# System Test

Introduction to Systems Engineering

I2ISE

## Here’s a fact about test

Testing can only show the *presence* of errors, never their *absence*

- What does this mean? What are the consequences?

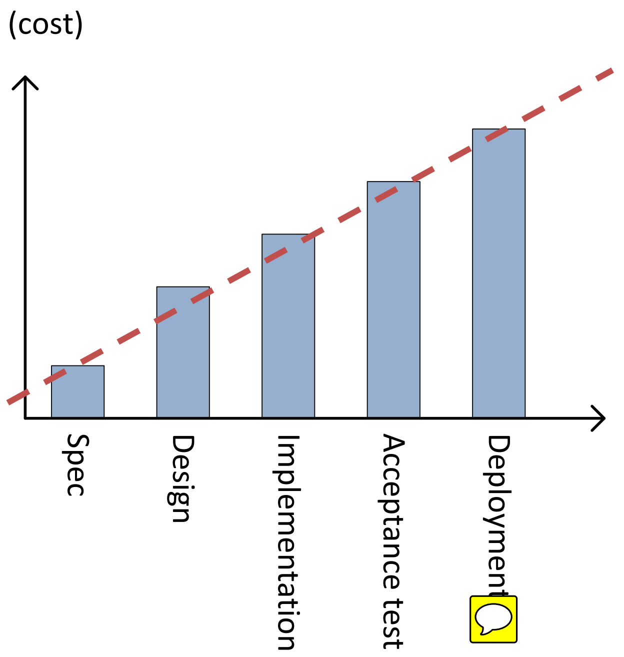
## A short discussion

- What is the *value* of testing?
  - For the system
  - For the developer
  - For the company
  - For the customer
  - For the users

- What is the *cost* of testing?

# The cost of errors

- Finding errors early is in the best interest of you and your company

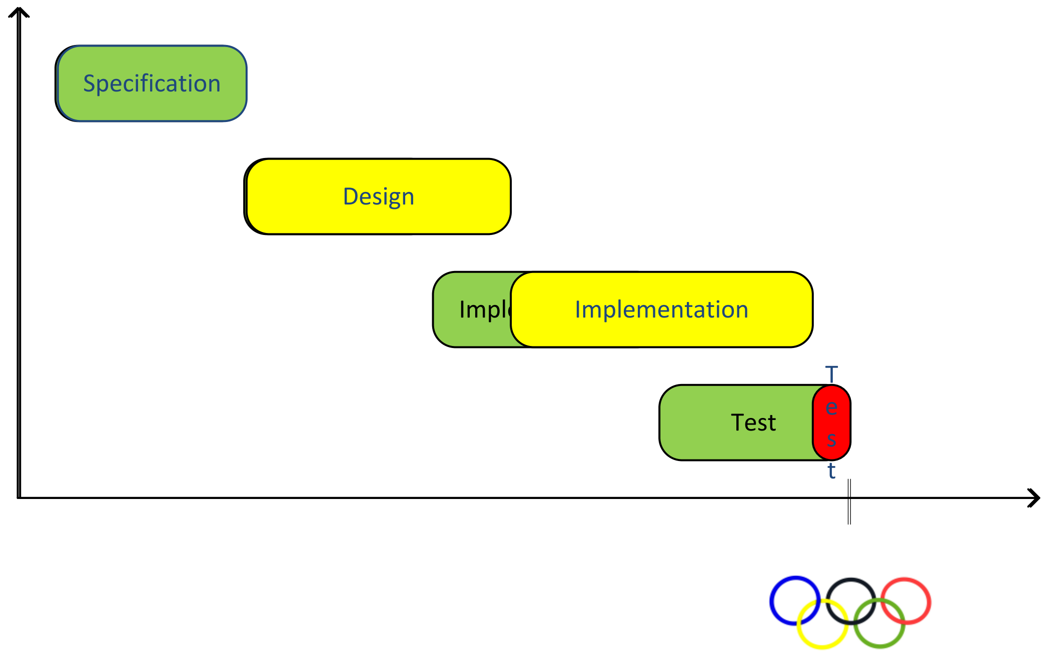


To this, add damage done to
- humans
- property
- company image
- loss of productivity
- follow-on sales

