Hochschule Konstanz
Fakultät Informatik

Software Engineering

10 - Components

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Definitions of Software Architecture

- Software Architecture is the structure of the components of a program/system, their interrelationships, and principles and guidelines governing their design and evolution over time.
  - Garlan and Perry, 1995
- The software architecture of a program or computing system is the structure or structures of the system, which comprise software components, the externally visible properties of those elements, and the relationships among them.
  - From Software Architecture in Practice (2nd ed.): Bass, Clements, Kazman; Addison-Wesley 2003
- Architecture is [..] the fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution.
  - From ANSI/IEEE Standard 1471-2000

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What are Components

- A software component is a software element, that conforms to a component model and can be composed with other components according to a composition standard and executed without changes

The Metaphor

- Components are like parts of a prefabricated house
  - Clear dependencies
  - Build them up from bottom to top
  - Connect them in a simple, fast and reliable way
  - Reuse them in different contexts
  - Reduce development cost and time
  - Reduce complexity
- Components are even better than parts of prefabricated houses
  - We want to be able to replace components with a better or adapted version at any later time

The Counterpart Metaphor

- Components need to be composable and decomposable
- In construction the decomposition is not as important
  - So often there are huge interdependencies
  - In Software these would be entanglements

Components in Java

- So, how do we define a component in Java?
  - Does the language provide a keyword?
  - Does the language provide a different construct or concept?

Components vs Packages

- Components should be
  - Modular
  - Cohesive
  - Reusable
  - Replaceable

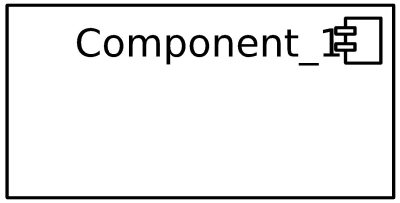
- Packages
  - Organizes Types into namespaces
  - Grouped by
    - Category or
    - Functionality
- Packages do not have to be
  - Modular
  - Cohesive
  - Reusable
  - Replaceable
- But they can be!

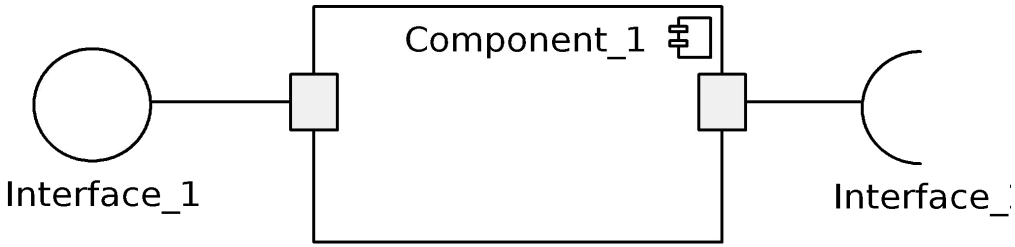
Components in Java

- There is no keyword for Components in Java
- In fact it is hard to see a Component in Java
- We need a higher level of abstraction to see and argue about Components
- Let's look at UML

Component Diagram

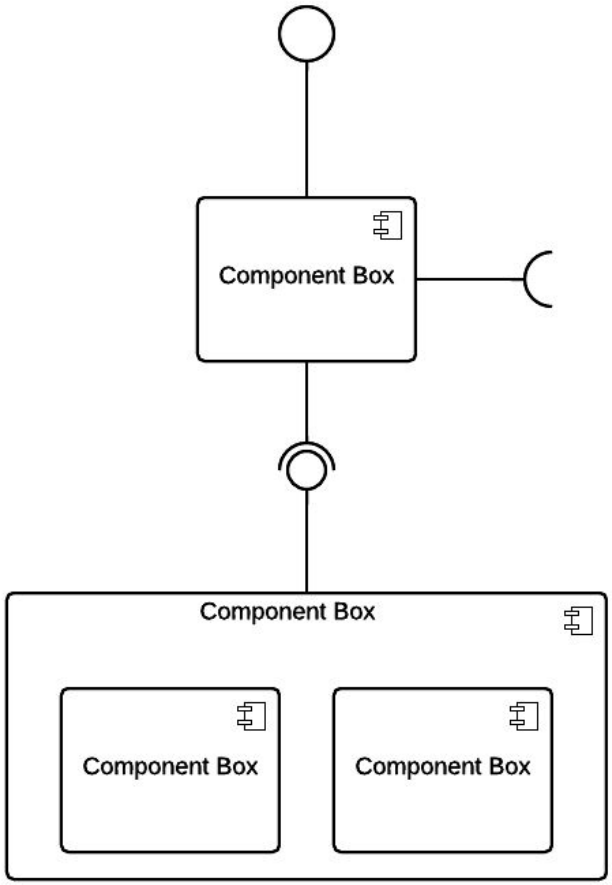
- UML 2 has a diagram type for Components
- Components can
  - have Ports
  - provide Interfaces
  - require Interfaces



