ICS 52: Introduction to Software Engineering

Fall Quarter 2002

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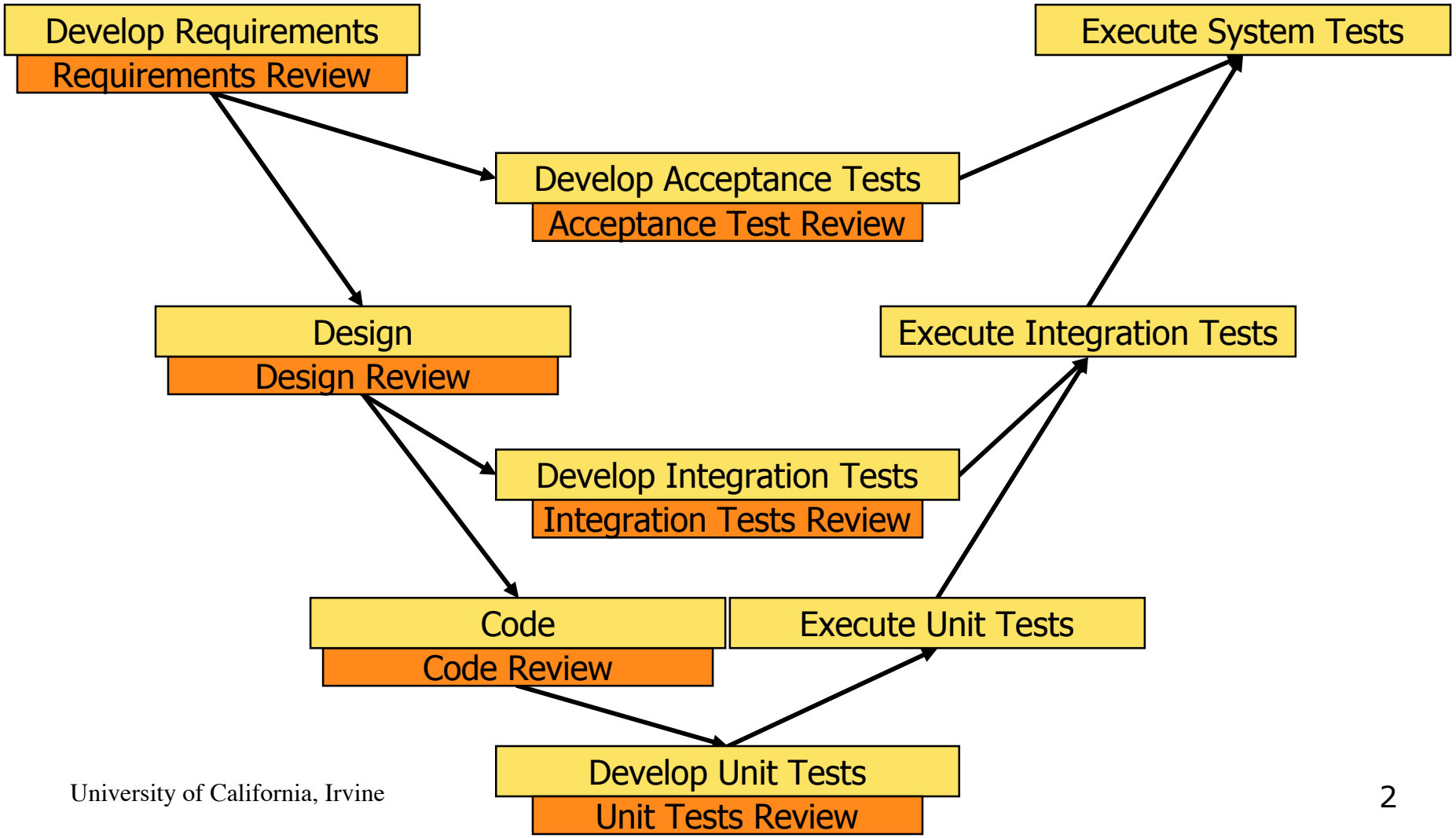
Lecture Notes