The test mantra:
*Test early, test often,*
*test enough*

# When to test?

## The nightmare, all-too-often-seen scenario



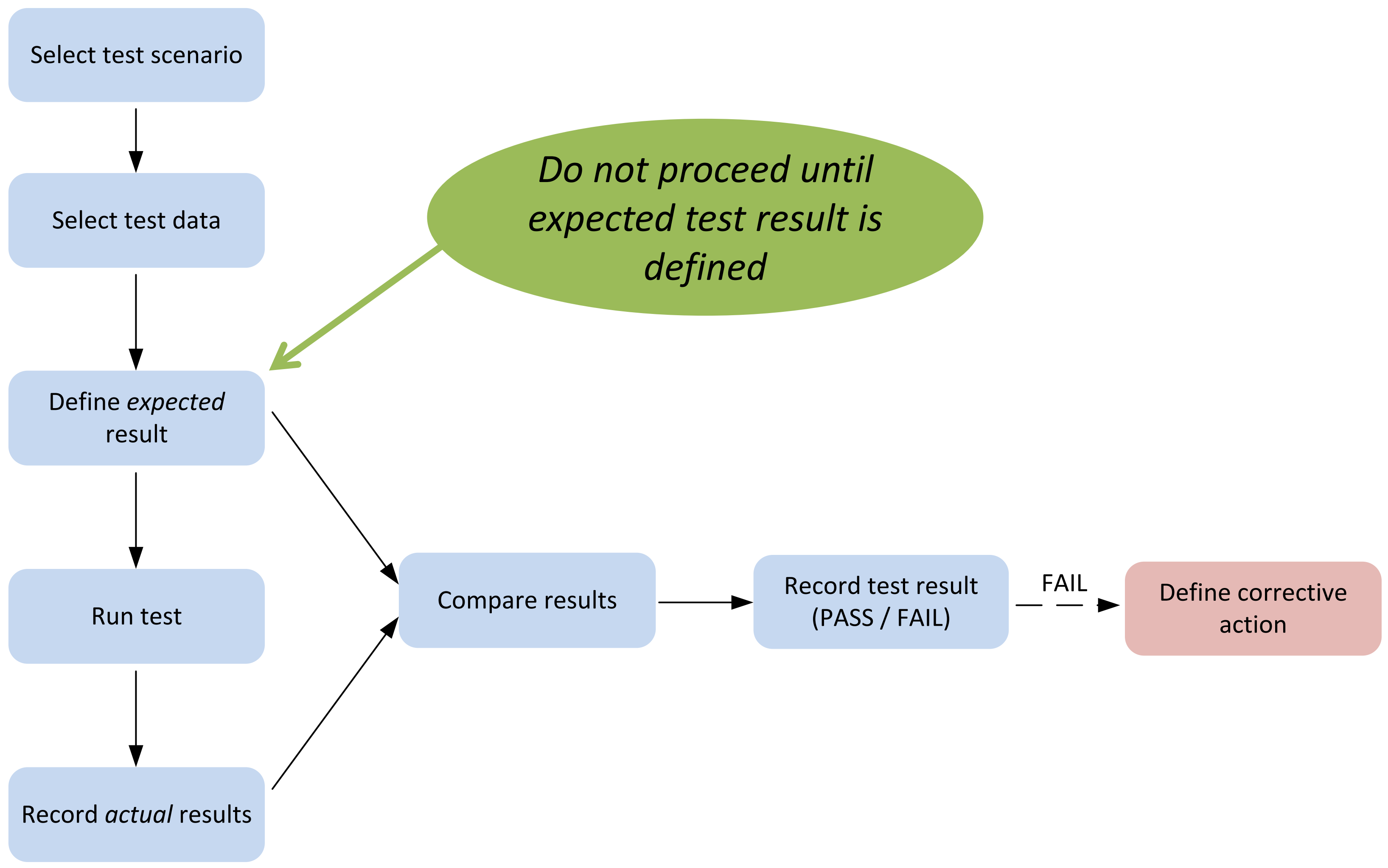
- What happens to the test effort in this case?

# Properties of a good test

- What are the properties of a good, valuable test?

- The test should be
  - independent
  - simple
  - repeatable
  - fine-grained
  - quick to run

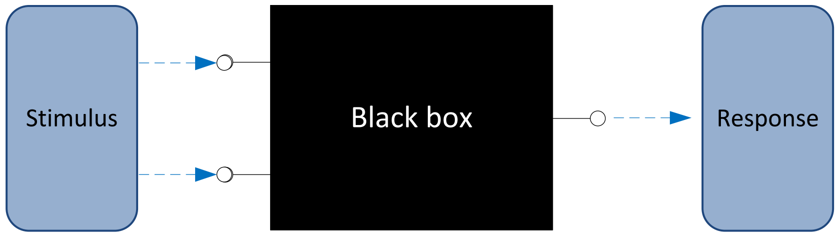
# Defining a test



## Test types: Black vs. white box testing

- Black box testing, AKA *functional* testing
  - Test only through system interfaces
  - No knowledge of internal workings

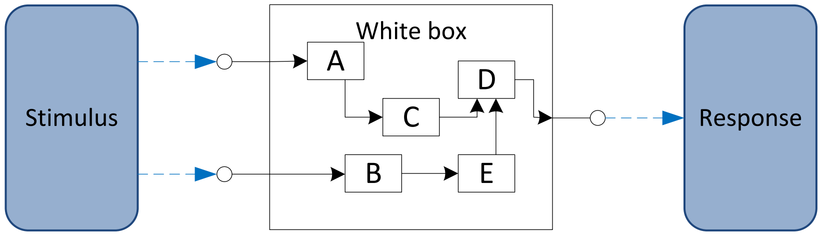
- Complete test → complete set of input tested (valid and invalid)



