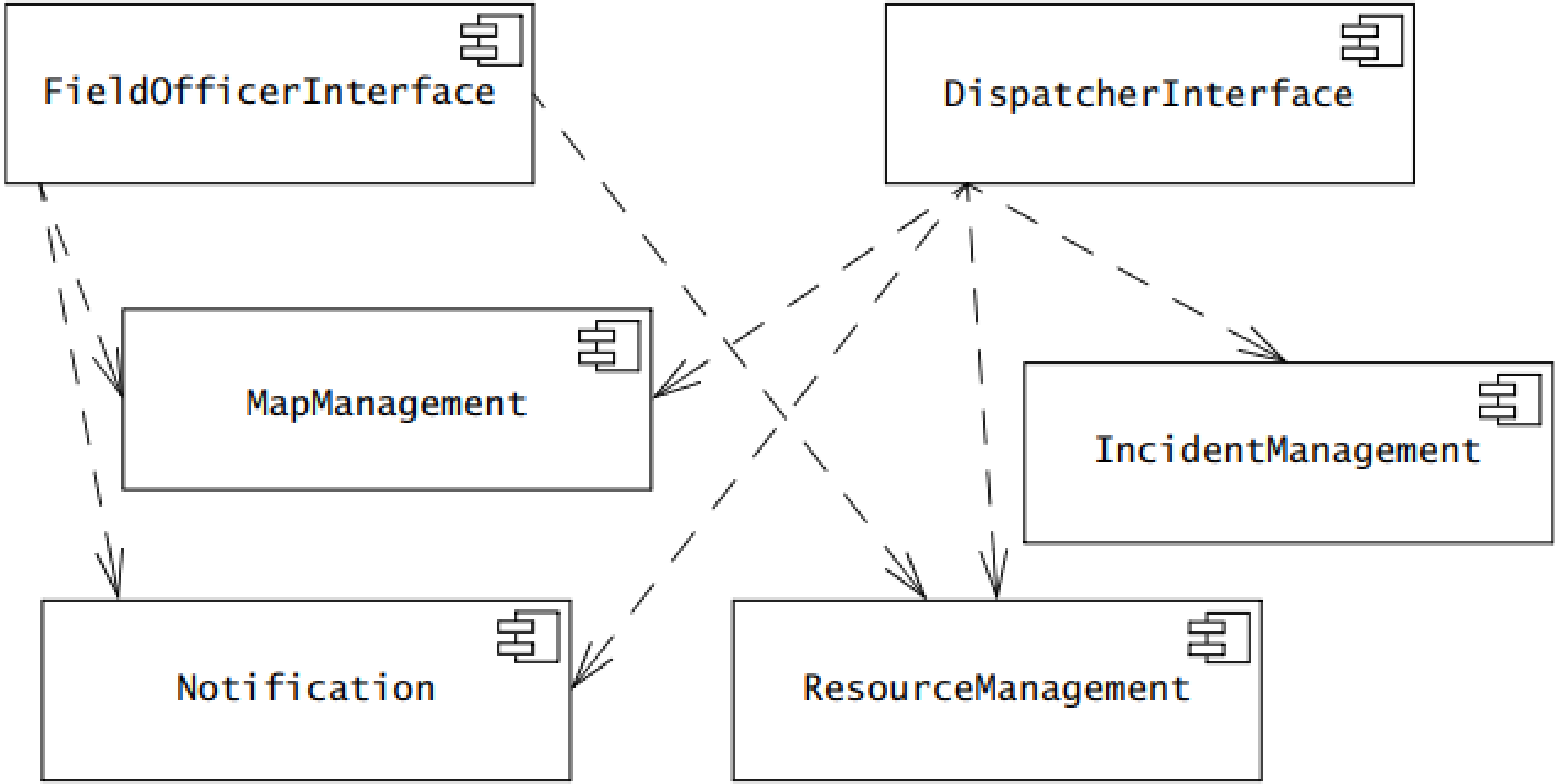
- Subsystem decomposition
- Services and subsystem interfaces
- Coupling and Coherence

Services and subsystem interfaces

- Subsystem
  - Subsystems provide services to other subsystems
  - The objects and classes from the object model are the “seeds” for the subsystems
  - In UML subsystems are modeled as packages
- Service
  - A set of related operations that share a common purpose
  - The origin (“seed”) for services are the use cases from the functional model