Week 7 Integration Testing and Implementation Issues

http://www.ics.uci.edu/~taylor/ICS_52_FQ02/syllabus.html

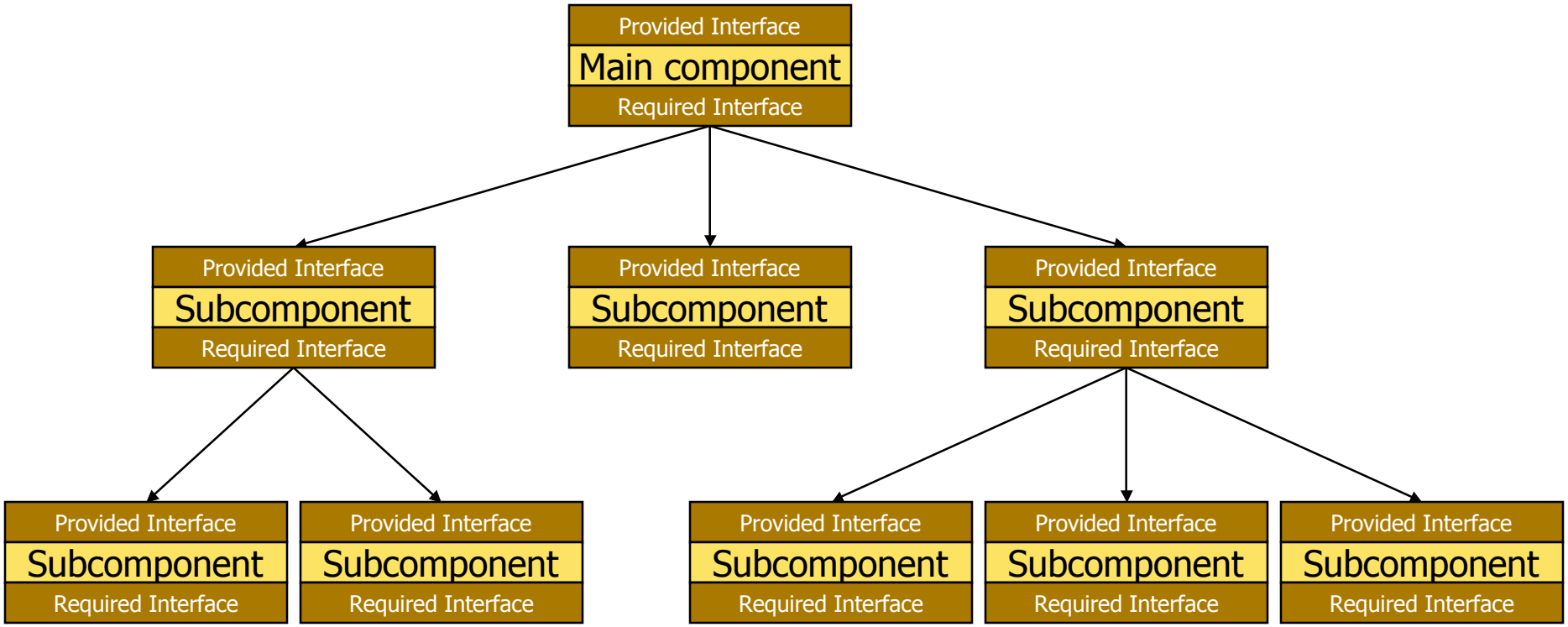
V-Model of Development and Testing



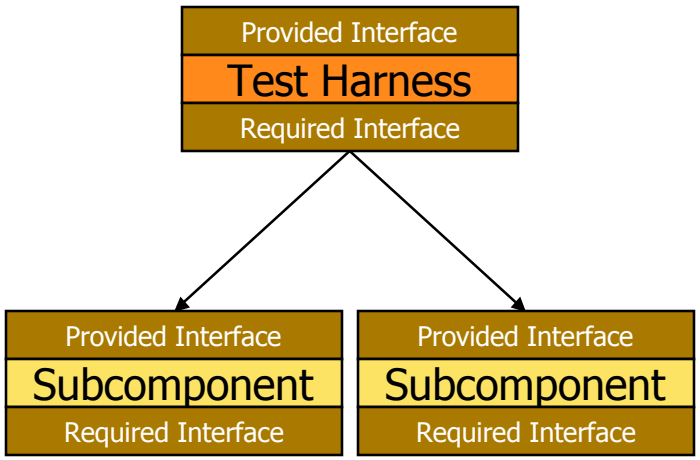
Integration Test Plan

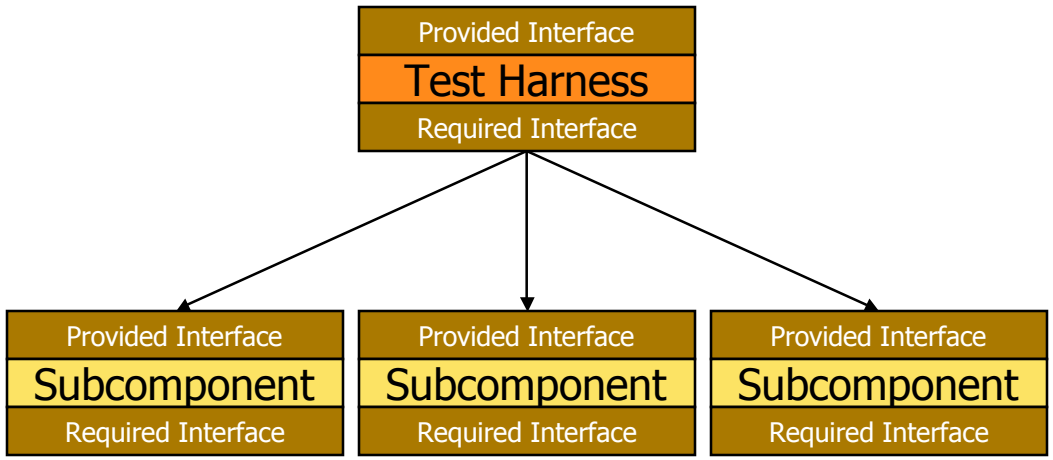
- Ensures module implementations adhere to assumptions and interfaces as designed
  - Uncovering interactions that highlight problems with assumptions is difficult
- Approach
  - Combine more and more modules
  - Use USES hierarchy
    - » Work up from level zero
      - Use test harnesses to test each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