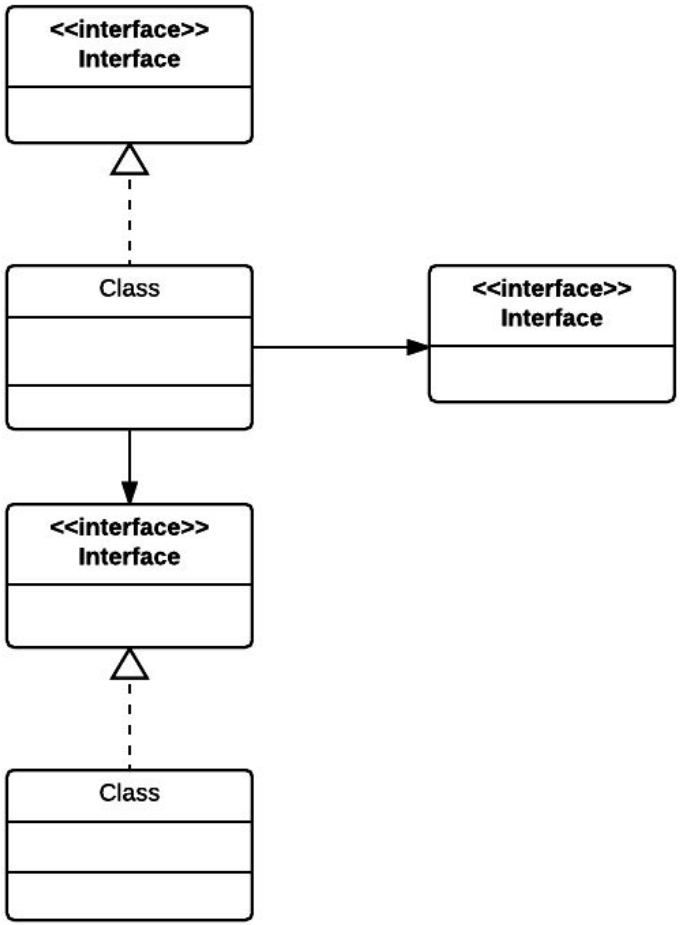


Component Diagram

Component Diagram

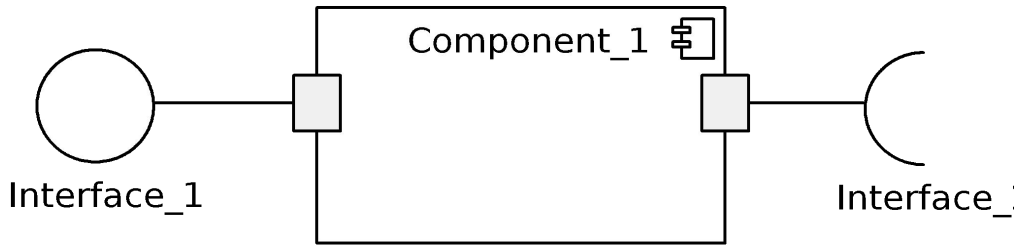


Class Diagram



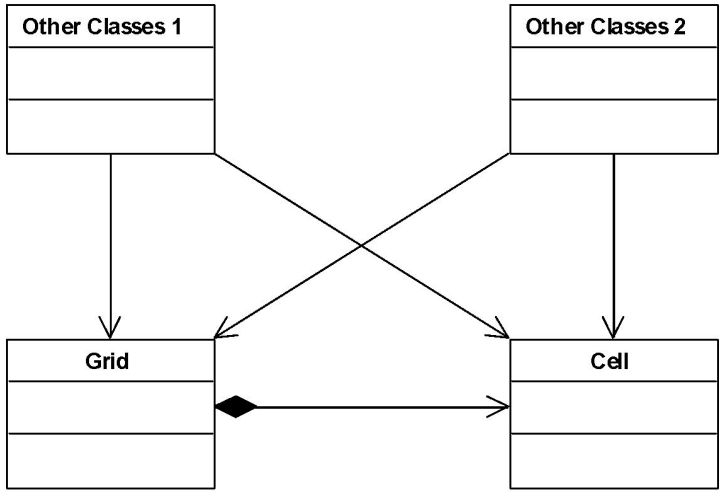
Ports

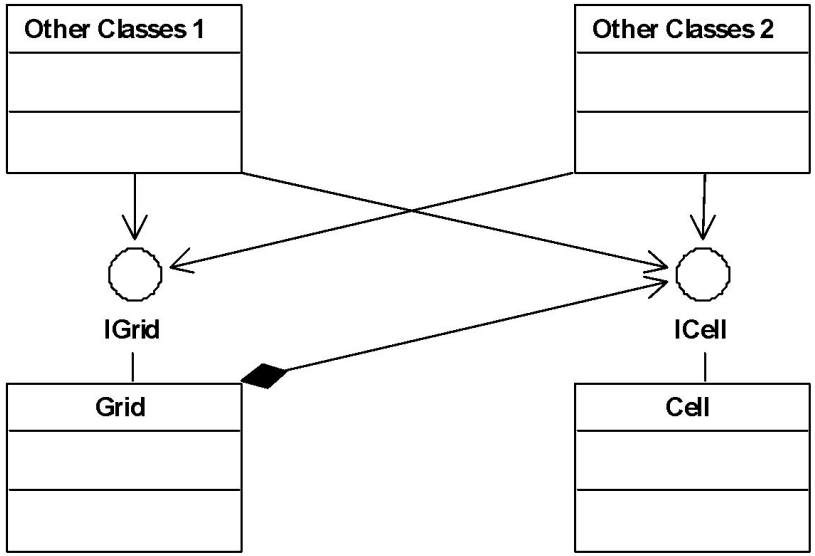
- A Port is a distinct interaction point of the component
- It is implemented by a Class
  - Port classes are public, all other should be package-private
  - often using a Facade Pattern