Services and subsystem interfaces

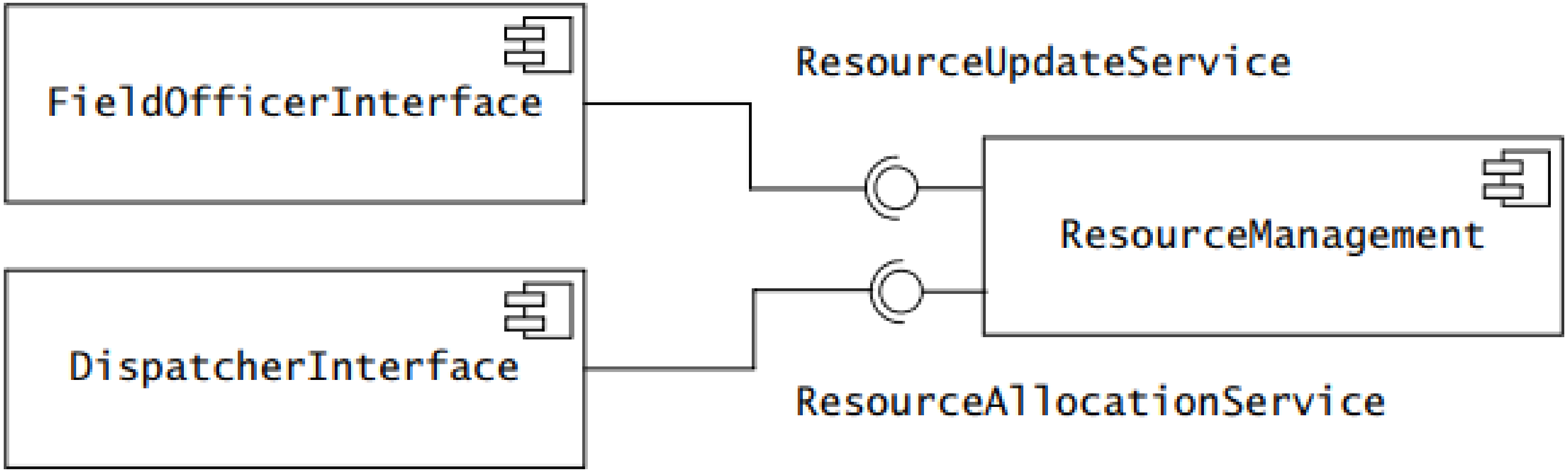
- During the early stages of system design, we do not know the exact services provided by each subsystem.
- In such cases, we use the dependency notation.



Services and subsystem interfaces

- Subsystem services: During **system design**, we define the subsystem in terms of the services it provides.
- A subsystem consists of a collection of classes, associations, operations, events and constraints that are closely interrelated with each other
- Subsystem interface: **During the object design**, we define the subsystem interface in terms of the operations it provides.