# Test types: Black vs. white box testing

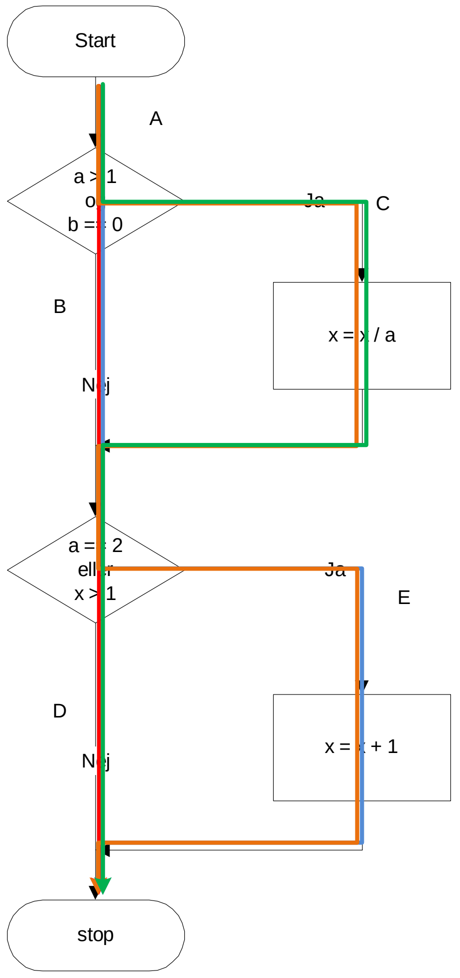
- White box testing
  - Test through system interfaces, but *with* knowledge of internal workings

- Complete test → complete *route coverage*

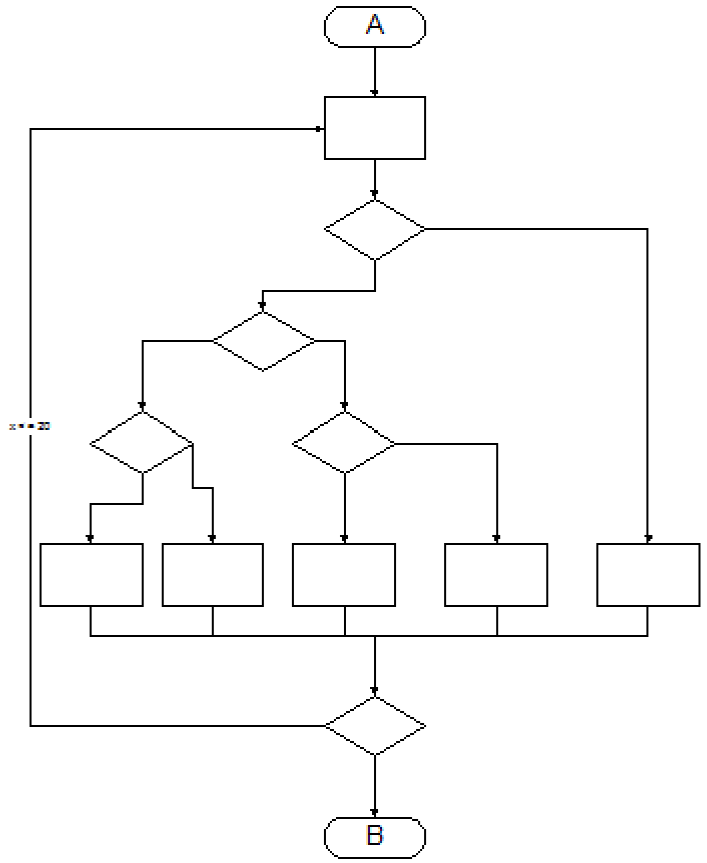


# Route coverage - example

```
void f(a, b, x)
{
  if ((a > 1) && (b == 0))
    x = x / a;
  if ((a == 2) || (x > 1))
    x = x + 1 ;
}
```



