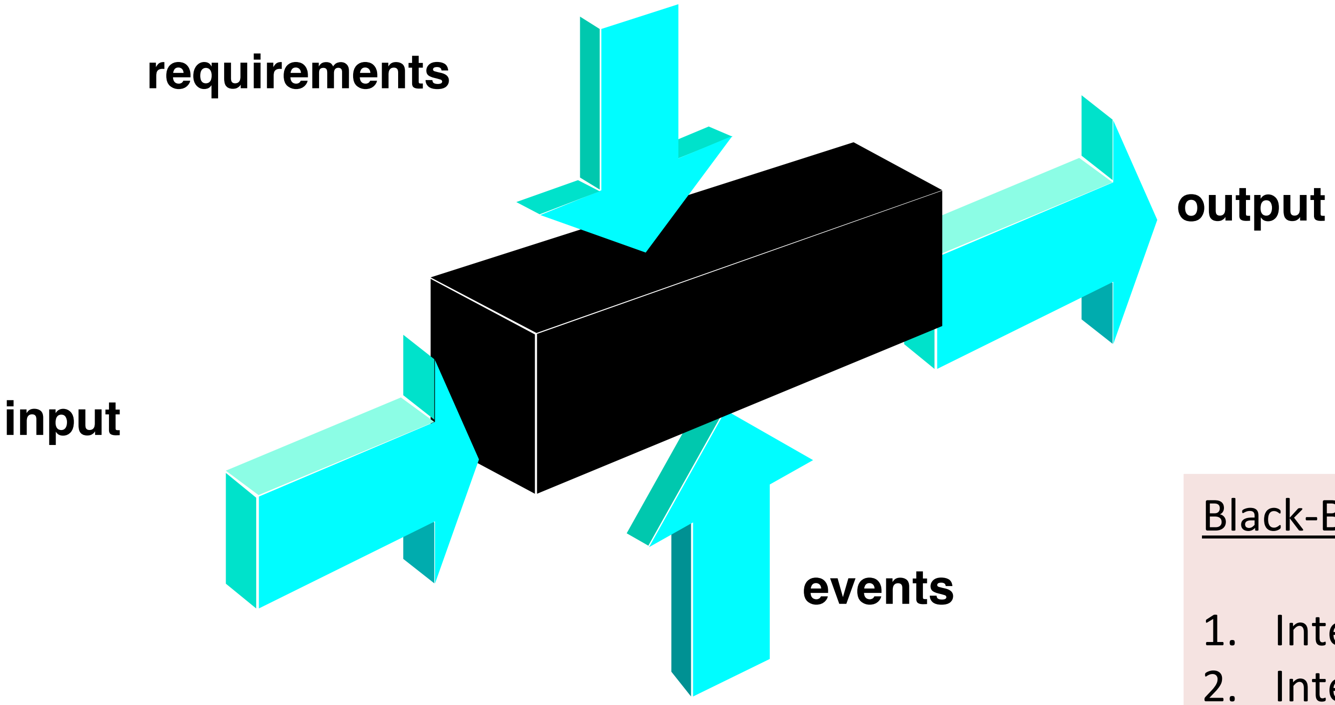
CMPS 310
Fall 2021

Lecture 14

Black-Box Testing

Black-Box Testing



Black-Box testing

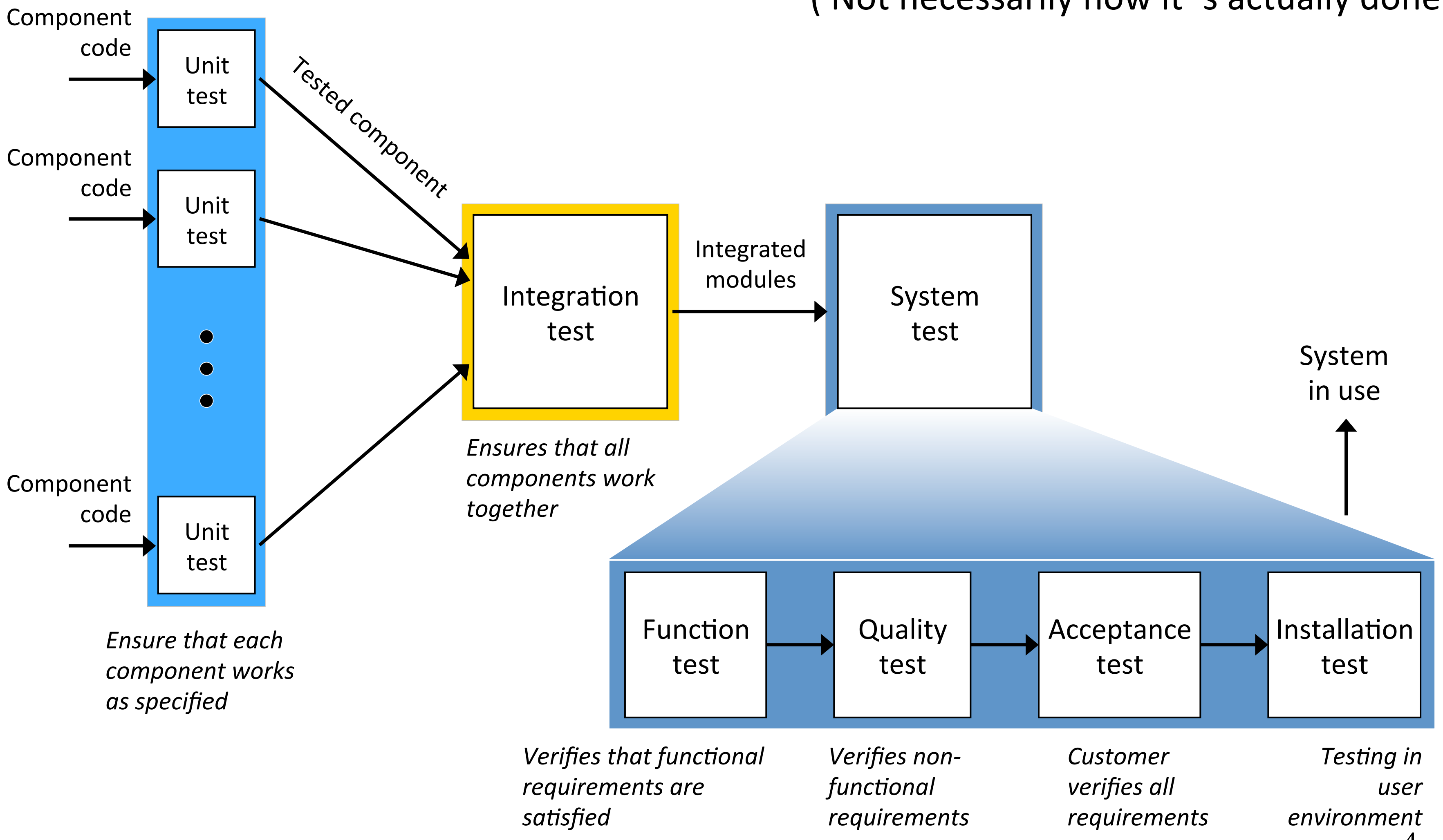
1. Integration testing
2. Interface testing
3. System testing
4. Use case testing
5. Release testing
6. User testing
7. Accepting testing