Services and subsystem interfaces Provided and Required Interfaces in UML

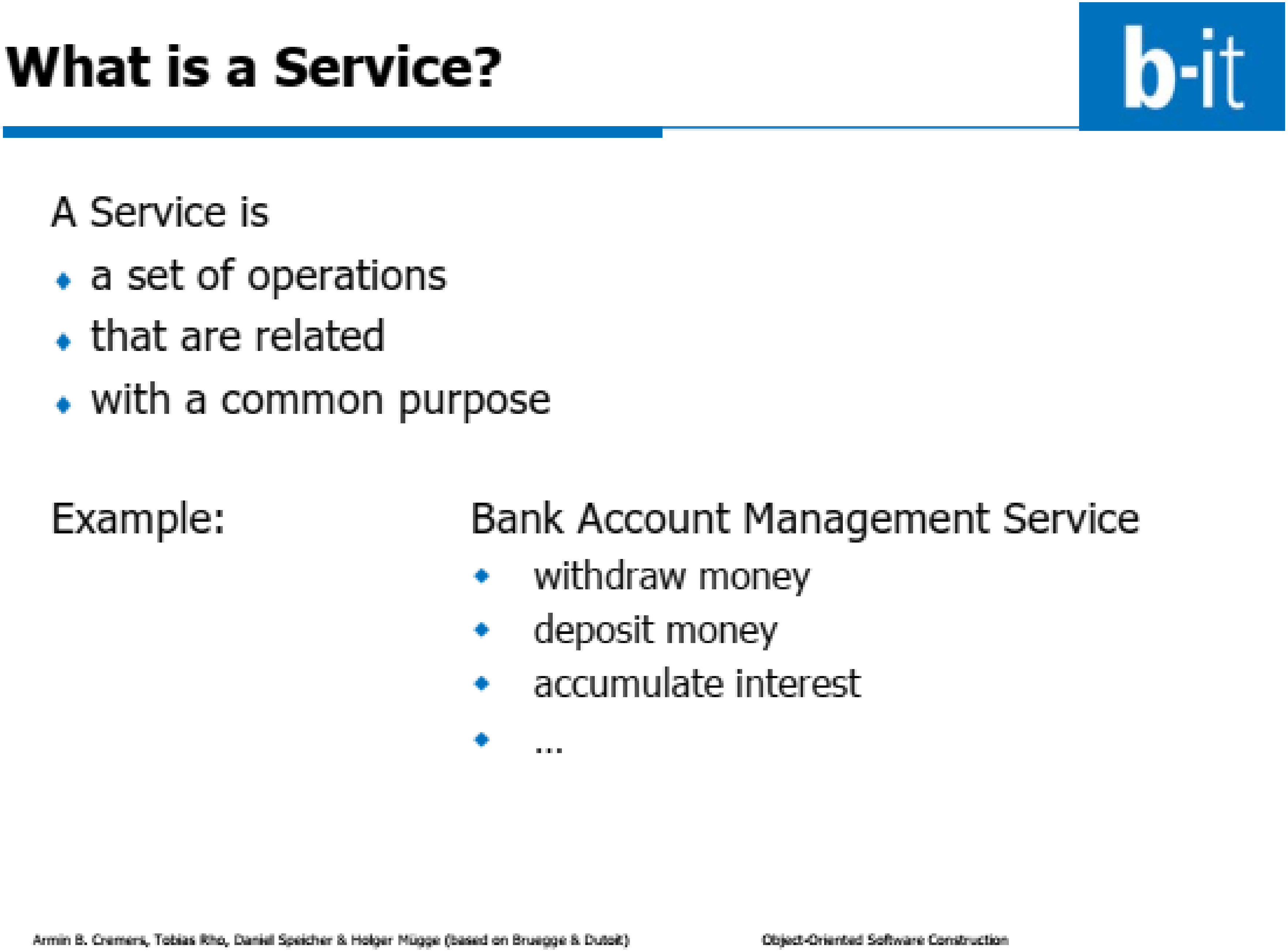


Services and subsystem interfaces

- Application programmer's interface (API)
  - The API is the specification of the subsystem interface in a specific programming language
  - APIs are defined during implementation
- The terms subsystem interface and API are often confused with each other
  - *The term API should not be used during system design and object design, but only during implementation.*

Example: Notification subsystem

- Service provided by Notification Subsystem
    - LookupChannel()
    - SubscribeToChannel()
    - SendNotice()
    - UnscubscribeFromChannel()
- Subsystem Interface of Notification Subsystem
    - Set of fully typed UML operations
- API of Notification Subsystem
    - Implementation in Java



What is a Service?

