ICS 52: Introduction to Software Engineering

Fall Quarter 2004

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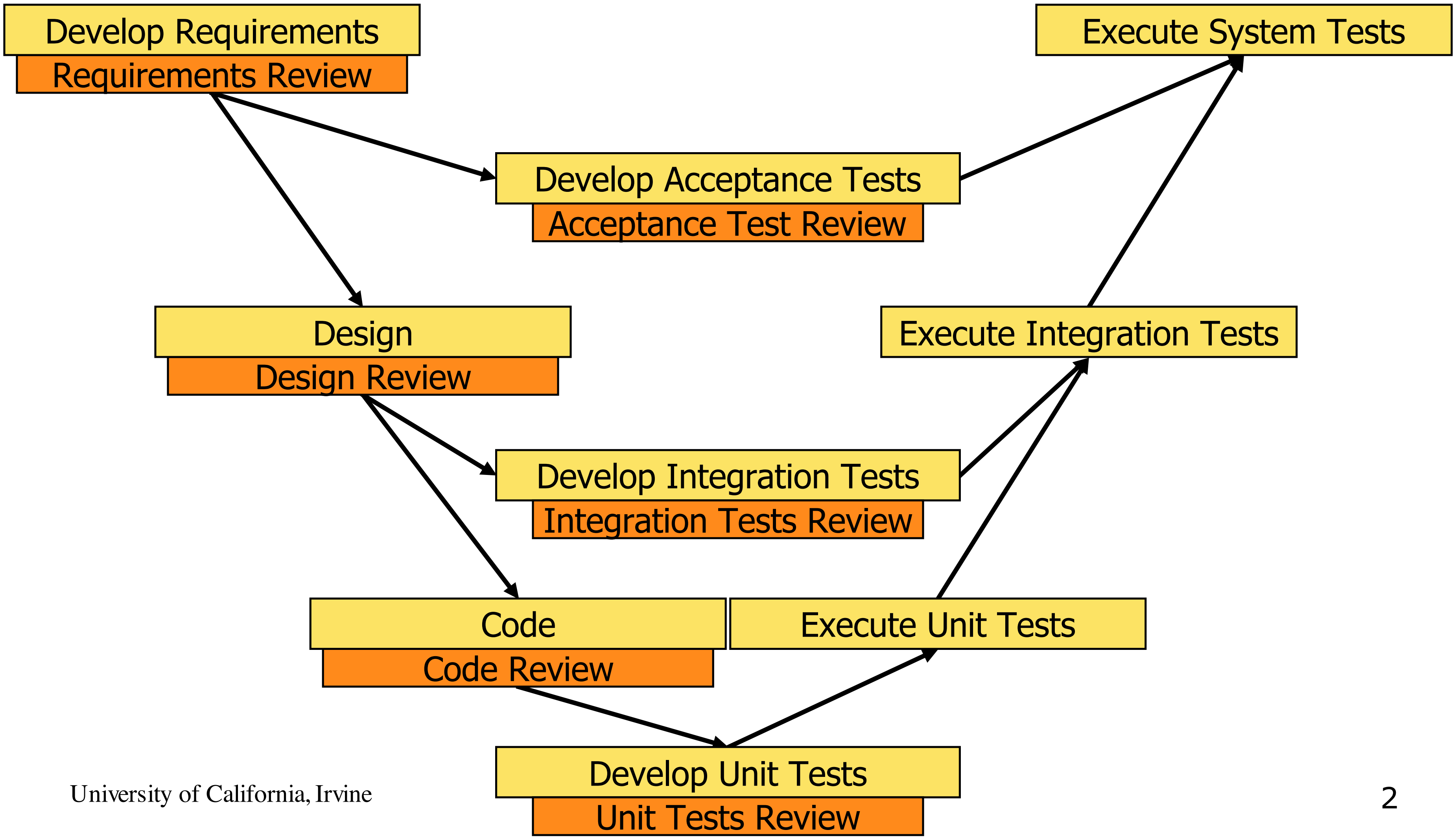
Lecture Notes