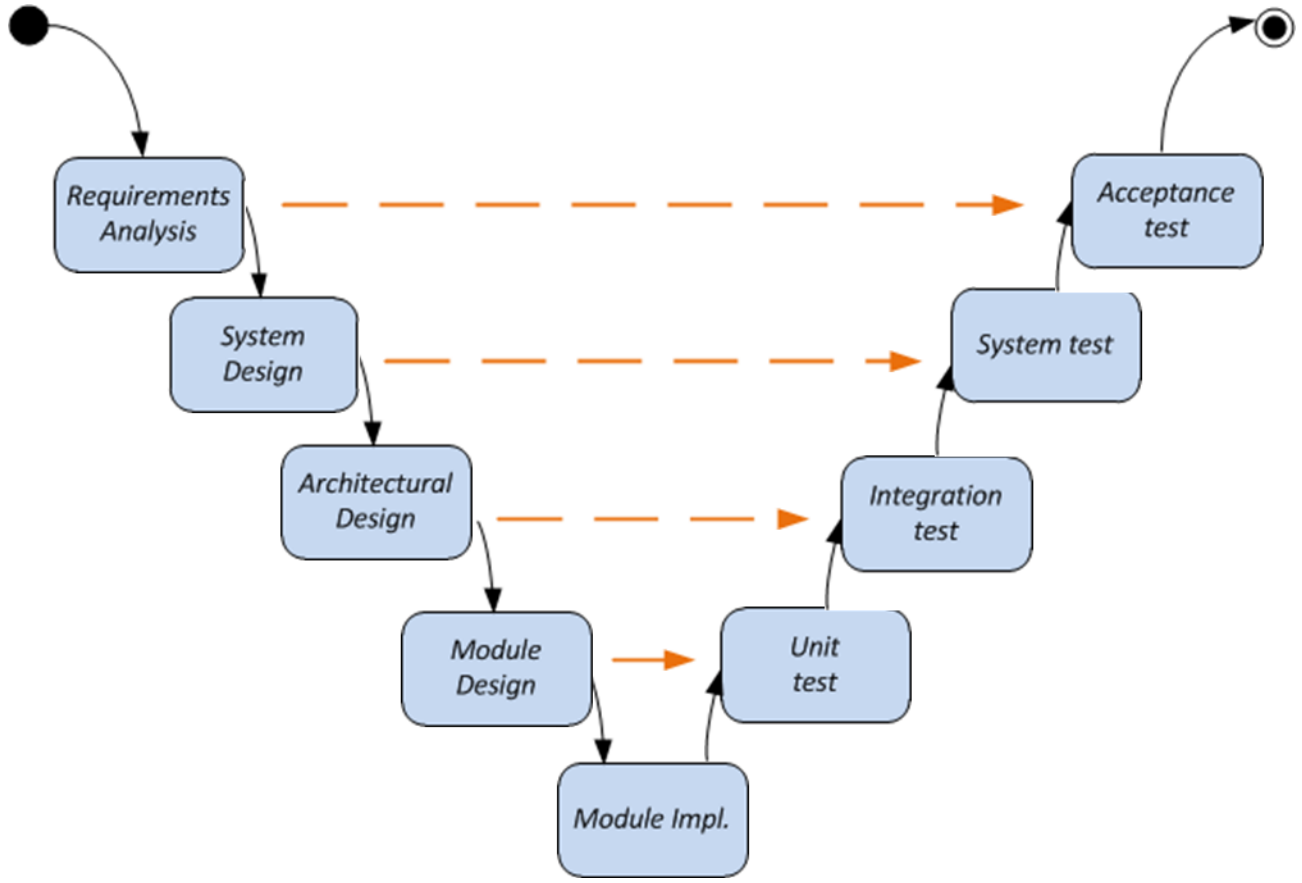
## Route coverage - example



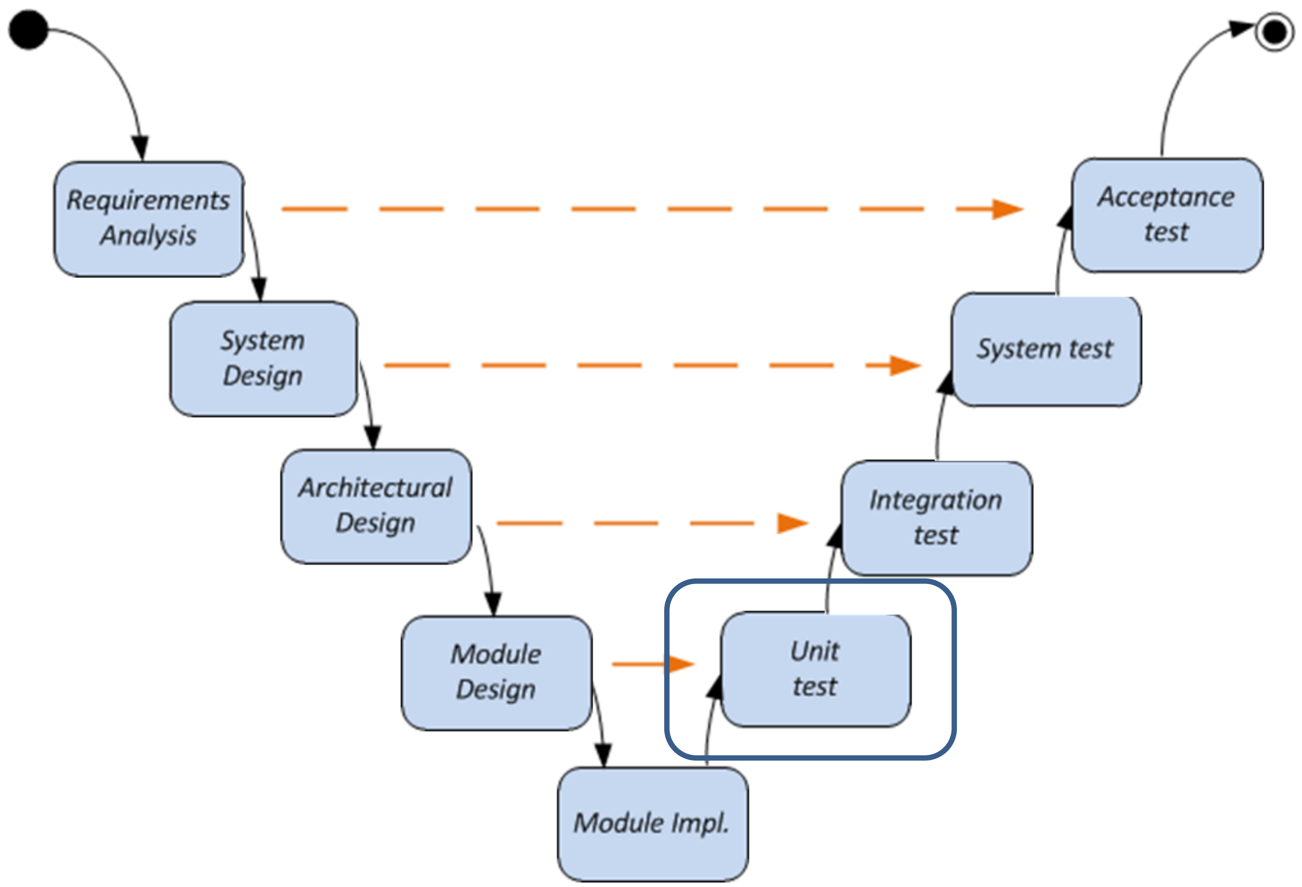
- 5 routes, up to 20 loops
- Independent decisions
  → $10^{14}$ routes