- The Port Class
  - provides Interfaces to the outside or
  - funnels requests from within to the outside
- The Ports encapsulate the component



The Current Situation

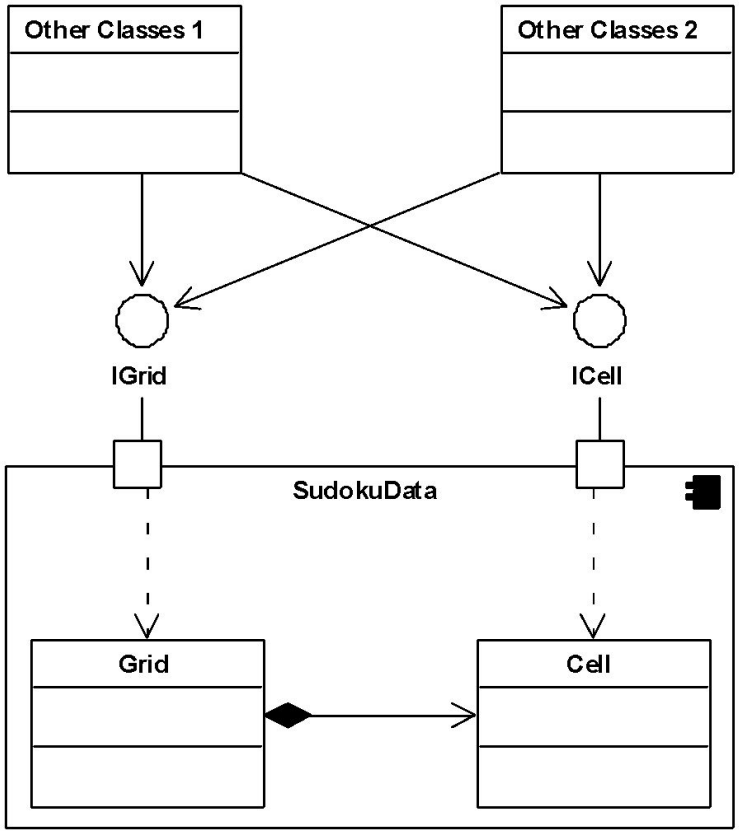
- We want to introduce Interfaces
- If we extract the Interface by refactoring „extract Interface“
  - All dependencies to Grid and Cell are through Interfaces
- This is not quite what we wanted