A Service is

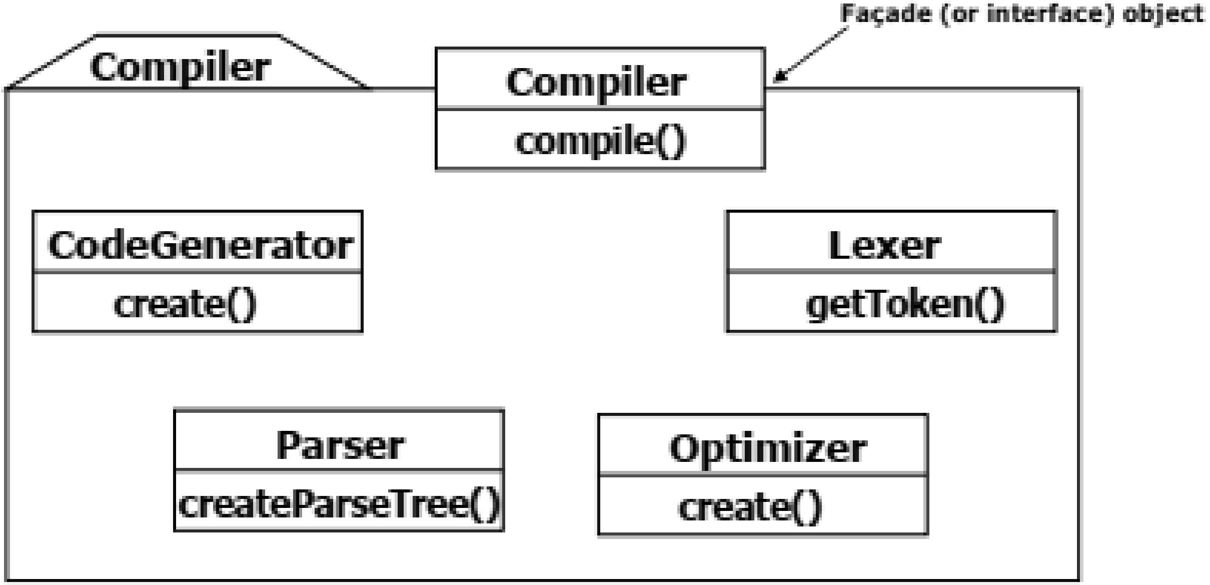
- a set of operations
- that are related
- with a common purpose

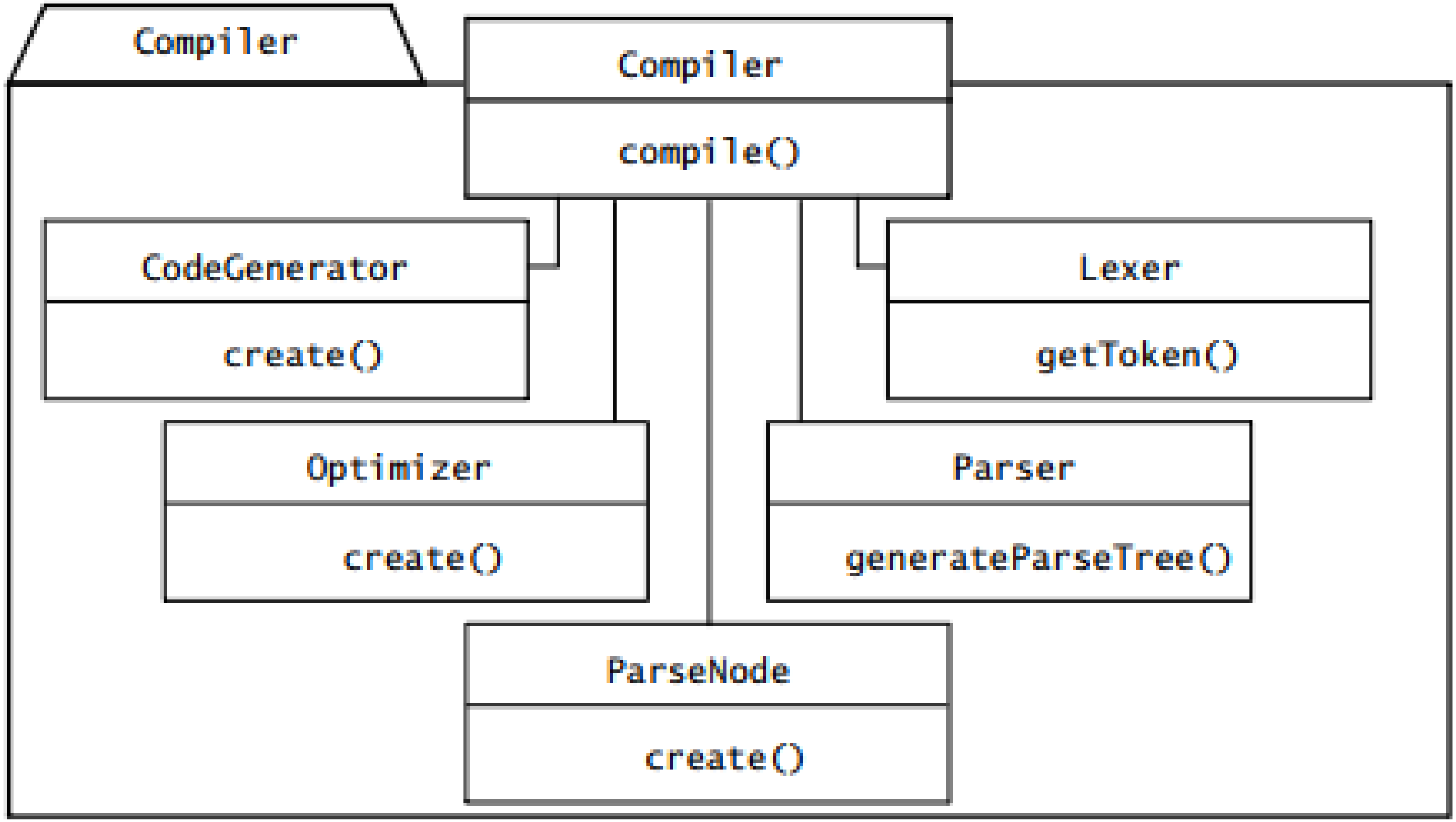
Example: Bank Account Management Service