- 1 us/test → 3.17 years

# Test levels


Requirements Analysis
System Design
Architectural Design
Module Design
Module Impl.
Unit test
Integration test
System test
Acceptance test

# Test levels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# Test levels: Unit test

- Unit testing is *by far* the most efficient bug-squasher

- Find a bug in unit testing ?
  - correct the bug, re-run the test

- Find *same* bug in acceptance testing ?
  - Explain to customer, schedule new test, damage control, correct bug, regression-test system, …

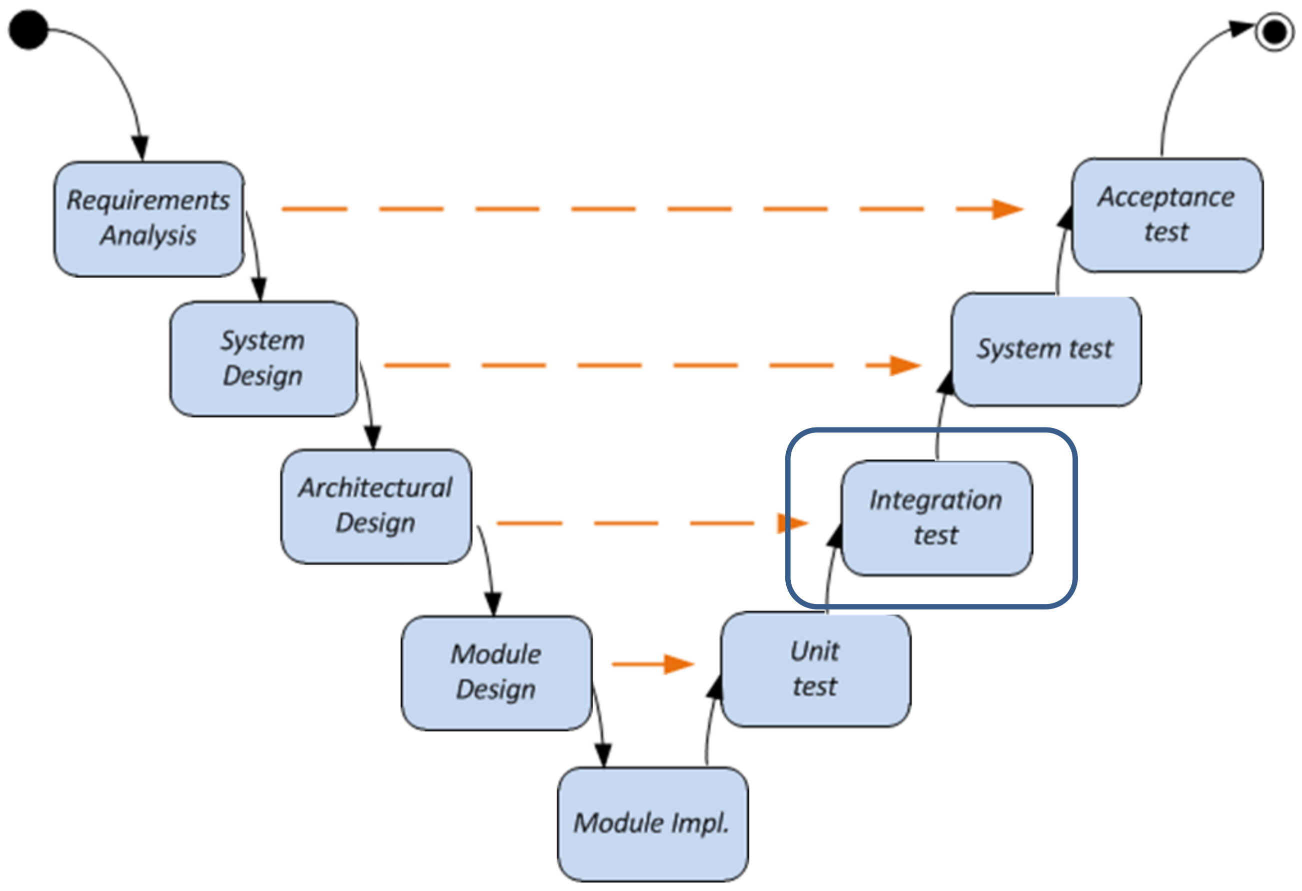
## Unit testing

- Unit testing is closely related to design and implementation

- Most often done by implementor – *a problem?*

- Automate tests whenever possible
  - Machines have no feelings

# Test levels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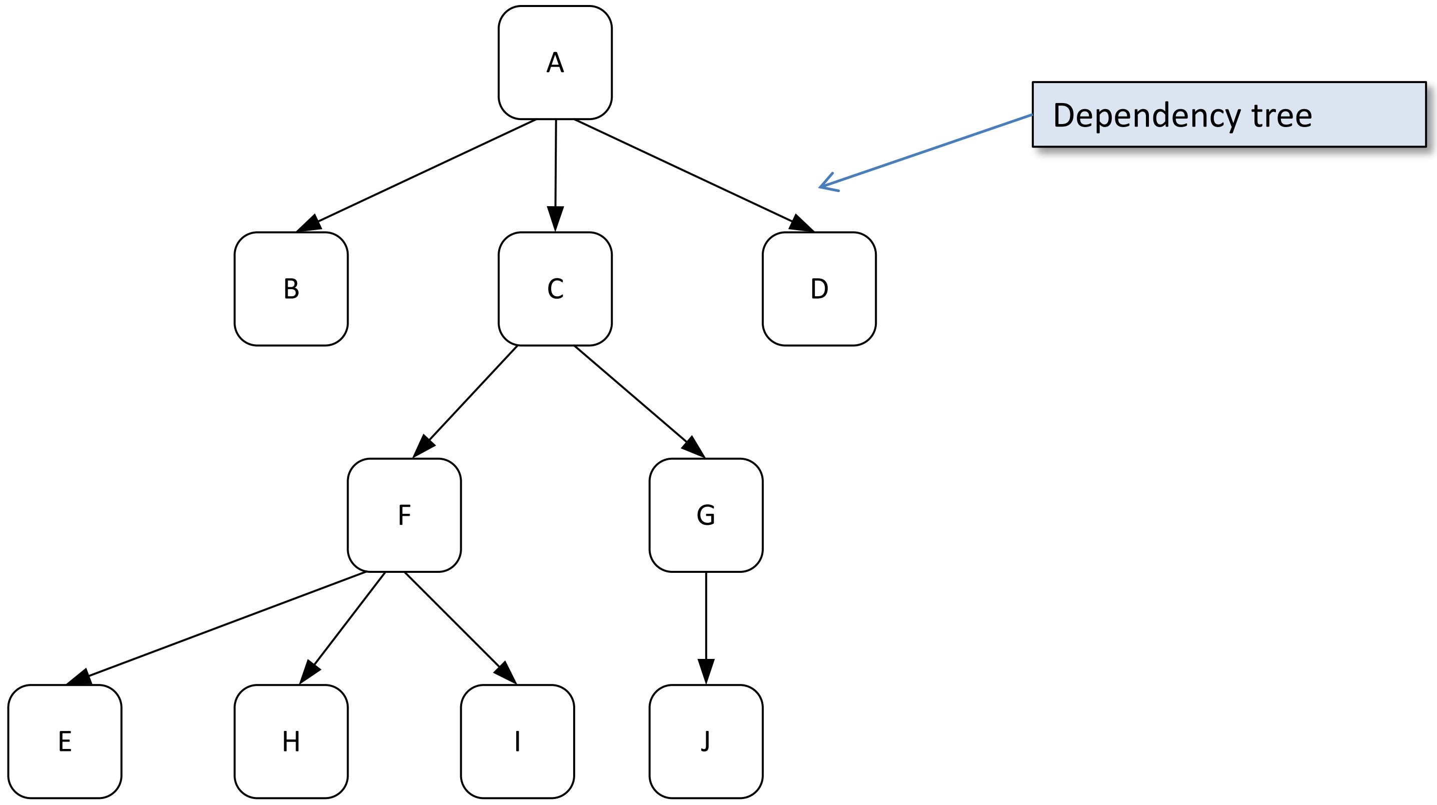
# Test levels: Integration test