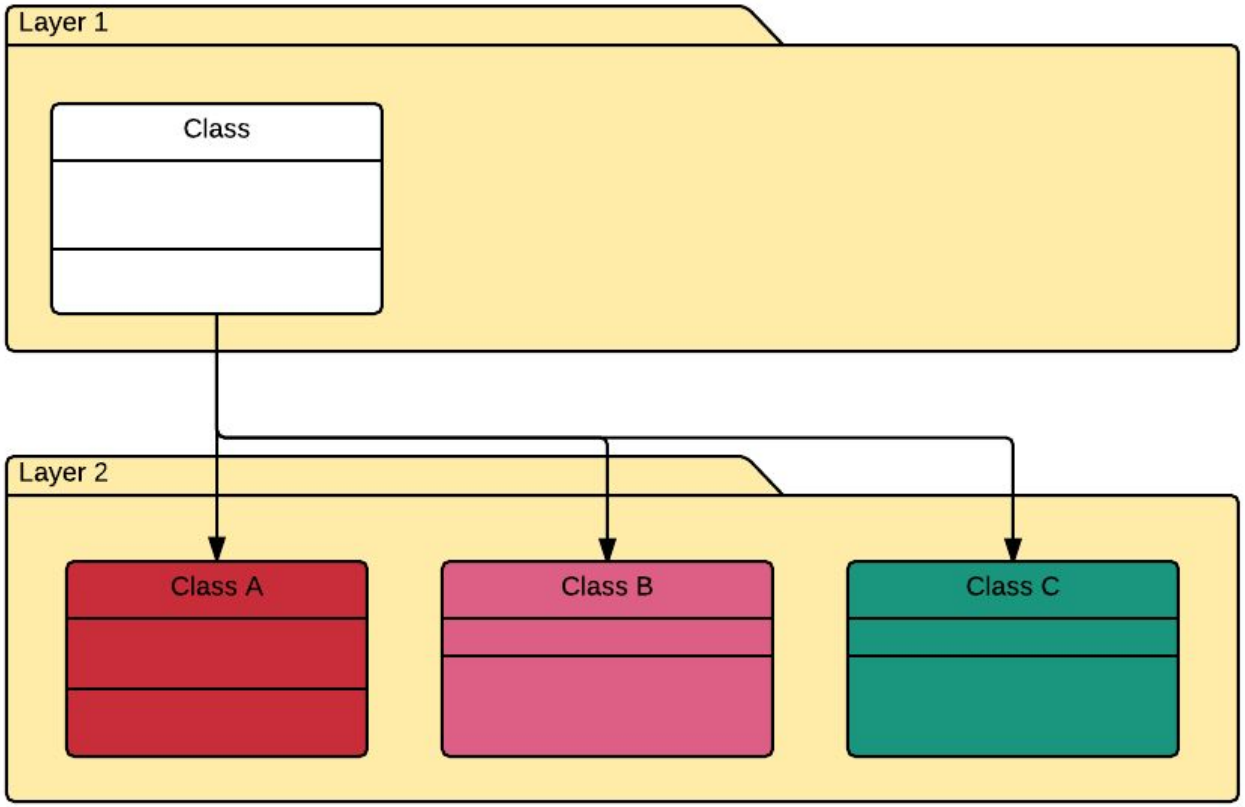


What we want

- A Component
  - Stable to the outside
  - Flexible to the inside
  - With a minimal Interface