Integration Test Example



Test Harnesses





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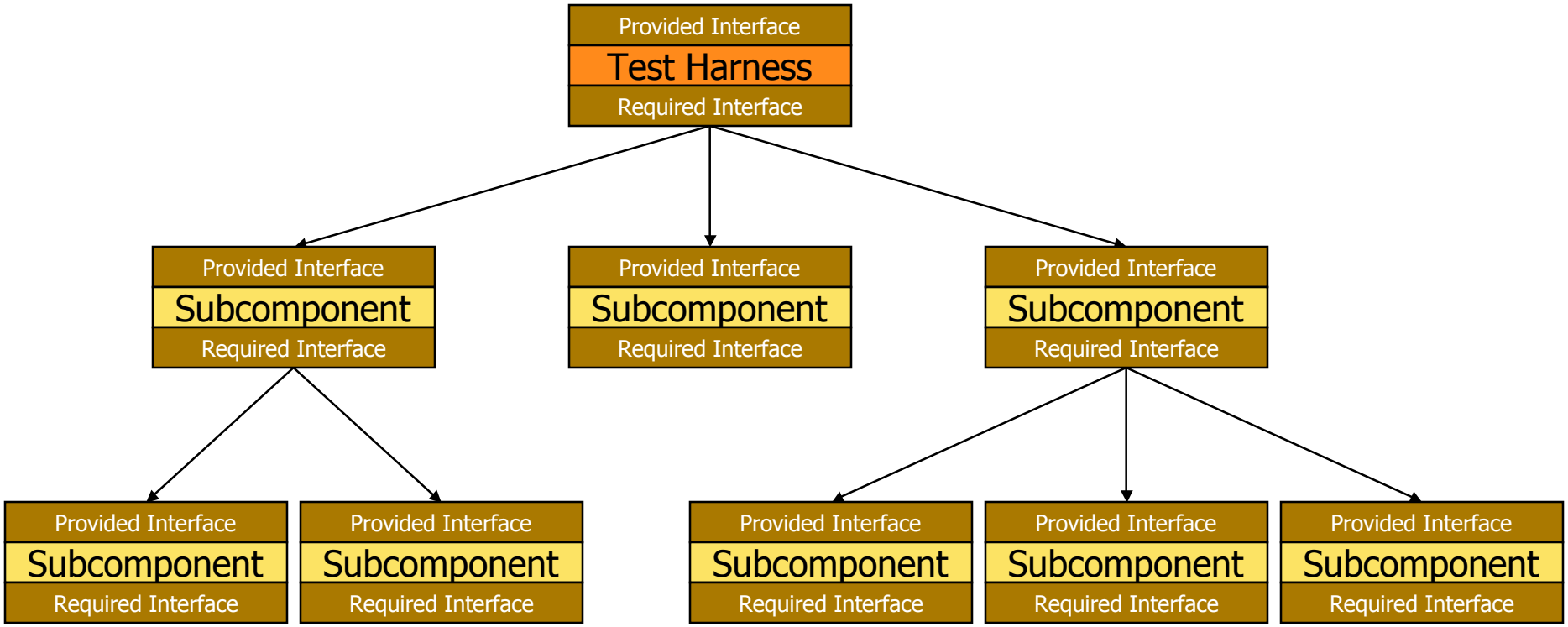
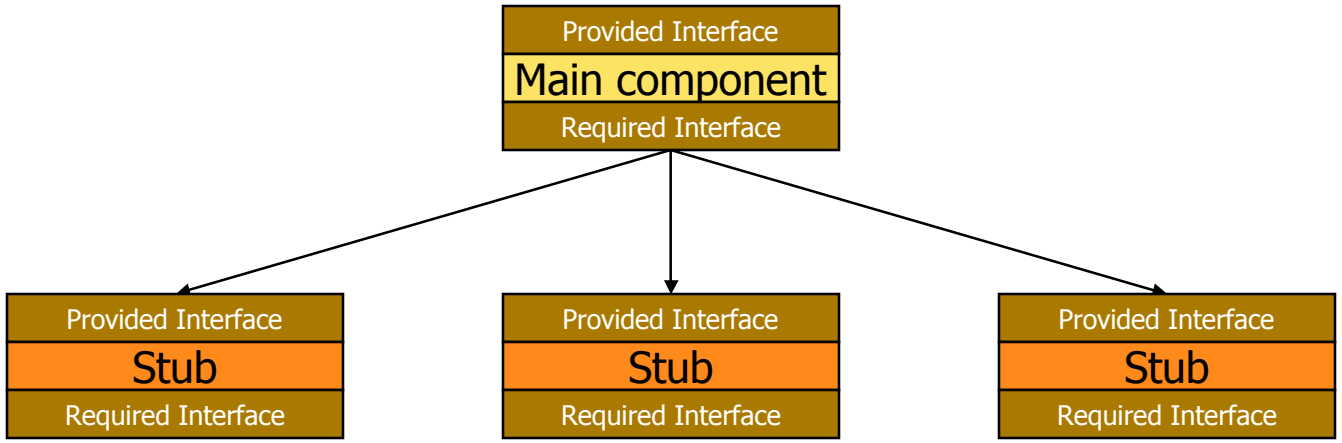
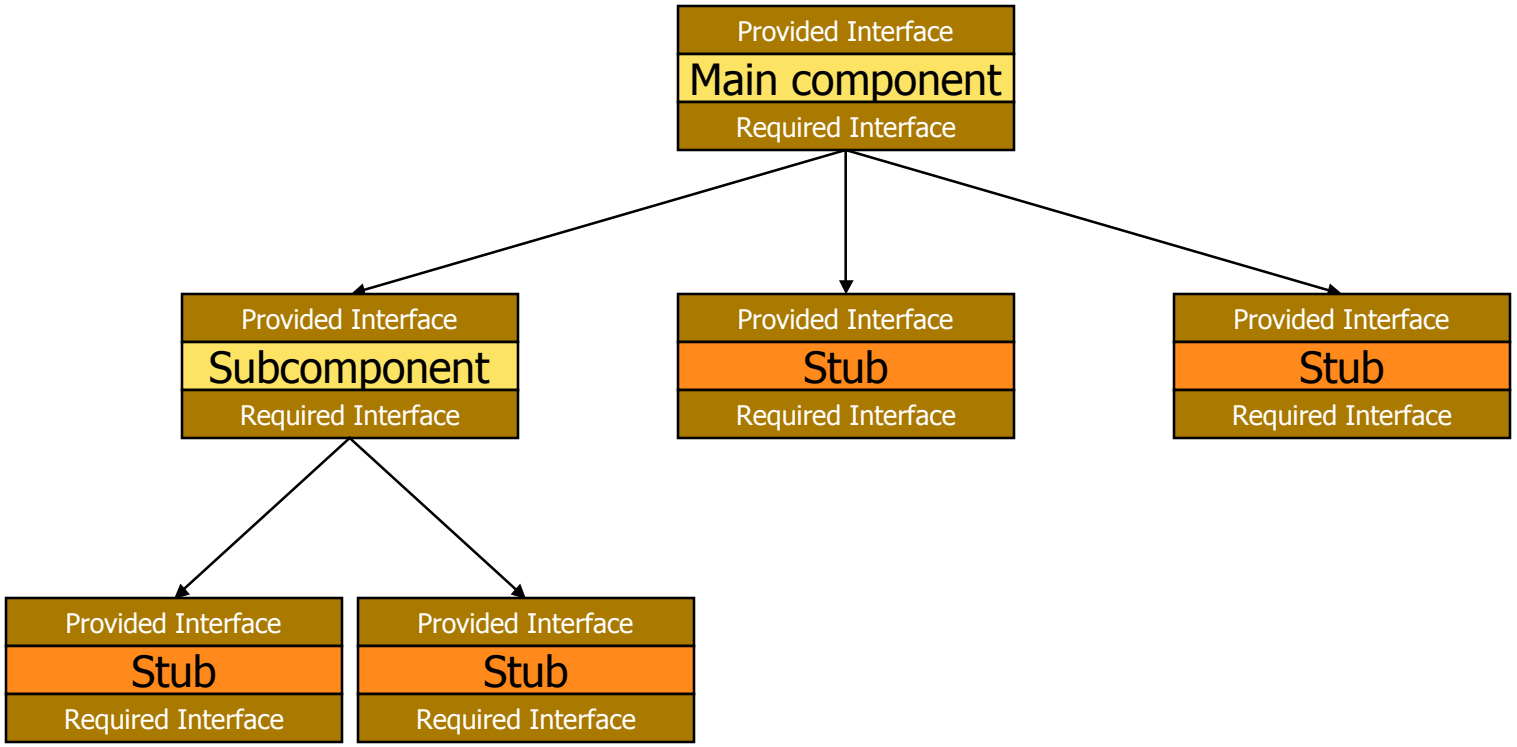