Week 7 Integration Testing and Implementation Issues

http://www.ics.uci.edu/~taylor/ICS_52_FQ04/syllabus.html

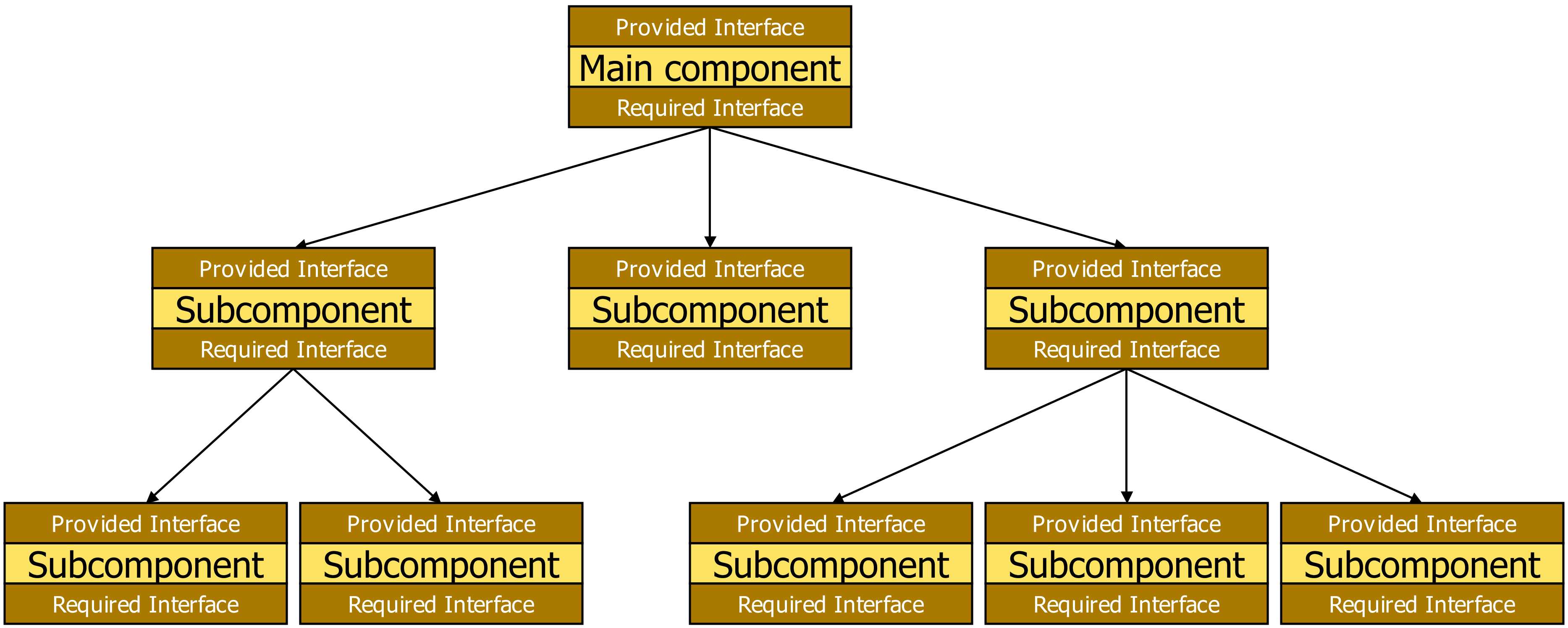
V-Model of Development and Testing



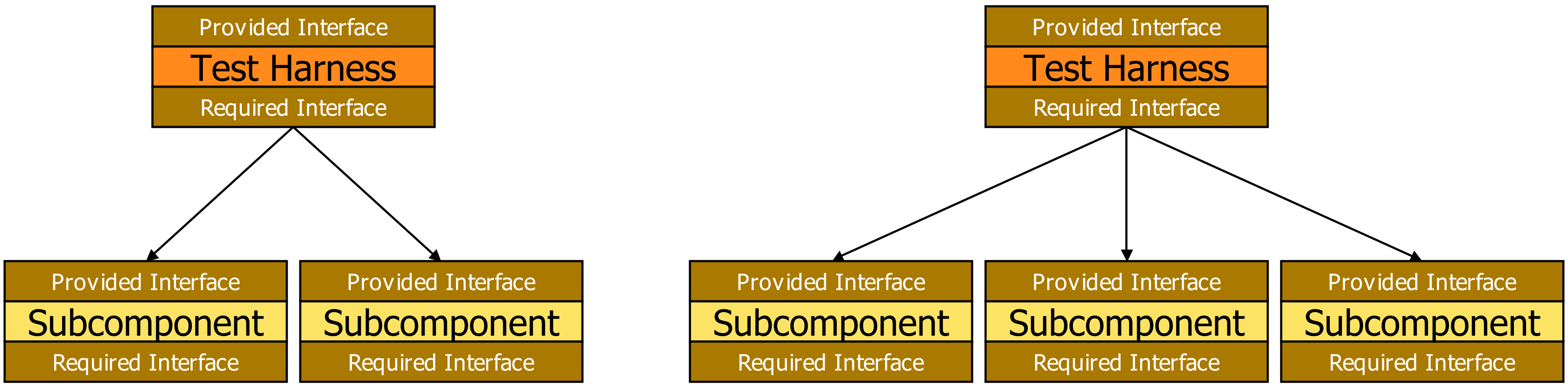
Integration Test Plan

- Ensures module implementations adhere to assumptions and interfaces as designed
  - Uncovering interactions that highlight problems with assumptions is difficult
- Approach
  - Combine more and more modules
  - Use USES hierarchy
    - » Work up from level zero
      - Use test harnesses to test each group of modules
    - » Work down from highest number
      - Use stubs as mockups to test each group of modules
- Can be done <u>during</u> implementation effort