Starting Point



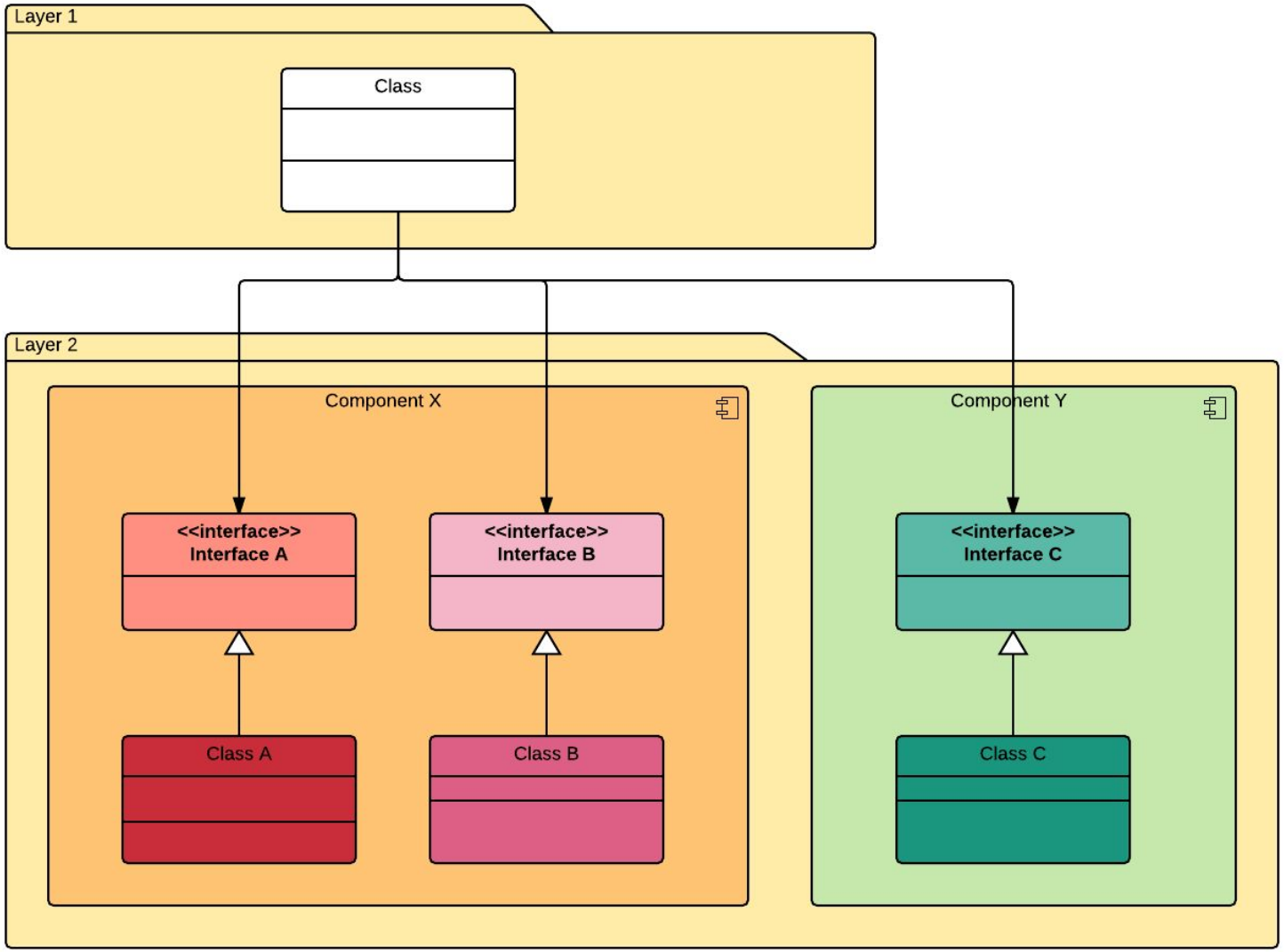
Interfaces

- Interfaces provide a stable connection point to a higher layer
- Interfaces need to remain stable
- The implementation underneath may change
- Dependency Inversion Principle