- withdraw money
- deposit money
- accumulate interest
- …

Definition: Subsystem Interface Object

- A Subsystem Interface Object provides a service
  - This is the set of public methods provided by the subsystem
  - The Subsystem interface describes all the methods of the subsystem interface object
- Use a Facade pattern for the subsystem interface object




Compiler
Compiler
compile()
CodeGenerator
create()
Lexer
getToken()
Optimizer
create()
Parser
generateParseTree()
ParseNode
create()

Subsystem Interface Object

- Good design: The subsystem interface object describes *all* the services of the subsystem interface

- Subsystem Interface Object
    - The set of public operations provided by a subsystem

Subsystem Interface Objects can be realized with the Façade pattern (=> lecture on design patterns).

Coupling and Coherence of Subsystems

- Goal: Reduce system complexity while allowing change
- Coherence measures dependency among classes
  - High coherence: The classes in the subsystem perform similar tasks and are related to each other via many associations
  - Low coherence: Lots of miscellaneous and auxiliary classes, almost no associations
- Coupling measures dependency among subsystems
  - High coupling: Changes to one subsystem will have high impact on the other subsystem
  - Low coupling: A change in one subsystem does not affect any other subsystem.

Coupling and Coherence of Subsystems

Good Design

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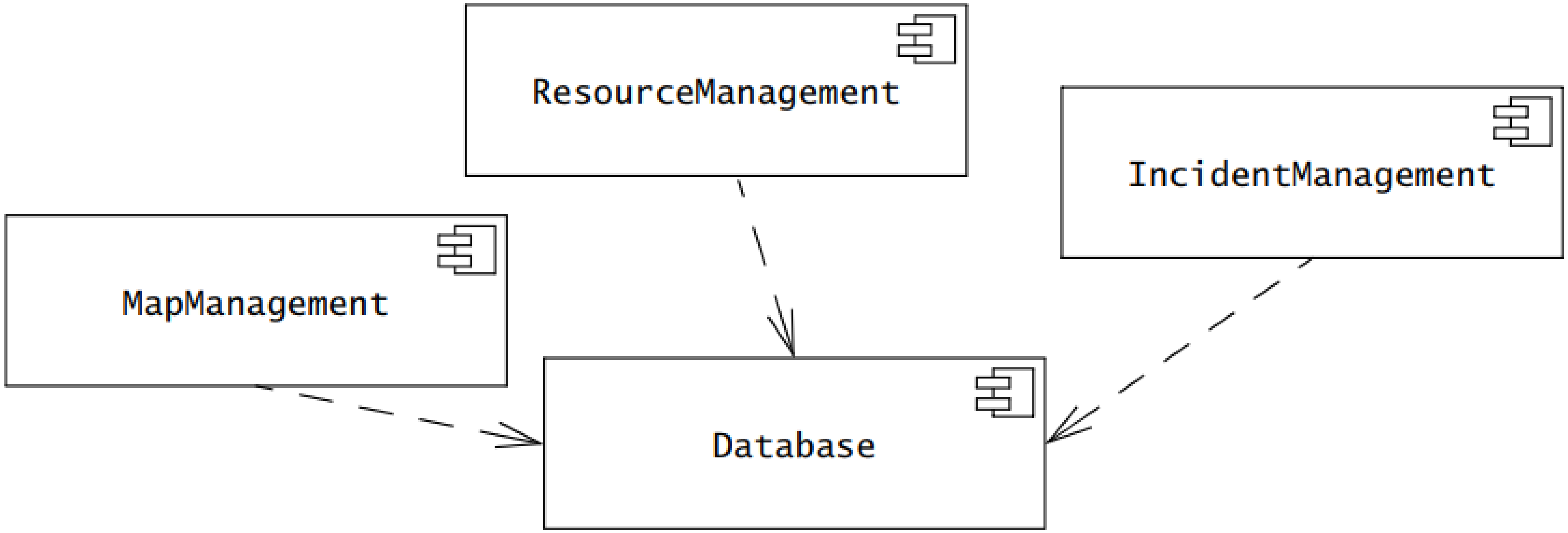
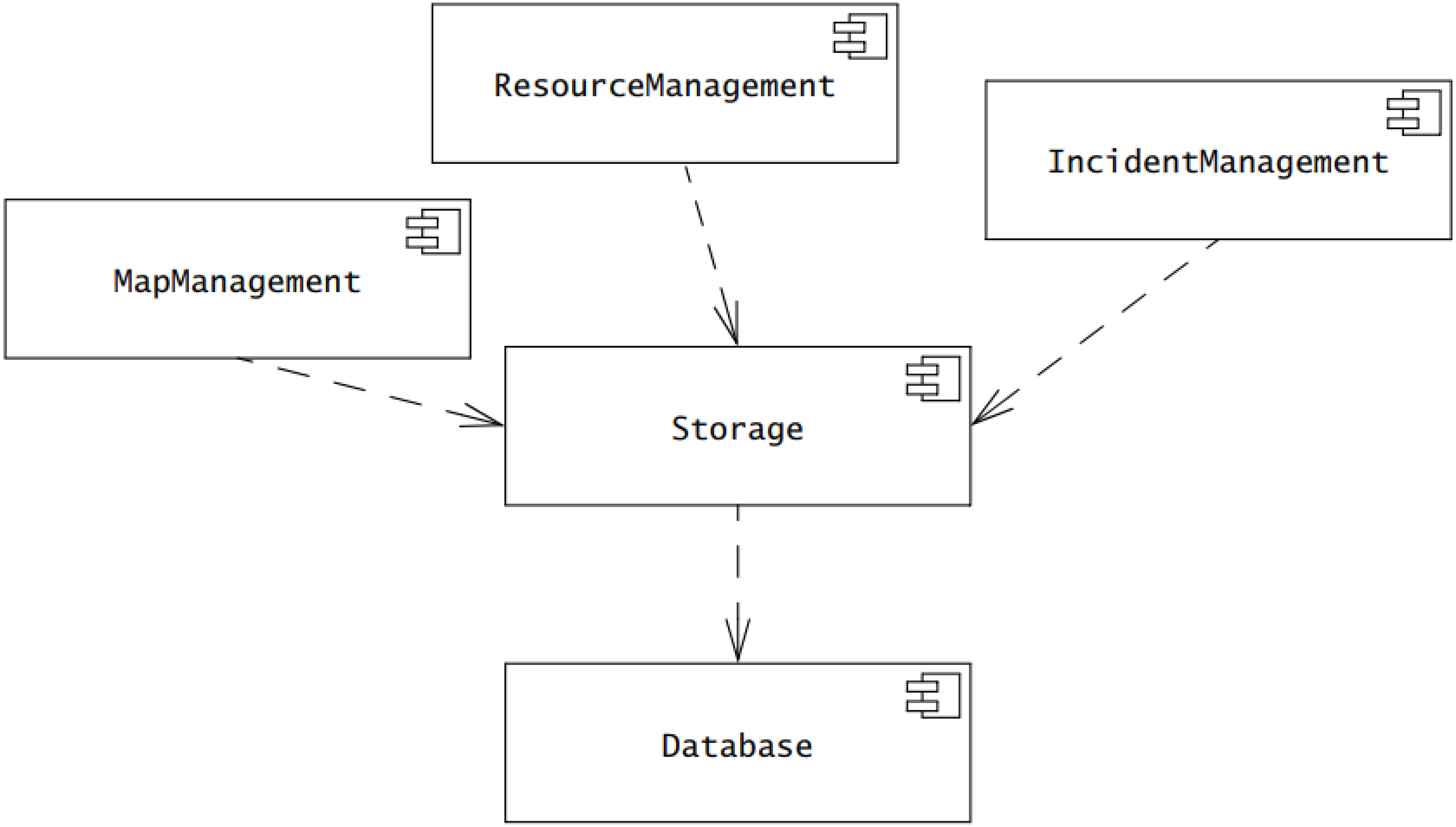
Coupling and Coherence of Subsystems