Black-Box Testing

- How is functional validity tested?
- How is system behavior and performance tested?
- What classes of input will make good test cases?
- Is the system particularly sensitive to certain input values?
- How are the boundaries of a data class isolated?
- What data rates and data volume can the system tolerate?
- What effect will specific combinations of data have on system operation?

Logical Organization of Testing

(Not necessarily how it's actually done!)



Ensure that each component works as specified

Ensures that all components work together

Verifies that functional requirements are satisfied

Verifies non-functional requirements

Customer verifies all requirements

Testing in user environment

Types of Black-Box Testing

- **Unit** Testing:
  - Individual *subsystem*
  - Carried out by developers
  - Goal: Confirm that individual subsystem/module is correctly coded and carries out the intended functionality
- **Integration** Testing:
  - Groups of subsystems (collection of classes) and eventually the entire system
  - Carried out by developers
  - Goal: Test the *interface* among the subsystem

System Testing

- ✧ **System** Testing (Functional test and Performance test):
  - The entire system
  - Carried out by developers
  - Goal: Determine if the system meets the *requirements* (functional and *non functional*)
- ✧ **Acceptance** Testing and Installation Testing:
  - Evaluates the system delivered by developers
  - Carried out by the *client*. May involve executing typical transactions on site on a trial basis
  - Goal: Demonstrate that the system meets customer *requirement*s and is ready to use