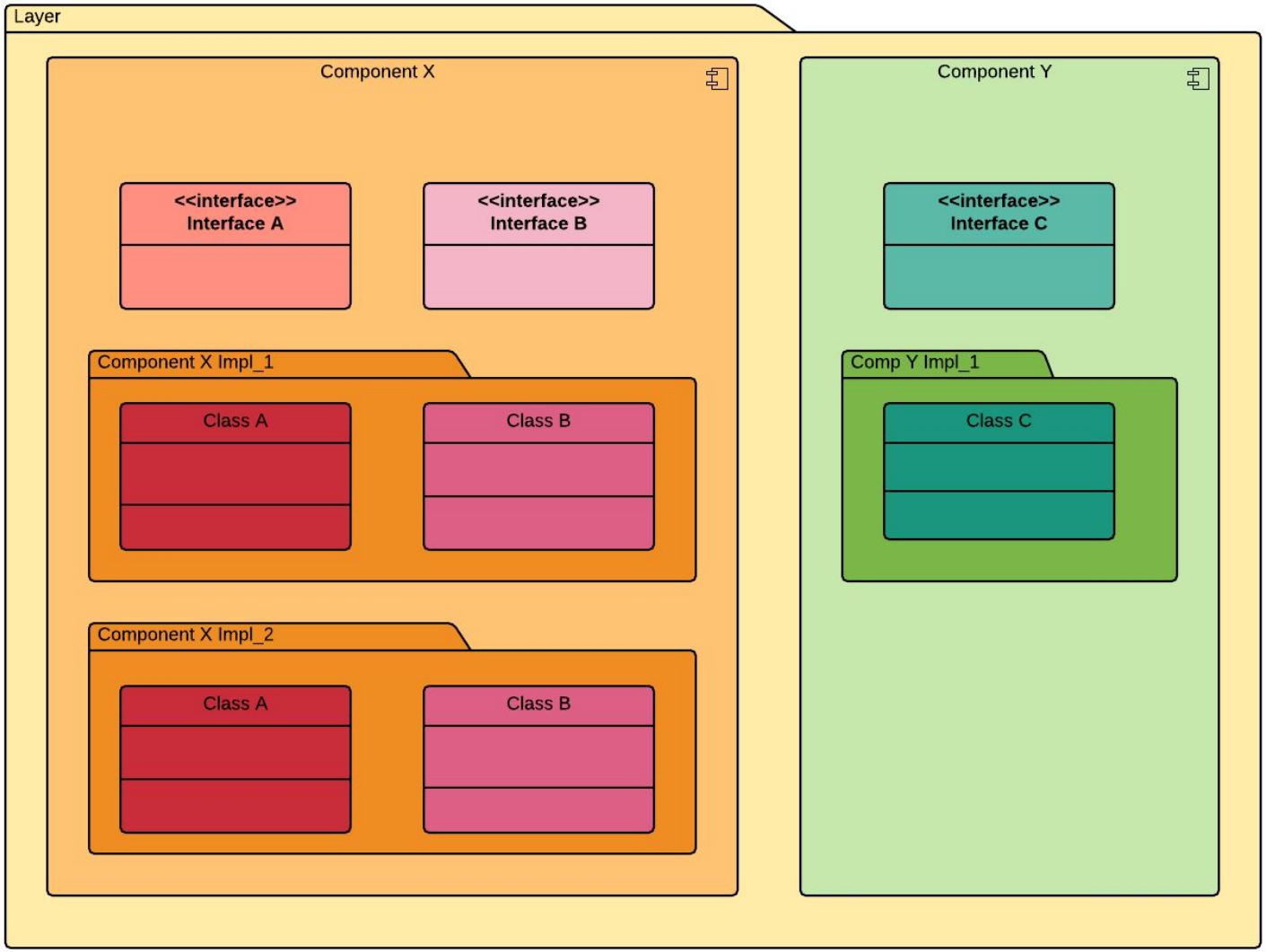
Interfaces

- A key mechanism for components is to separate them with Interfaces.
  - Every access or interaction between components must be done through an interface
  - The interfaces should be small and tailored to different users
    - Interface Segregation Principle
  - The interface encapsulates units of code that could be replaced by a different version later on
  - The interface of the component will have to remain stable, so make them clean, clear and concise
  - Interfaces should be documented very well