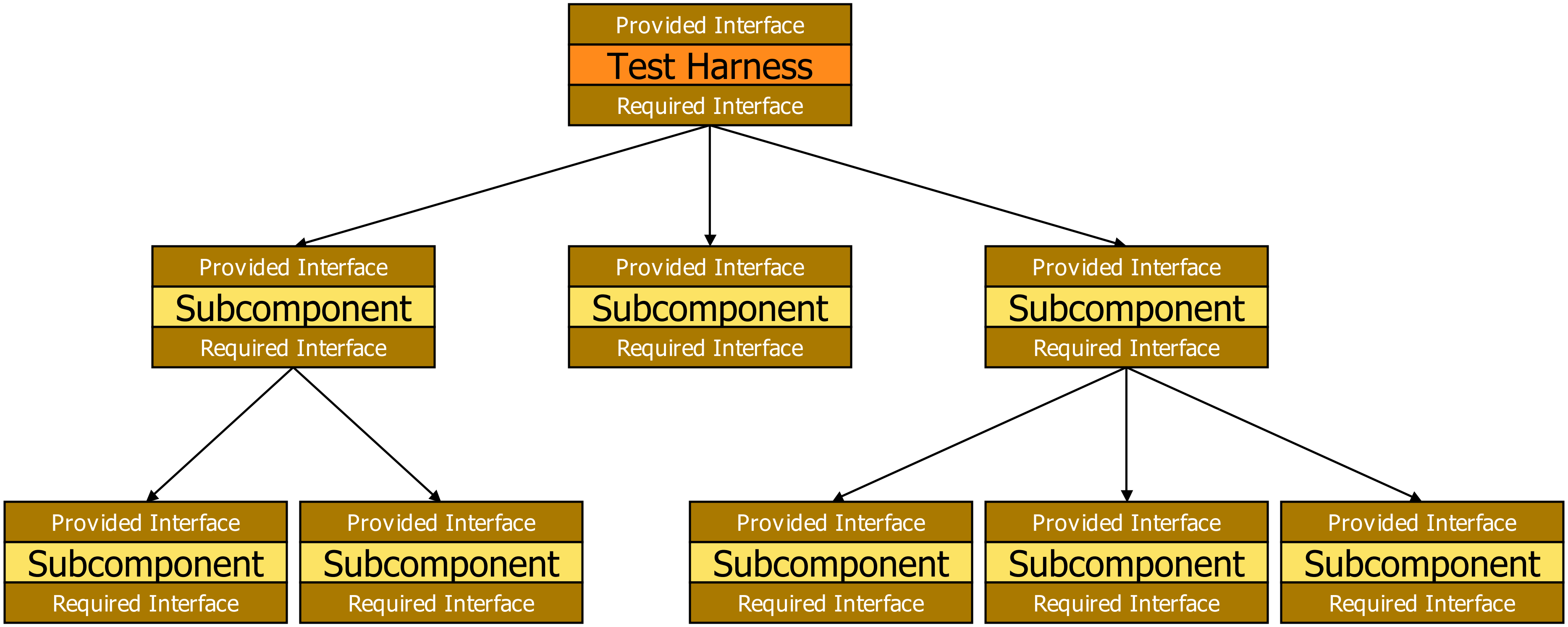
Integration Test Example



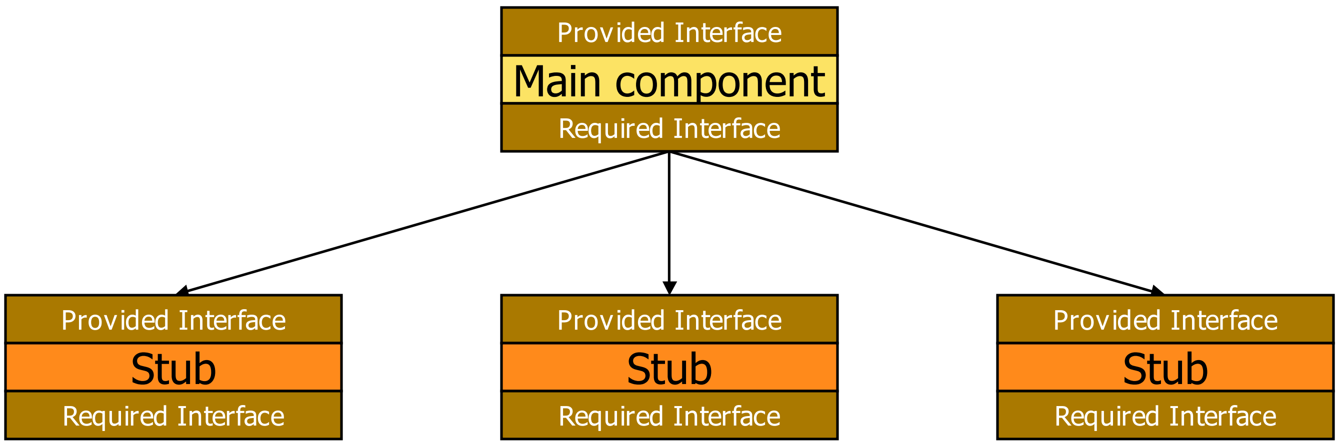
Test Harnesses



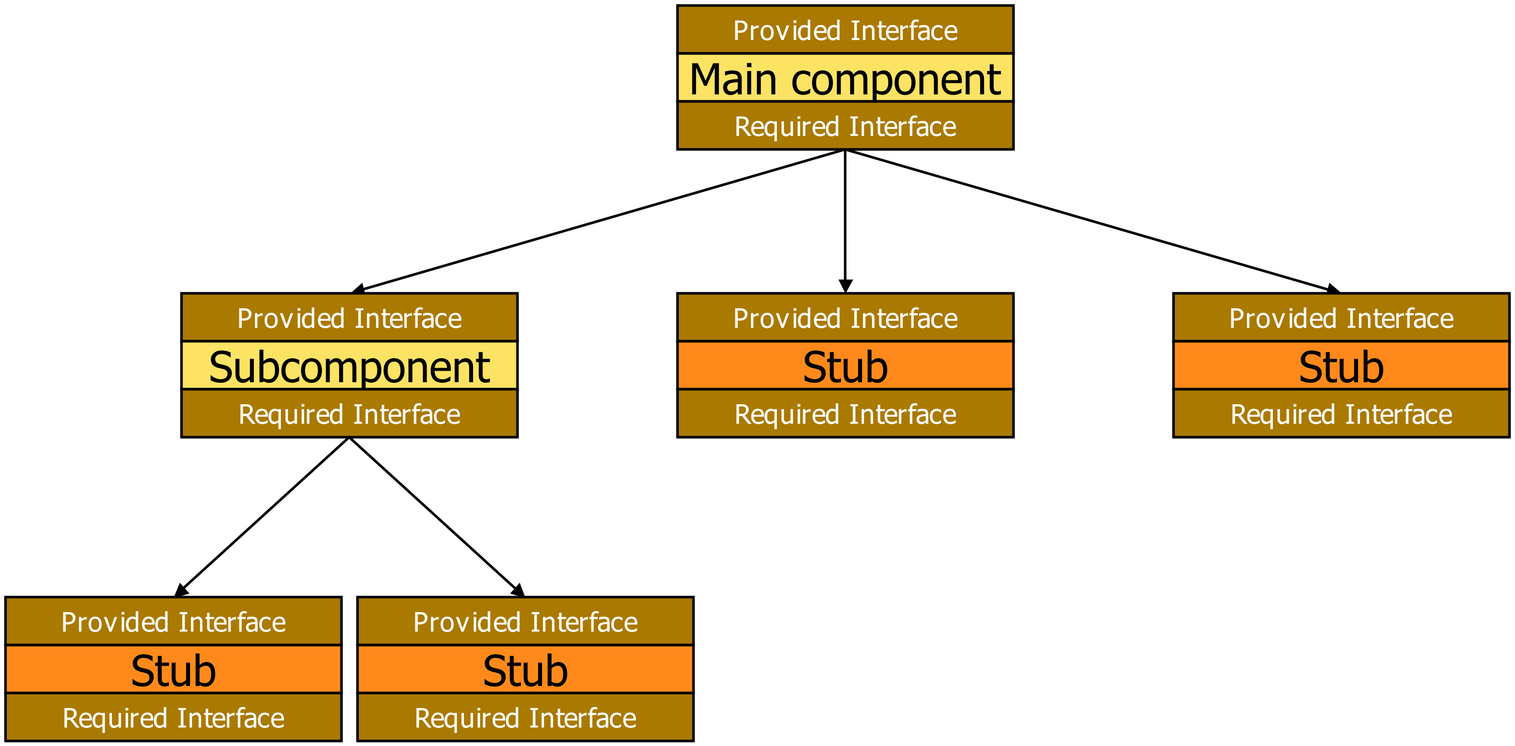
Test Harnesses



Stubs


Provided Interface
Main component
Required Interface
Provided Interface
Stub
Required Interface
Provided Interface
Stub
Required Interface
Provided Interface
Stub
Required Interface