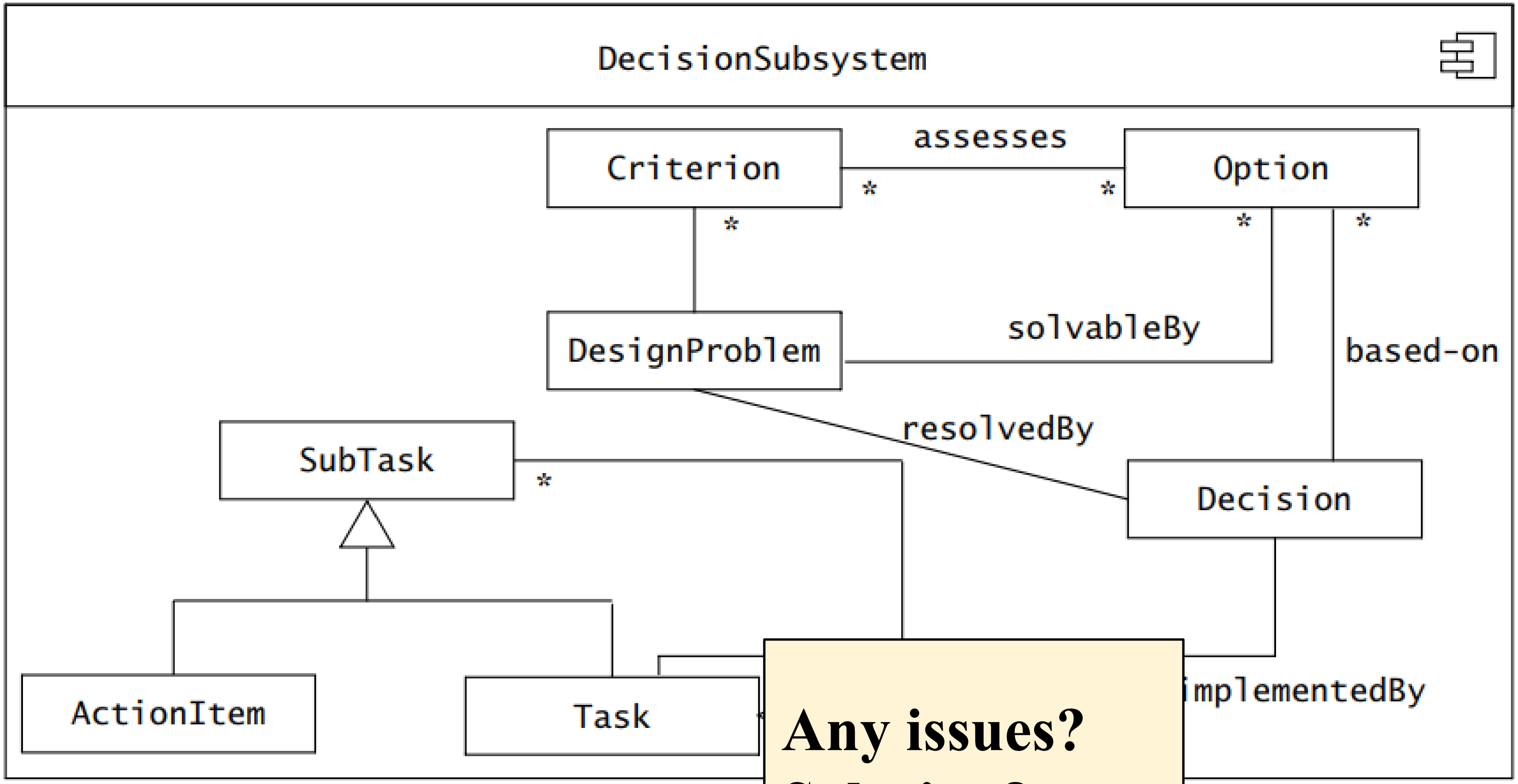


Any issues?
Solution?