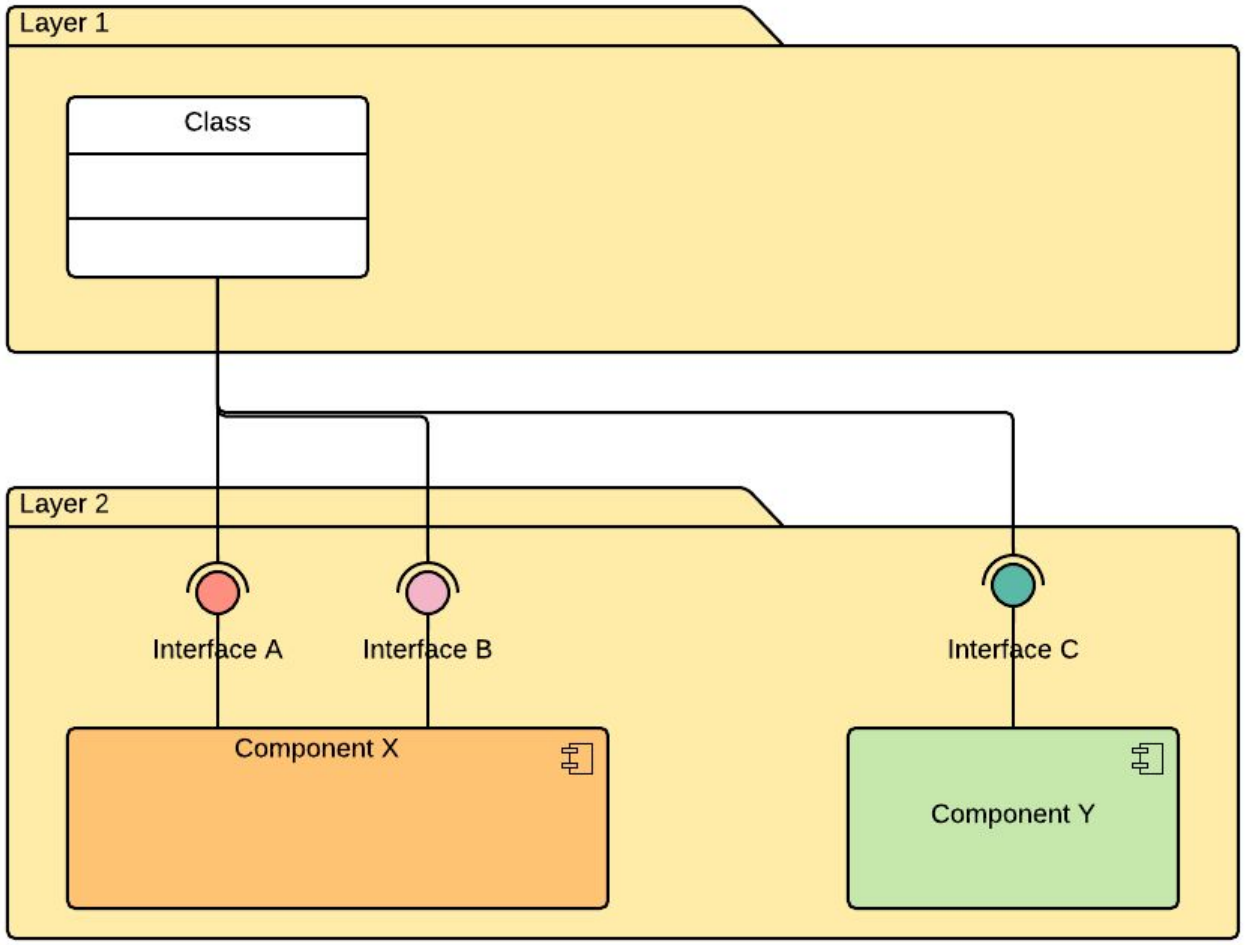
Introducing Interfaces



Component Structure

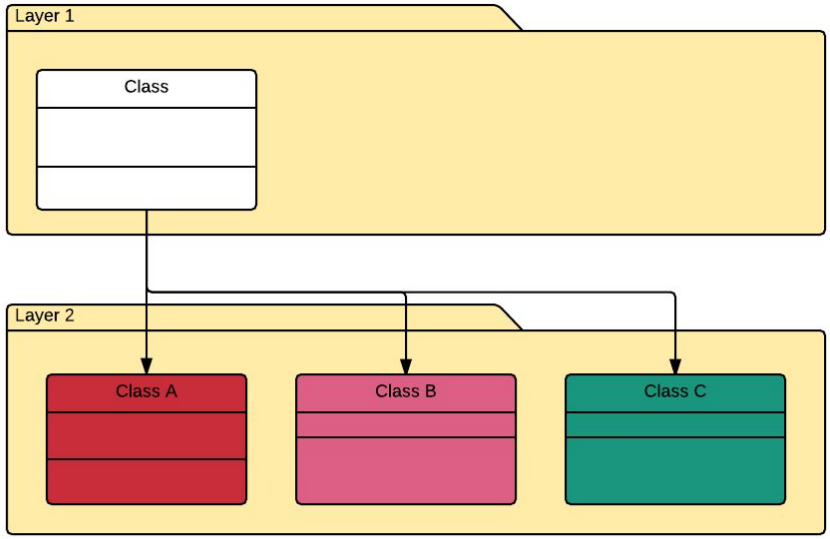


Endpoint

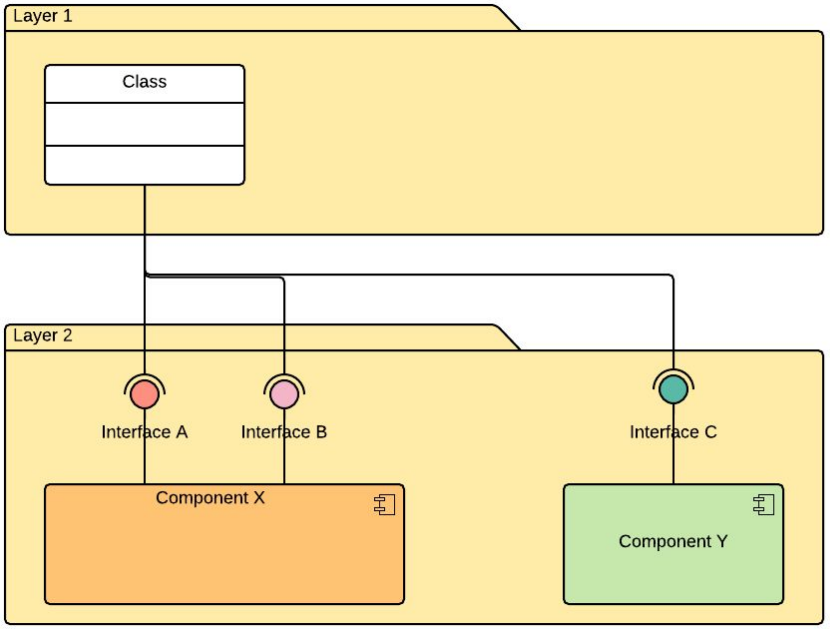

Layer 1
Class
Layer 2
Interface A
Interface B
Interface C
Component X
Component Y