Stubs



Provided Interface
Main component
Required Interface
Provided Interface
Subcomponent
Required Interface
Provided Interface
Stub
Required Interface
Provided Interface
Stub
Required Interface
Provided Interface
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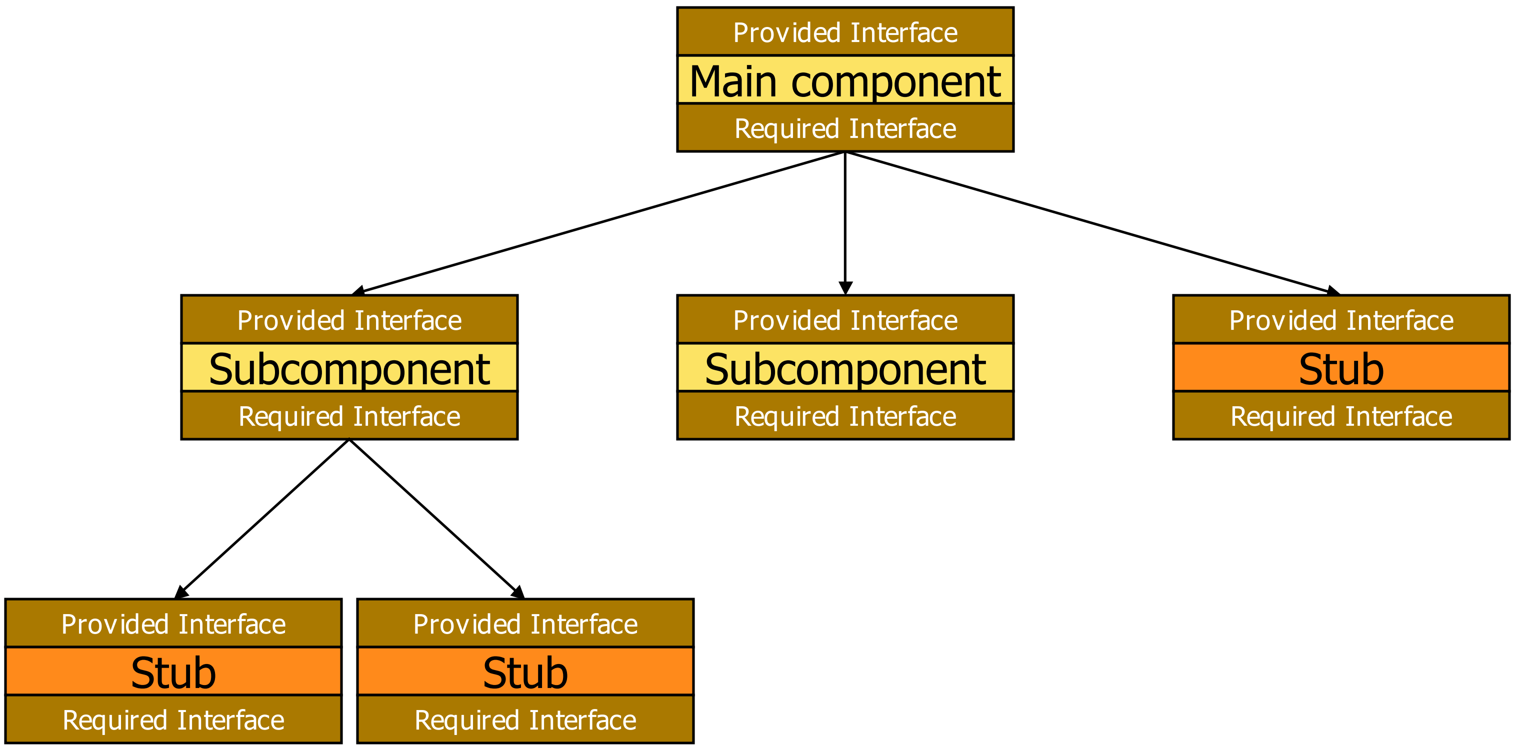
Required Interface
Provided Interface
Stub
Required Interface