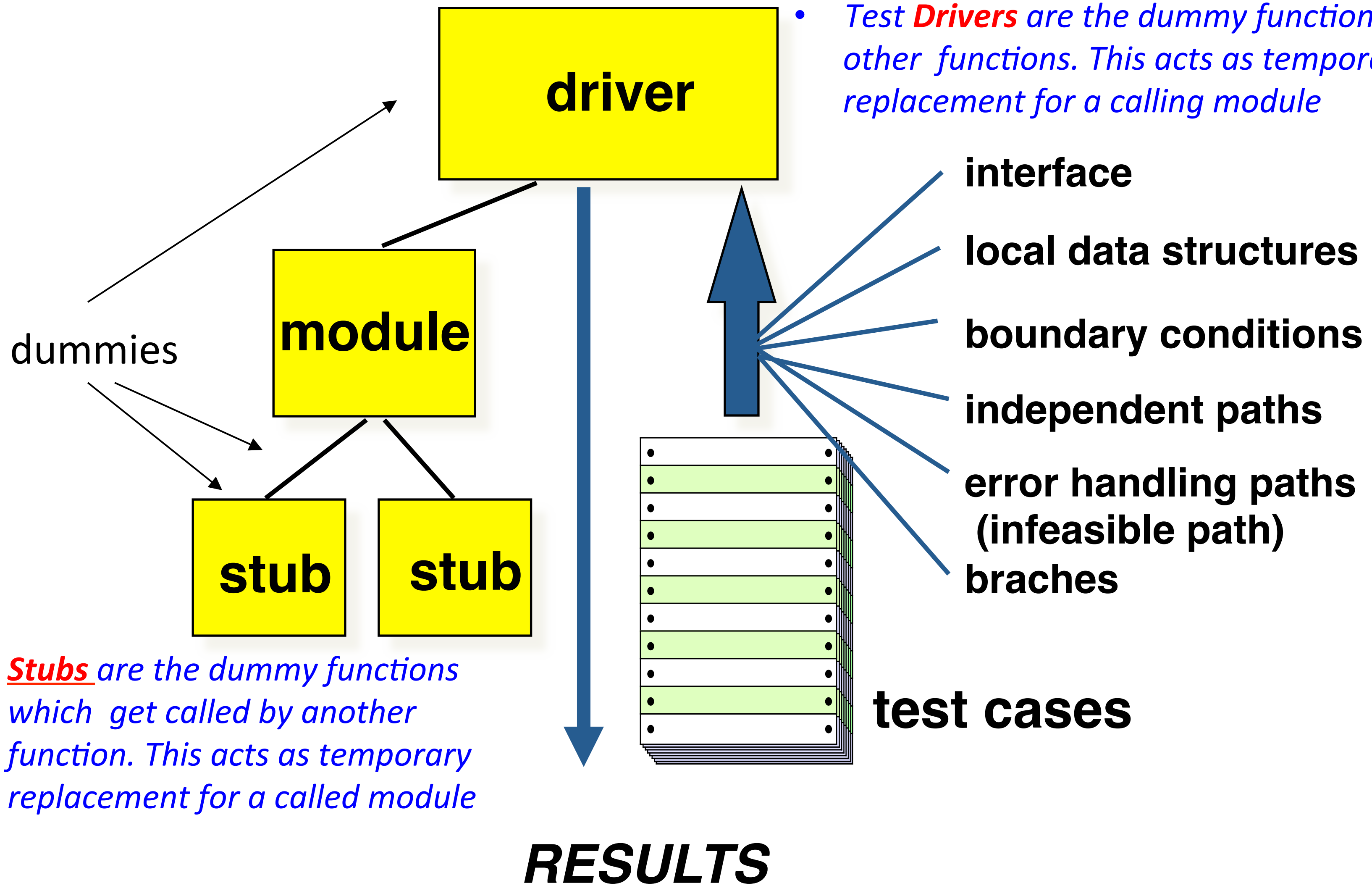
Unit Testing

- ✧ Informal:
  - Incremental coding

Write a little, test a little

- ✧ Static Analysis:
  - Hand execution: Reading the *source code*
  - Walk-Through (informal presentation to others)
  - Code Inspection (formal presentation to others)
  - Automated Tools, checking for
    - syntactic and semantic errors
    - departure from coding standards
- ✧ Dynamic Analysis:
  - *White-box* testing (Test the internal logic of the subsystem or object)
  - Black-box testing (Test the input/output behavior)
  - Data-structure based testing (Data types determine test cases)

Unit Test Environment



- *Test* ***Drivers*** *are the dummy functions which call other functions. This acts as temporary replacement for a calling module*

driver

module

stub

stub

dummies

interface

local data structures

boundary conditions

independent paths

error handling paths
(infeasible path)

braches

test cases

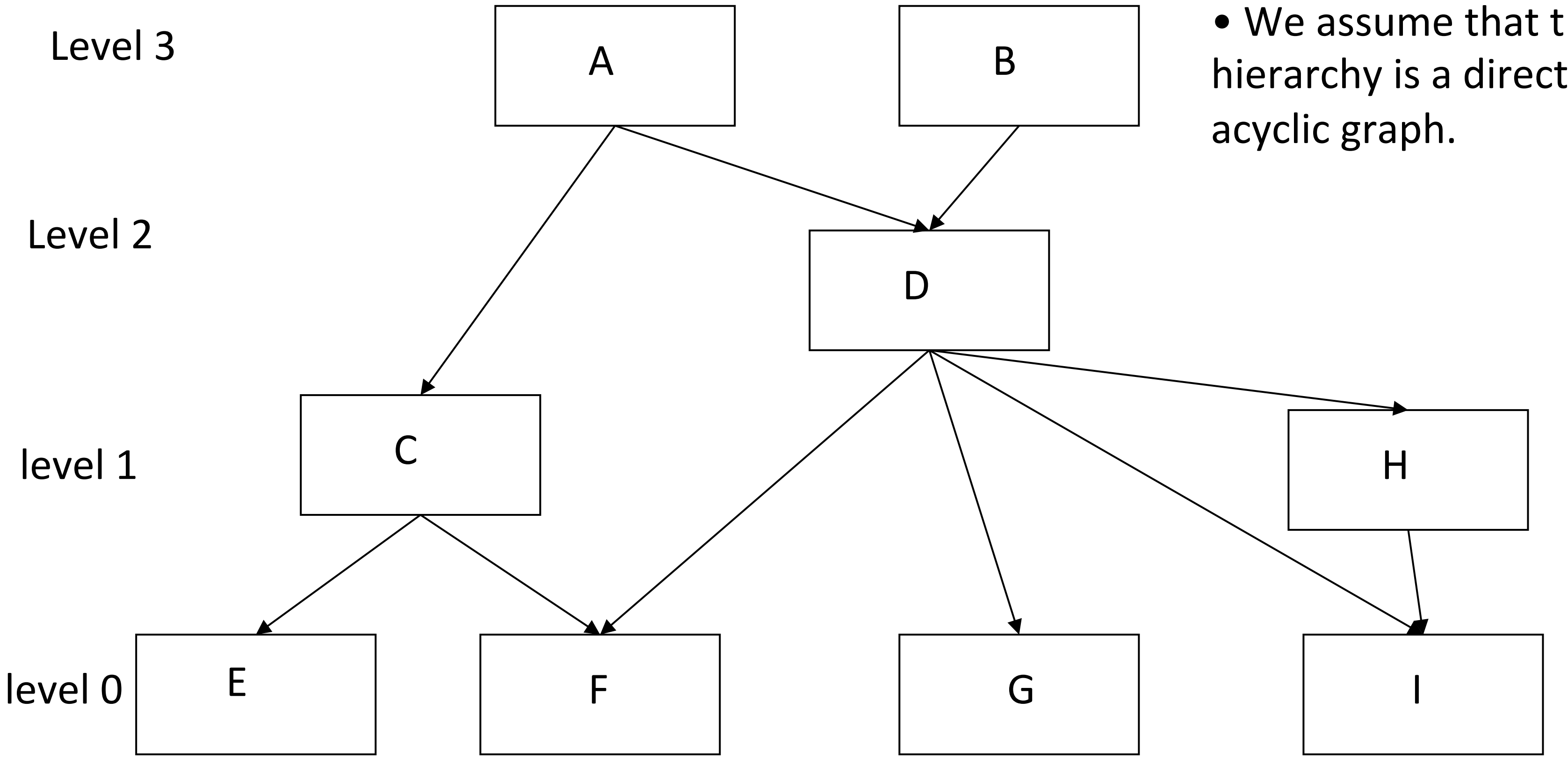
RESULTS

Stubs *are the dummy functions which get called by another function. This acts as temporary replacement for a called module*

Integration Testing

- Integration testing: Integrated collection of modules tested as a group or partial system
- Integration plan specifies the order in which to combine modules into partial systems
- Different approaches to integration testing
  - Bottom-up
  - Top-down
  - Big-bang
  - Sandwich
- Stubs are used during Top-down integration testing, in order to simulate the behaviour of the lower-level modules that are not yet integrated or developed.
- Stubs are the modules that act as temporary replacement for a called module and give the same output as that of the actual product.
- Drivers are used during Bottom-up integrating testing.