From Start to End

- Direct dependency on implementation



- Dependency only to Abstractions
- Implementation can change

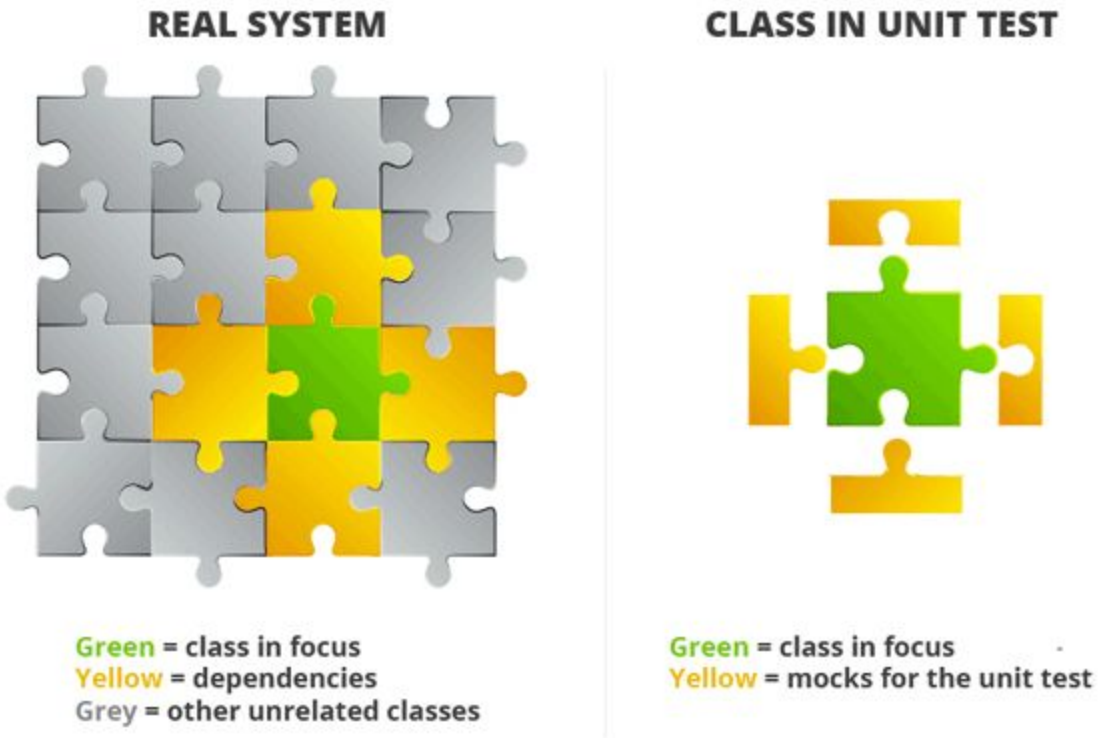


How to Cut the Components

Contain Cohesion into Components
Allow orchestration of Components
Minimize communication between Components
Minimize dependencies between Components
Layer Components
Use Components inside Components
Make Components testable

Testing Components

Isolate the component from its dependencies using Test Doubles



Test Doubles

Components can be simulated during testing using Test Doubles

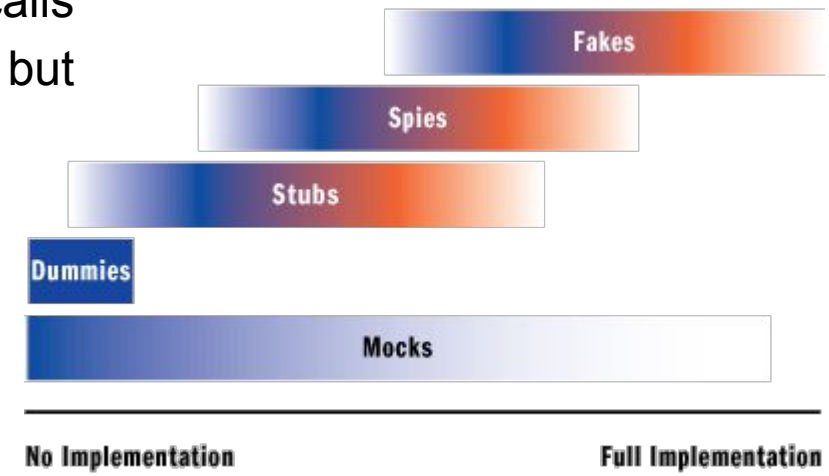
Dummies have no implementation, but compile

Stubs return a hard coded response

Spies count the number of calls

Fakes are implementations, but not the real thing

Mocks are simulations of an implementation



Task 10: Introduce Interfaces and Components

Cut your application into Components

Encapsulate every Component with Interfaces

Make sure only the Interfaces are accessed

Cut all access to the inner workings of the Component