Stubs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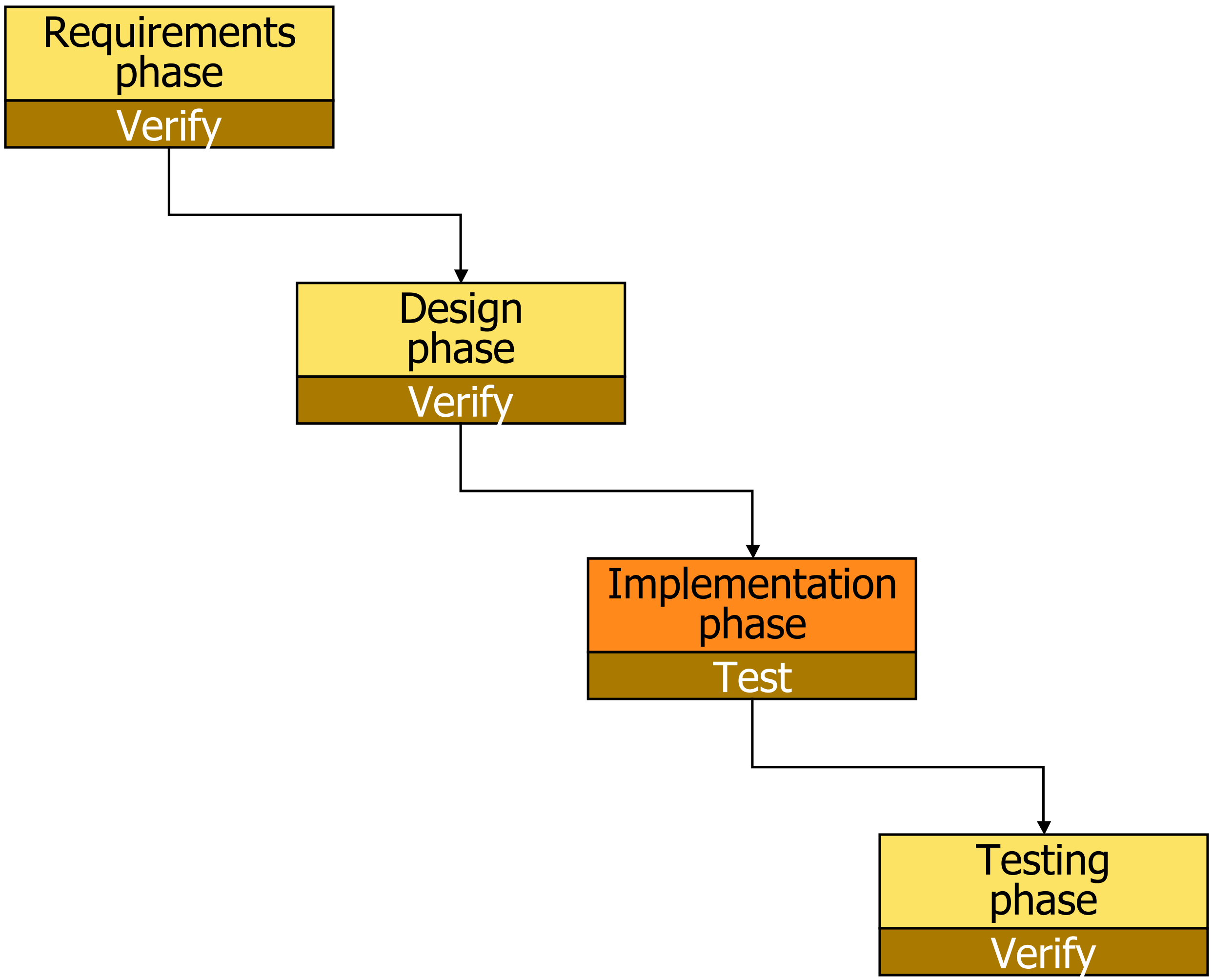
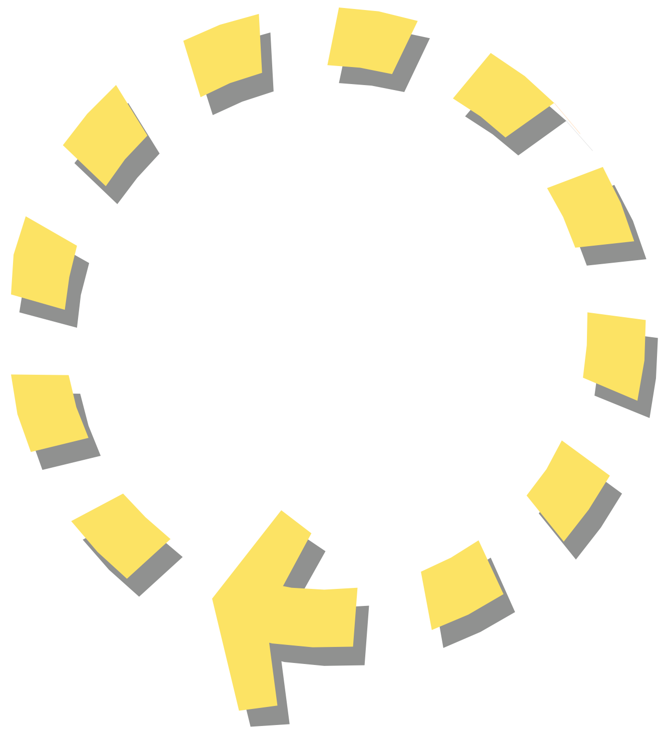
Required Interface

ICS 52 Life Cycle



Design/Implementation Interaction

Design
(previous lectures)



Implementation
(this lecture)

A Good Design…

- …is half the implementation effort!
  - Rigor ensures all requirements are addressed
  - Separation of concerns
    - Modularity allows work in isolation because components are independent of each other
    - Abstraction allows work in isolation because interfaces guarantee that components will work together
  - Anticipation of change allows changes to be absorbed seamlessly
  - Generality allows components to be reused throughout the system
  - Incrementality allows the software to be developed with intermediate working results