Coupling and Coherence of Subsystems



Coupling and Coherence of Subsystems



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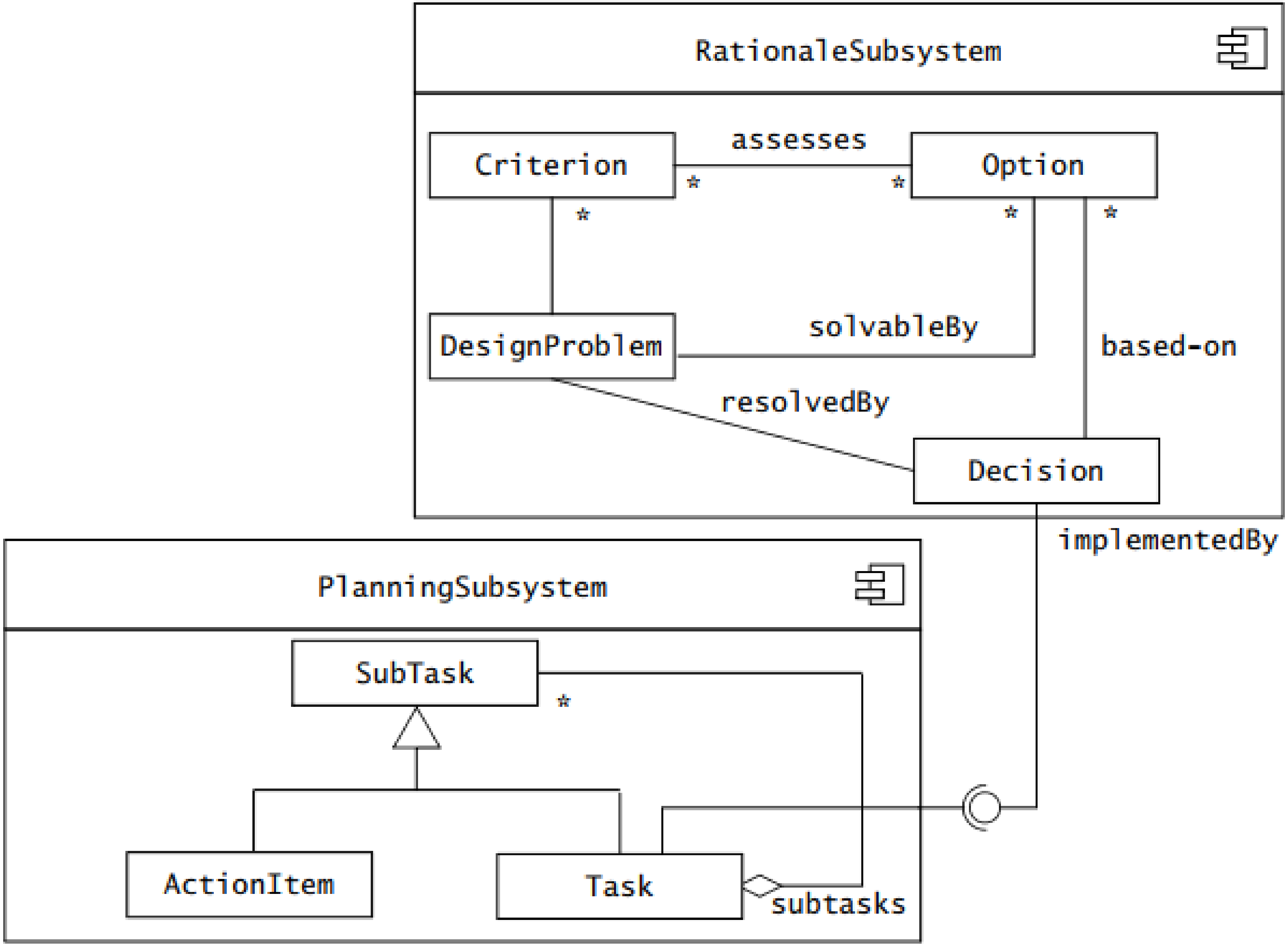
Coupling and Coherence of Subsystems



Required Readings

- Chapter 6 from Bruegge’s OOSE textbook:
  Bruegge, Bernd, and Allen H. Dutoit. "Object-oriented software Engineering." *ed: Prentice Hall* , Third Edtiton