Stubs


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

Stubs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Main component
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Subcomponent
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Stub
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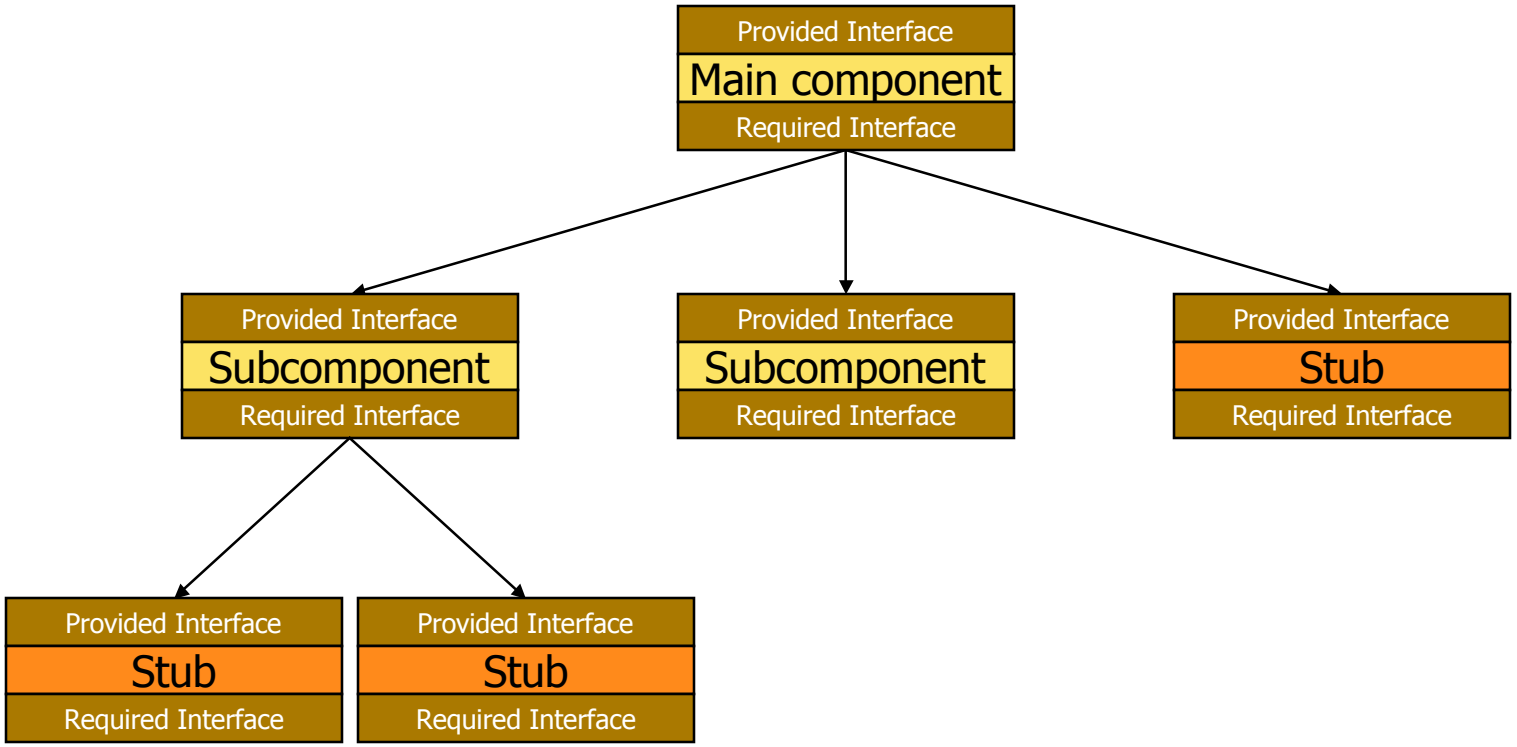
Stubs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Stub
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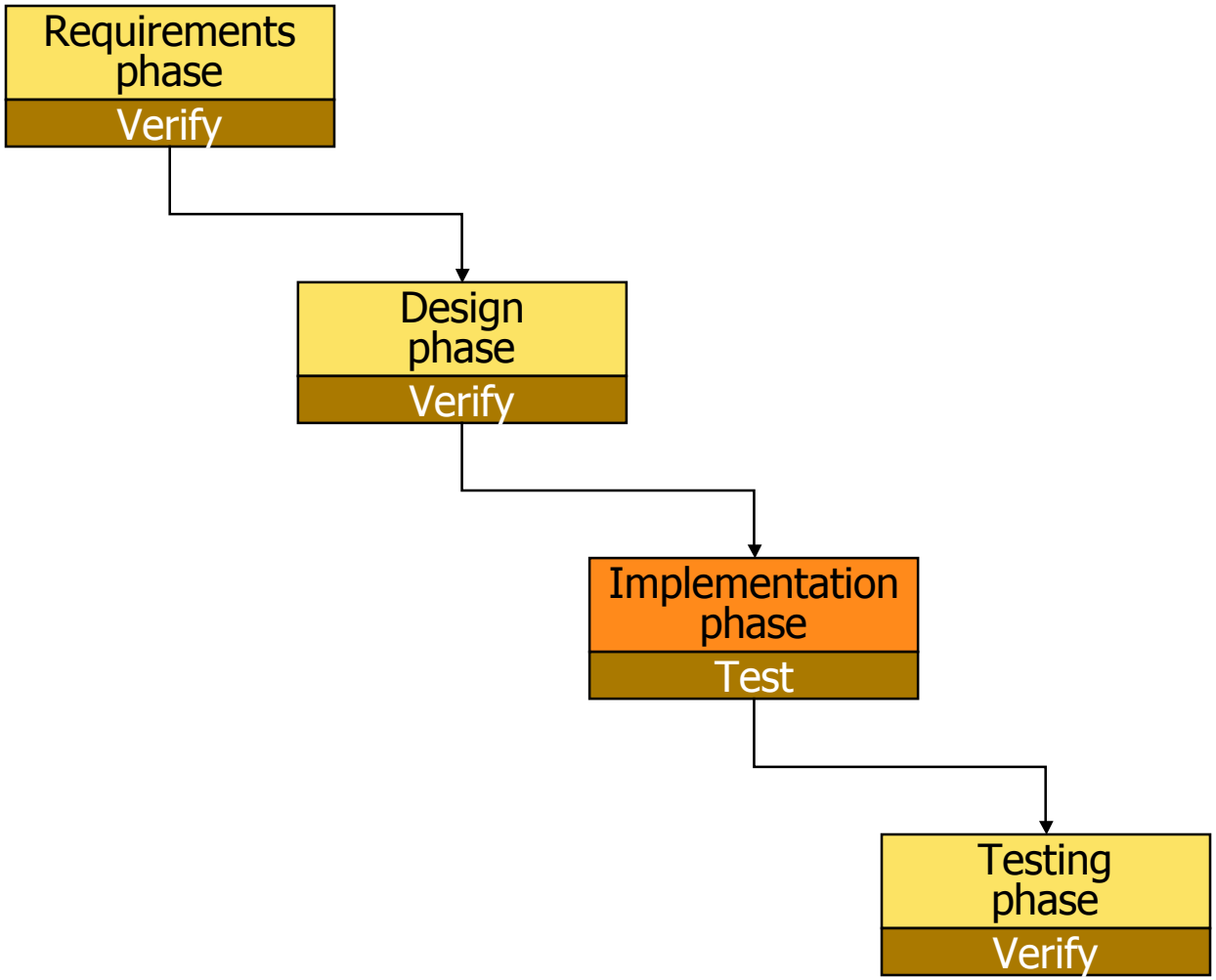
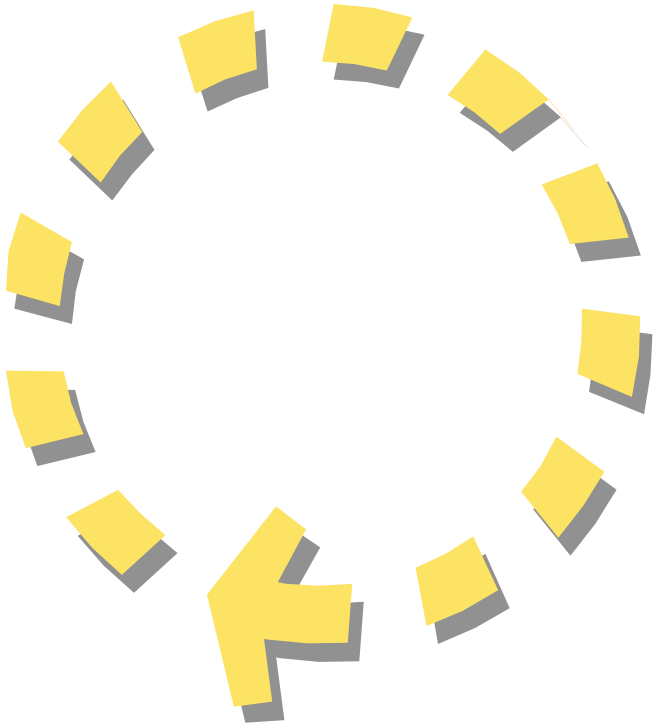
ICS 52 Life Cycle



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
- 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 rarely needed and that if they are needed, they are only needed in a few 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 not exist!
  - Meaningful variable names, crisp code layout, and small and simple modules all help…
  - …but they are not enough
- Every module needs a description of its purpose
- Every function needs a description of its purpose, input and output parameters, return values, and exceptions
- Every 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