- Integration test: Integrating dependent (unit-tested) components

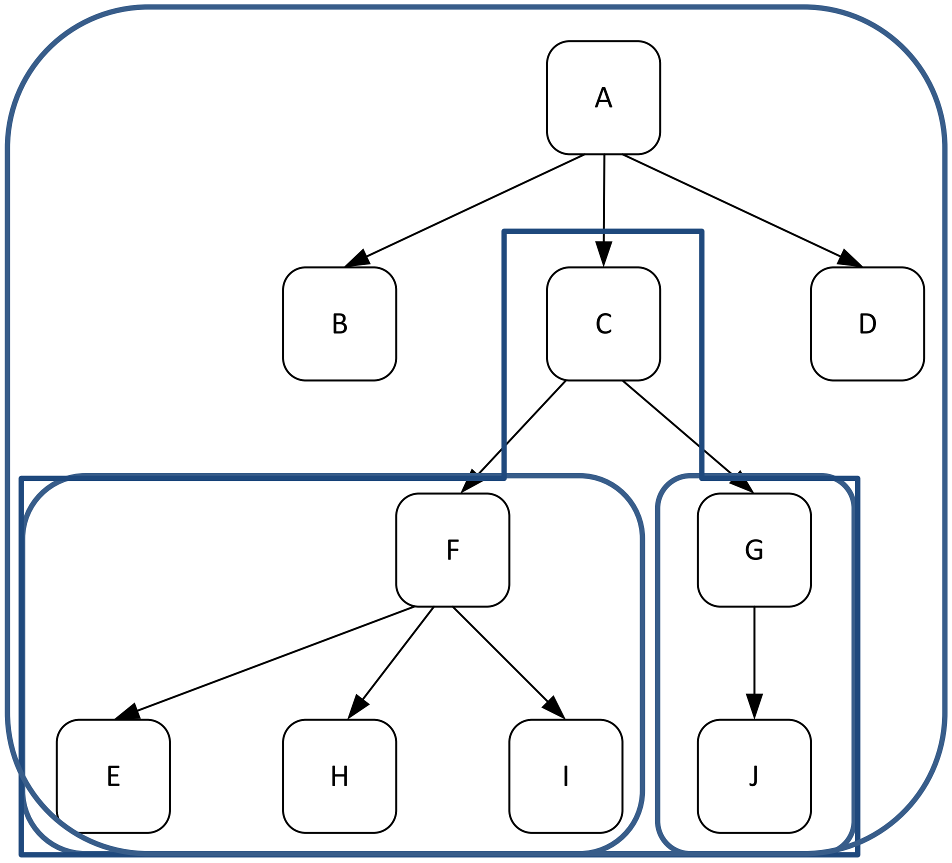
- Various strategies:
  - Big-bang
  - Bottom-up
  - Top-down
  - Sandwich (other hybrids)