A Bad Design…

- …will never be implemented!
  - Lack of rigor leads to missing functionality
  - Separation of concerns
    - » Lack of modularity leads to conflicts among developers
    - » Lack of abstraction leads to massive integration problems (and headaches)
  - Lack of anticipation of change leads to redesigns and reimplementations
  - Lack of generality leads to “code bloat”
  - Lack of incrementality leads to a big-bang approach that is likely to “bomb”

From Design to Implementation

- Choose a suitable implementation language
- Establish coding conventions
- Divide work effort
- Implement
  - Code
  - Unit tests
  - Code reviews
  - Inspections
- Perform integration tests

Choose a Suitable Language

- 4th Generation language
  - Databases
  - Visual Basic
  - Forms
- "Real" programming language
  - Java + Class Libraries
  - C++/C + STL (Standard Template Library)
  - Cobol
  - Fortran
- Assembly language
  - Machine specific

Choose a Suitable Language

- Maintain the design "picture"
  - Mapping of design elements onto implementation
  - Module inside versus outside
    - Does the language enforce a boundary?
    - Interfaces!
  - Explicit representation of uses relationship
    - Just function calls?
- Error handling
  - Return values
  - Exceptions

Establish Coding Conventions

- Naming
  - Avoid confusing characters
    - 1, l, L, o, O, 0, S, 5, G, 6
  - Avoid misleading names
  - Avoid names with similar meaning
  - Use capitalization wisely -- and consistently
- Hungarian notation
  - Example: pch (pointer to a character)
  - pchFirst (pointer to the first element of an array of characters)
  - mpmipfn
- Code layout
  - White space / blank lines
  - Grouping
  - Alignment
  - Indentation
  - Parentheses

Divide Work Effort

- Assign different modules to different developers
  - Assignments can be incremental
  - Assignments change
    - » Illness
    - » New employees
    - » Employees who quit
    - » Schedule adjustments
    - » Star programmers
- Interfaces are tremendously important
  - "Contracts" among modules

Coding

- FIRST MAKE IT WORK CLEANLY
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Code Optimizations

- Only make optimizations to a cleanly working module if absolutely necessary
  - Performance
  - Memory usage
- Isolate these optimizations
- Document these optimizations

Empirical evidence has proven that these optimizations are <u>rarely</u> needed and that if they are needed, they are only needed in a <u>few</u> critical places

Defensive Programming

- Make your code robust and reliable
  - Use assertions
  - Use tracing
  - Handle, do not ignore, exceptions
    - Contain the damage caused
    - Garbage in does not mean garbage out
  - Anticipate changes
  - Check return values
- Plan to be able to remove debugging aids in the final, deliverable version

Do not sacrifice any of these when facing a deadline

Comments

- Self documenting code does <u>not</u> exist!
  - Meaningful variable names, crisp code layout, and small and simple modules all help…
  - …but they are not enough
- <u>Every</u> module needs a description of its purpose
- <u>Every</u> function needs a description of its purpose, input and output parameters, return values, and exceptions
- <u>Every</u> piece of code that remotely may need explanation should be explained

Unit Tests

- Developer tests the code just produced
  - Needs to ensure that the code functions properly before releasing it to the other developers
- Benefits
  - Knows the code best
  - Has easy access to the code
- Drawbacks
  - Bias
    - "I trust my code"
    - "I always write correct code"
  - Blind spots

Code Reviews ("Walk-throughs")

- Developer presents the code to a small group of colleagues
  - Developer describes software
  - Developer describes how it works
    - "Walks through the code"
  - Free-form commentary/questioning by colleagues
- Benefits
  - Many eyes, many minds
  - Effective
- Drawbacks
  - Can lead to problems between developer and colleagues

Inspections

- Developer presents the code to a small group of colleagues
  - Colleagues look for predefined types of errors
    - » Checklists
  - Colleagues read code beforehand
  - Moderator leads discussion
- Benefits
  - Avoids personal “attacks”
  - Effective
- Drawbacks
  - Only verifies code with respect to a predefined list of problem areas

Use the Principles

- Rigor and formality
- Separation of concerns
  - Modularity
  - Abstraction
- Anticipation of change
- Generality
- Incrementality