Module Structure



- We assume that the hierarchy is a directed acyclic graph.

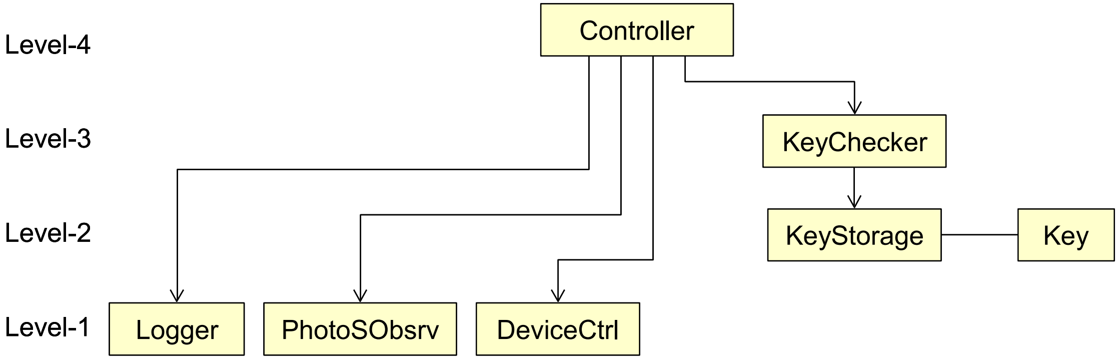
- A uses C and D; B uses D; C uses E and F; D uses F, G, H and I; H uses I
- Modules A and B are at level 3; Module D is at level 2

Modules C and H are at level 1; Modules E, F, G, I are at level 0

- level 0 components do not use any other components
- level *i* components use at least one component on level *i*-1 and no component at a level higher than *i*-1

Horizontal Integration Testing

System hierarchy:



Level-4

Level-3

Level-2

Level-1

Controller

KeyChecker

KeyStorage

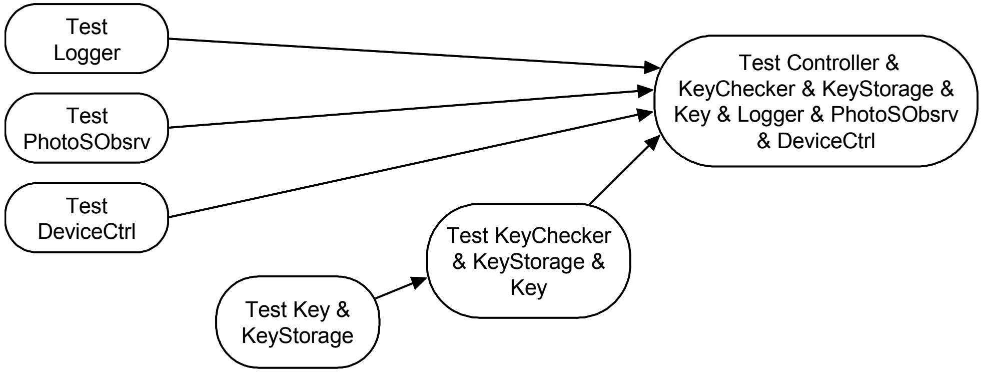
Key

Logger

PhotoSObsrv

DeviceCtrl

Bottom-up integration testing:



Test Logger

Test PhotoSObsrv

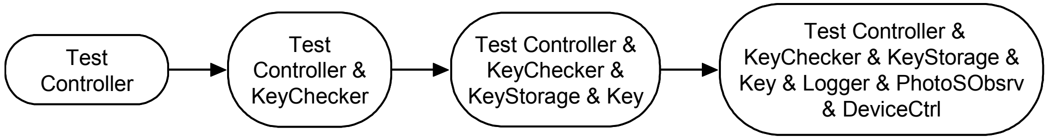
Test DeviceCtrl

Test Key & KeyStorage

Test KeyChecker & KeyStorage & Key

Test Controller & KeyChecker & KeyStorage & Key & Logger & PhotoSObsrv & DeviceCtrl

Top-down integration testing:



Test Controller

Test Controller & KeyChecker

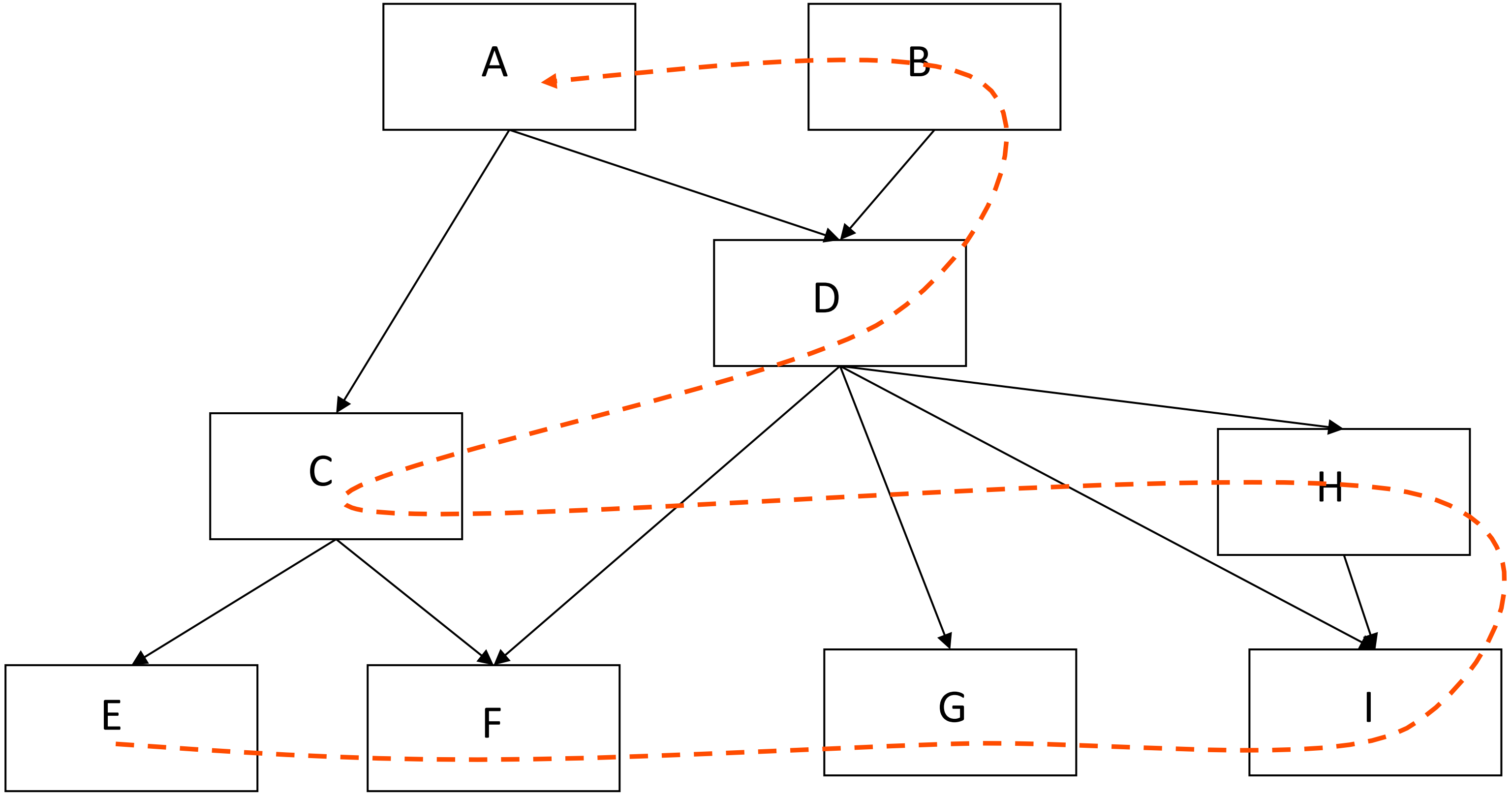
Test Controller & KeyChecker & KeyStorage & Key

Test Controller & KeyChecker & KeyStorage & Key & Logger & PhotoSObsrv & DeviceCtrl

Bottom-Up Integration (1)

- Only terminal modules (i.e., the modules that do not call other modules) are tested in isolation
- Modules at lower levels are tested using the previously tested higher level modules
- Non-terminal modules are not tested in isolation
- Requires a module driver for each module to feed the test case input to the interface of the module being tested
  - However, *stubs are not needed* since we are starting with the terminal modules and use already tested modules when testing modules in the lower levels.

Bottom-up Integration (2)



Top-down Integration (1)

- ✧ Only modules tested in isolation are the modules which are at the highest level

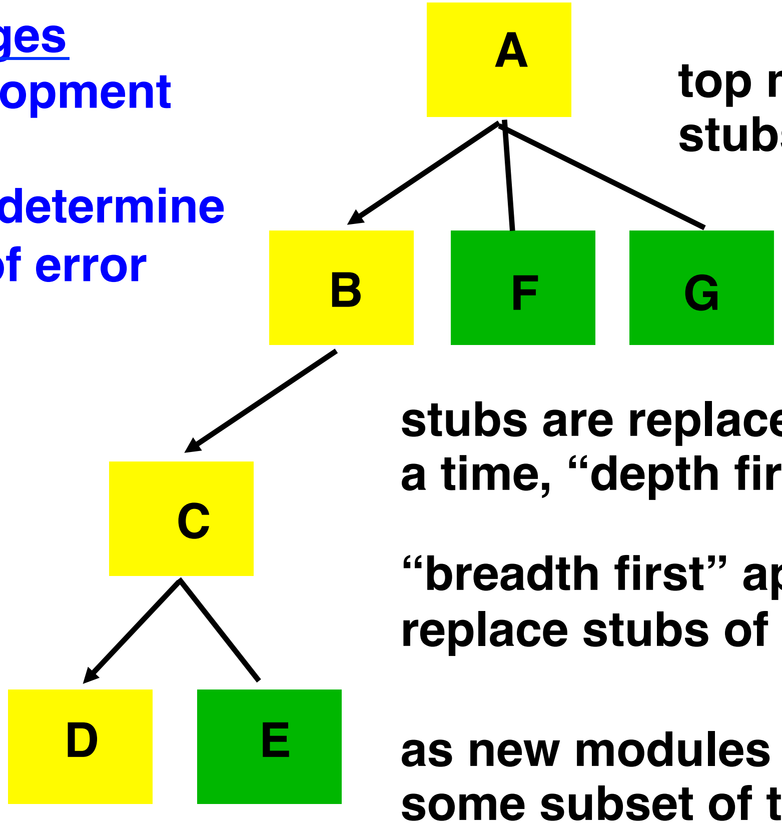
- ✧ After a module is tested, the modules directly called by that module are merged with the already tested module and the combination is tested

- ✧ Requires stub modules to simulate the functions of the missing modules that may be called
  - However, *drivers are not needed* since we are starting with the modules which is not used by any other module and use already tested modules when testing modules in the higher levels

Top Down Integration (2)