# Integration test: Mapping dependencies

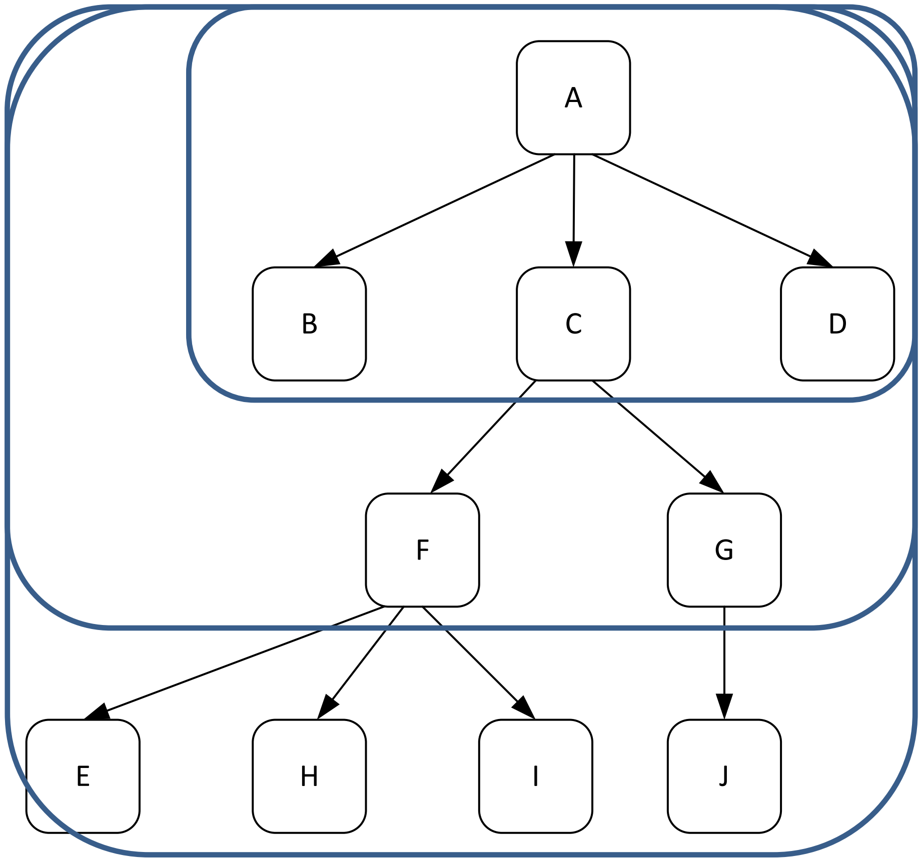


# Integration test:

Bottom-up –
requires *drivers*



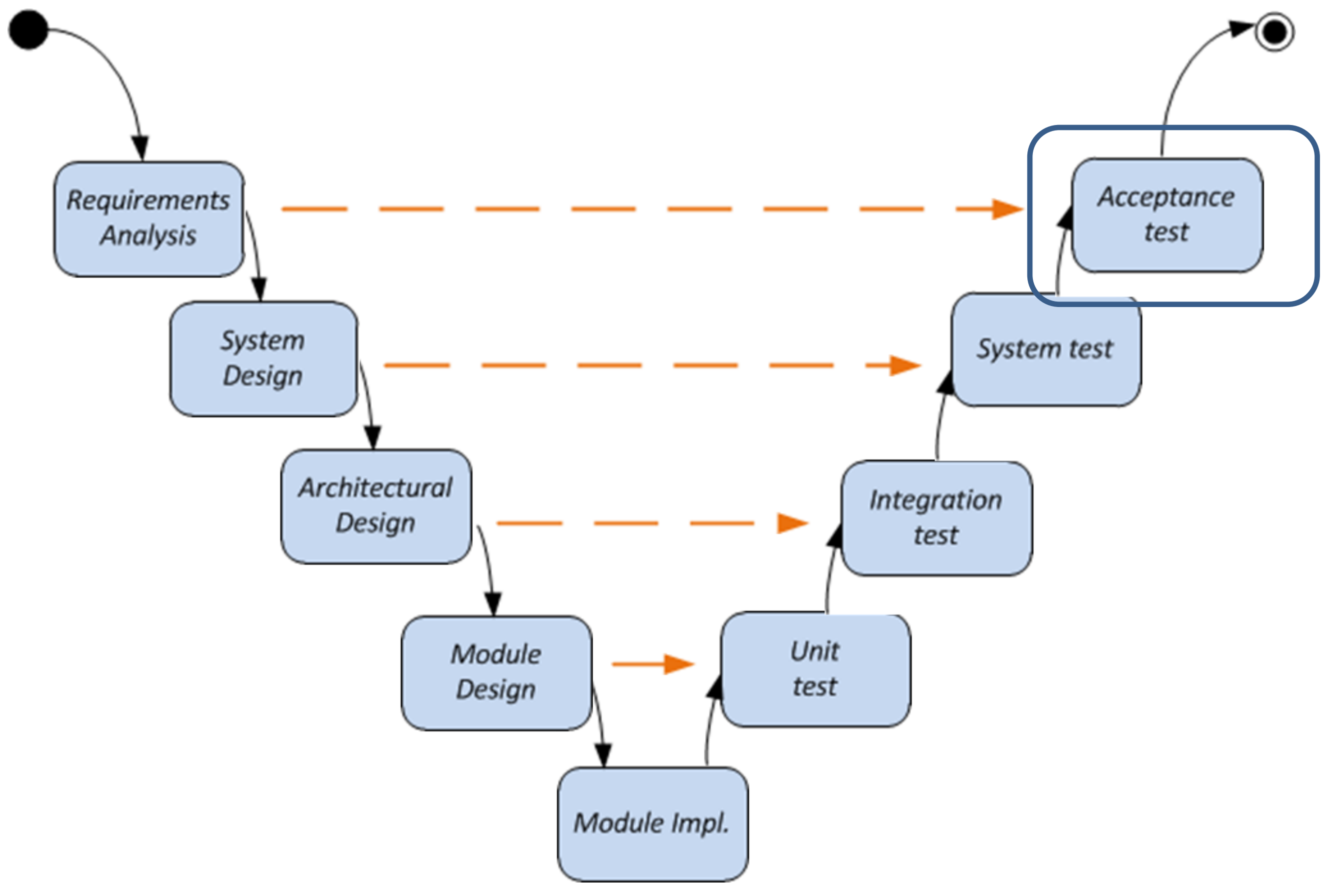
Top-down
- requires *stubs*



## Integration test: Discuss

- What are the benefits of top-down integration testing?
- What are the benefits of bottom-up integration testing?
- What is applicable when?
- Do we have to make a one-or-the-other choice?

# Test levels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# Acceptance test: UCs versus test

- Conducted with customer – signs off.
- The Use cases (UCs) for the system must map to the acceptance test – why?
- How do we make this happen?
  - An example: Req. spec and acceptance test doc.