<u>Disadvantages</u>

- Incur development overhead
- Difficult to determine real cause of error



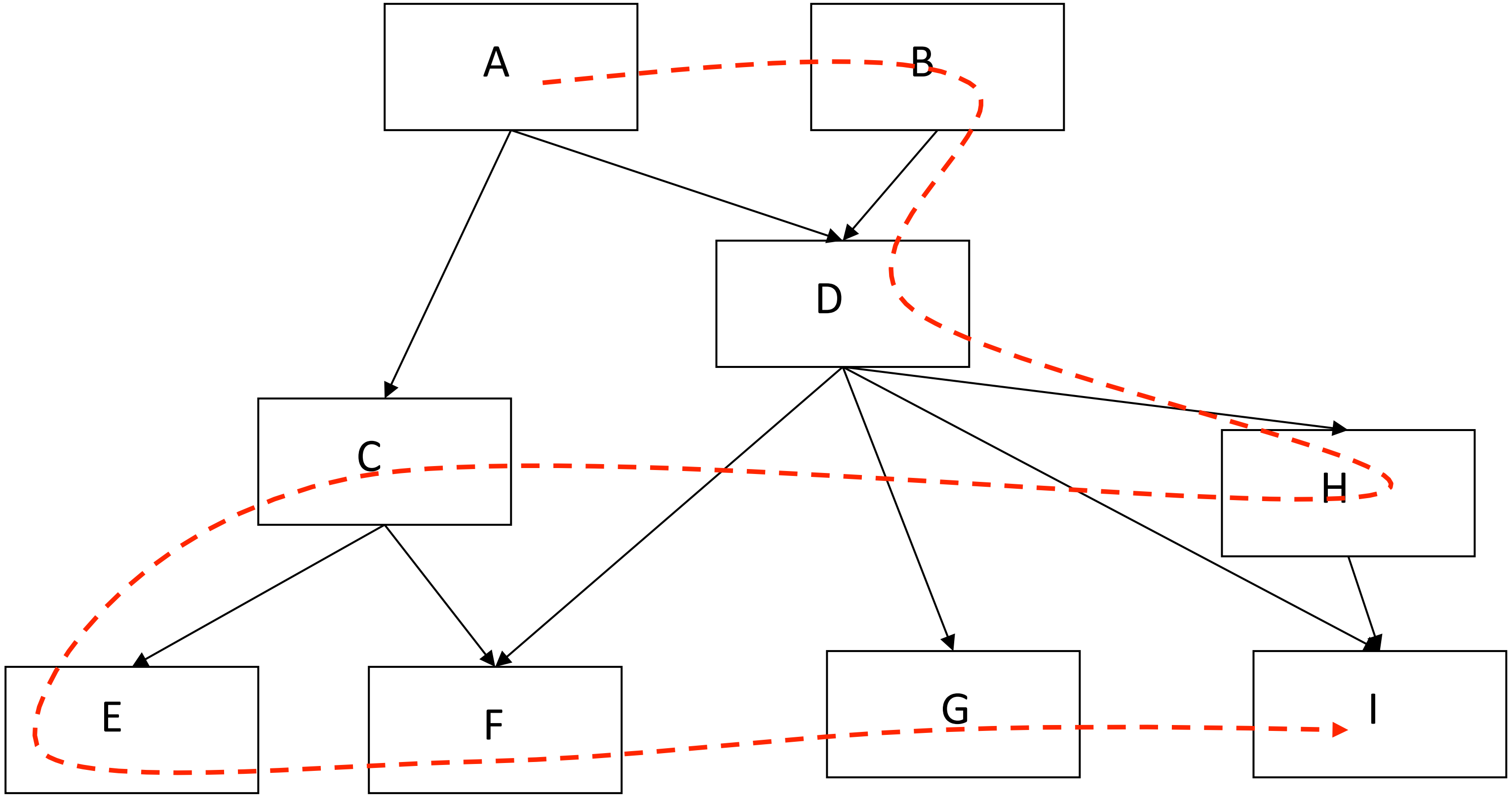
top module is tested with stubs

stubs are replaced one at a time, “depth first”

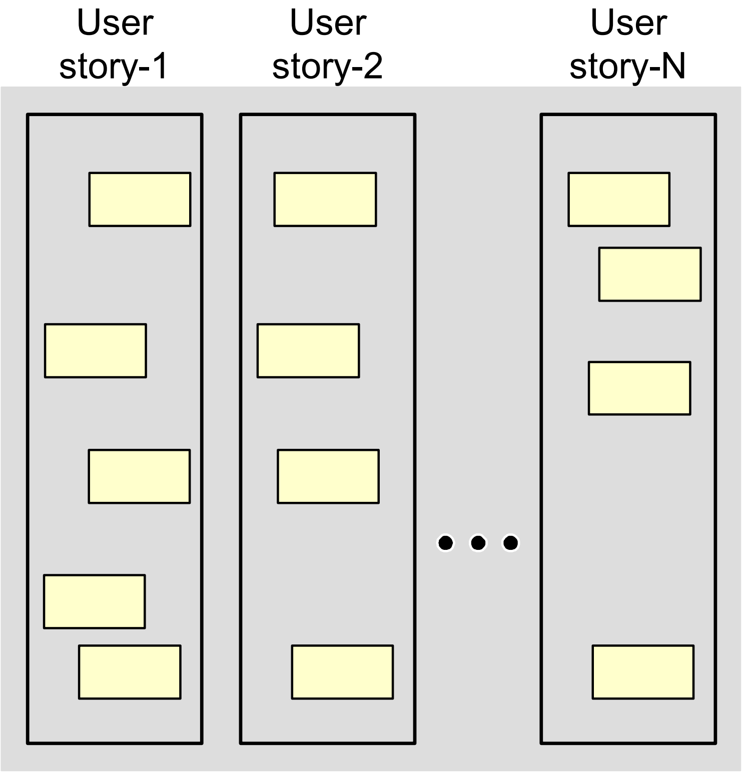
“breadth first” approach would replace stubs of the same level first

as new modules are integrated, some subset of tests is re-run

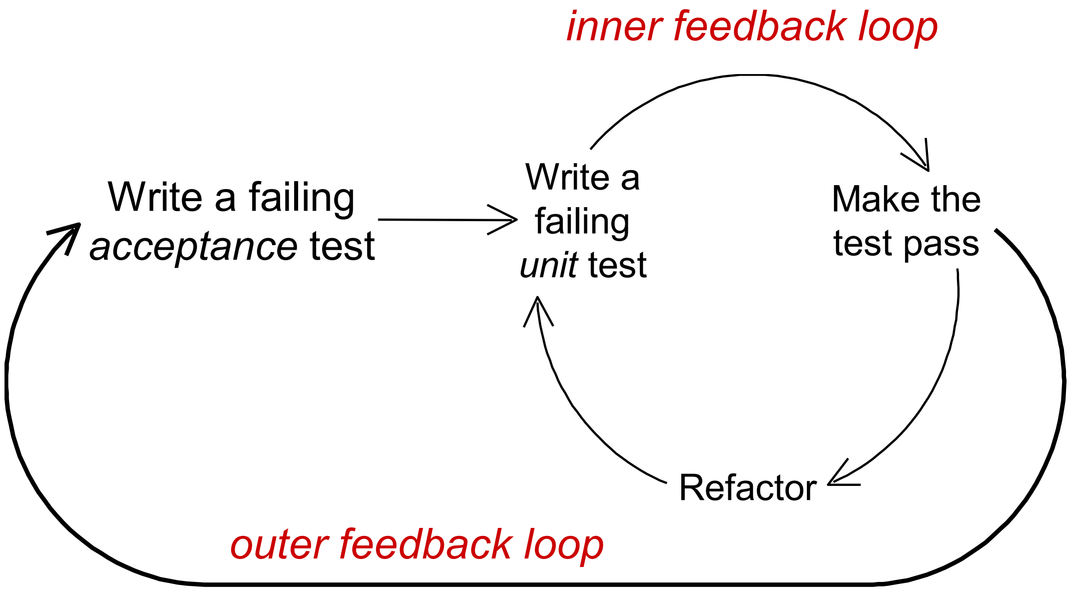
Top-down Integration (3)



Vertical Integration Testing



Whole system

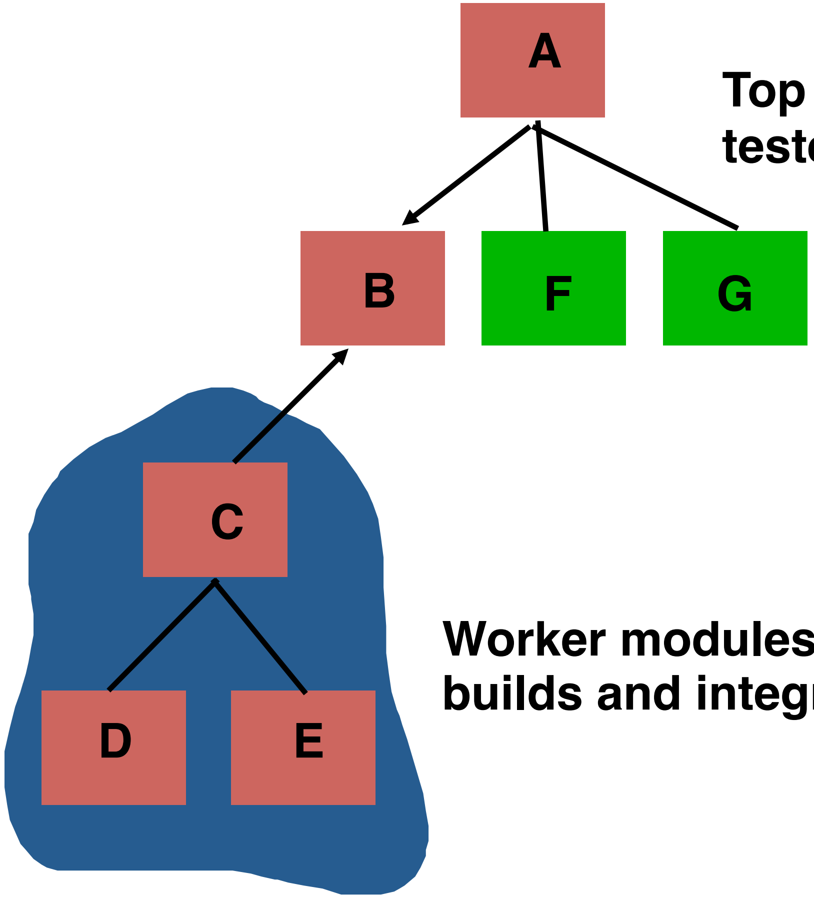


Developing user stories:

Each story is developed in a cycle that integrates **unit tests** in the **inner feedback loop** and the **acceptance test** in the **outer feedback loop**

Sandwich Integration

- Compromise between bottom-up and top-down testing
- Simultaneously begin bottom-up and top-down testing and meet at a predetermined point in the middle



Top modules are tested with stubs

Worker modules are grouped into builds and integrated

cluster / build

Big Bang Integration

- Every module is unit tested in isolation
- After all of the modules are tested they are all integrated together at once and tested
- No driver or stub is needed
- However, in this approach, it may be hard to isolate the bugs

System Testing and Acceptance Testing

- System and Acceptance testing follows the integration phase
  - testing the system as a whole
- Test cases can be constructed based on the requirements specifications
  - main purpose is to assure that the system meets its requirements
- Manual testing
  - Somebody uses the software on a bunch of scenarios and records the results
  - Use cases and use case scenarios in the requirements specification would be very helpful here
  - manual testing is sometimes unavoidable: usability testing

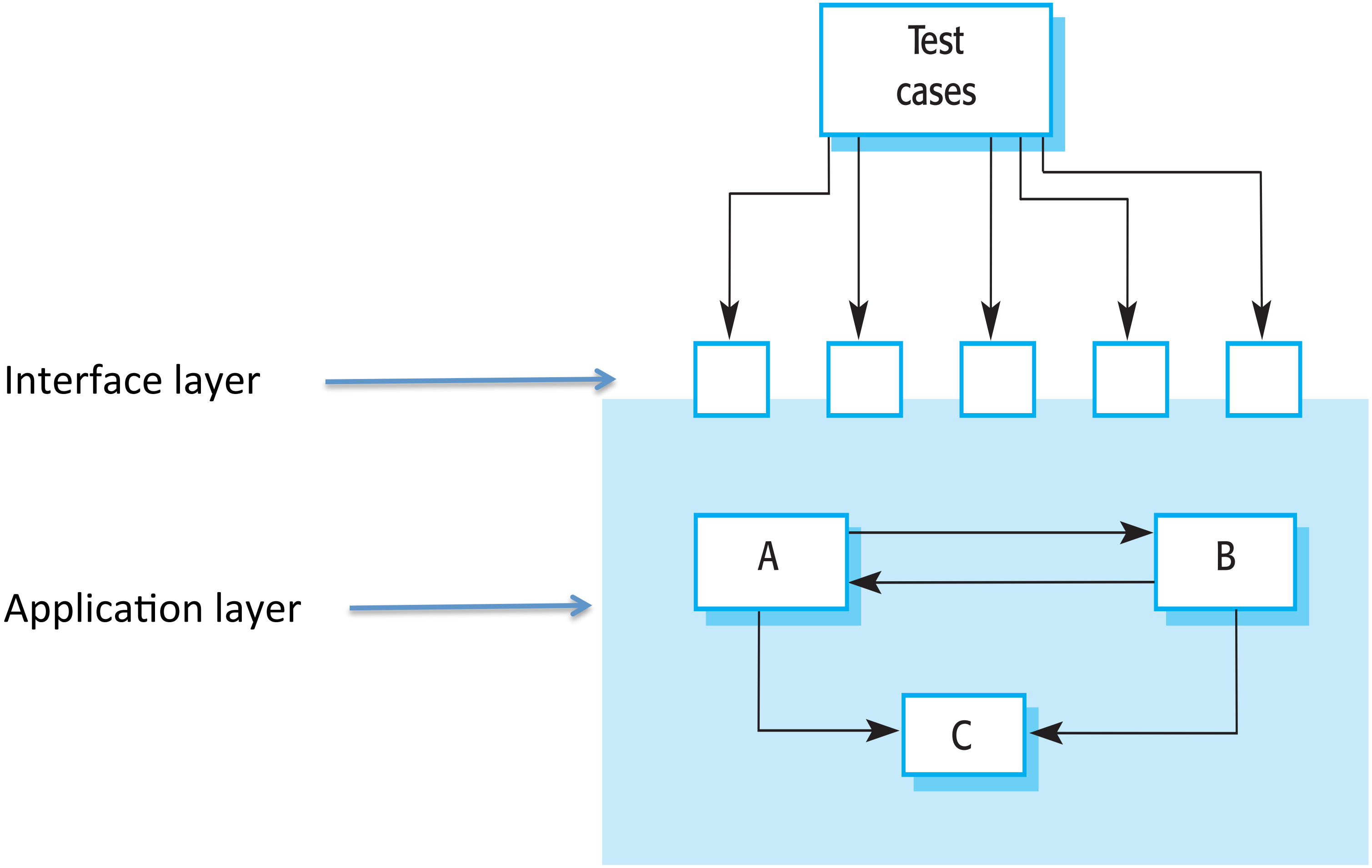
System Testing and Acceptance Testing

- Alpha testing is performed within the development organization

- Beta testing is performed by a select group of friendly customers

- Stress testing
  - push system to extreme situations and see if it fails
  - large number of data, high input rate, low input rate, etc.

Interface Testing



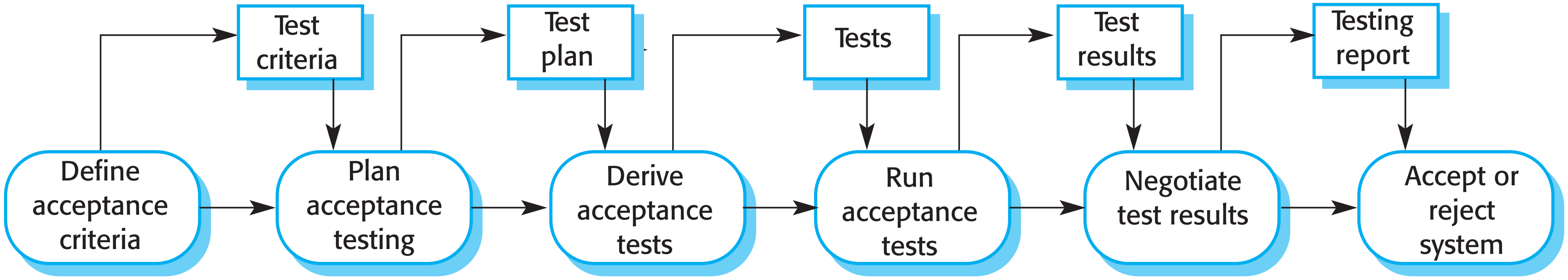
Release Testing

- **Release testing** is the process of testing a particular release of a system that is intended for use outside of the development team.
- The primary goal of the release testing process is to convince the client of the system that it is good enough for use.
  - Release testing, therefore, has to show that the system delivers its specified functionality, performance and dependability, and that it does not fail during normal use.
- Release testing is usually a black-box testing process where tests are only derived from the system specification.

User Testing

- ✧ Alpha testing
  - Users of the software work with the development team to test the software at the developer’s site.
- ✧ Beta testing
  - A release of the software is made available to users to allow them to experiment and to raise problems that they discover with the system developers.
- ✧ Acceptance testing
  - Customers test a system to decide whether or not it is ready to be accepted from the system developers and deployed in the customer environment. Primarily for custom systems.

The Acceptance Testing Process



Reference

- Your text book by Pressman (Chapter 17)
- Everett and Raymond: Software Testing. Wilkey and IEEE CS Press
- Black: Pragmatic Software Testing. Wiley.
- Perry: Effectice Methods of Software Testing, Wiley.
- Lee, and Yannakakis, "Principles and Methods of Testing Finite State Machines: A Survey", Proceedings of The IEEE, Vol. 84, No. 8, August 1996,
- Chow, "Testing Software Design Modeled by Finite-State Machines" IEEE Transactions on Software Engineering, vol.4, no. 3, pp. 178-187, May 1978