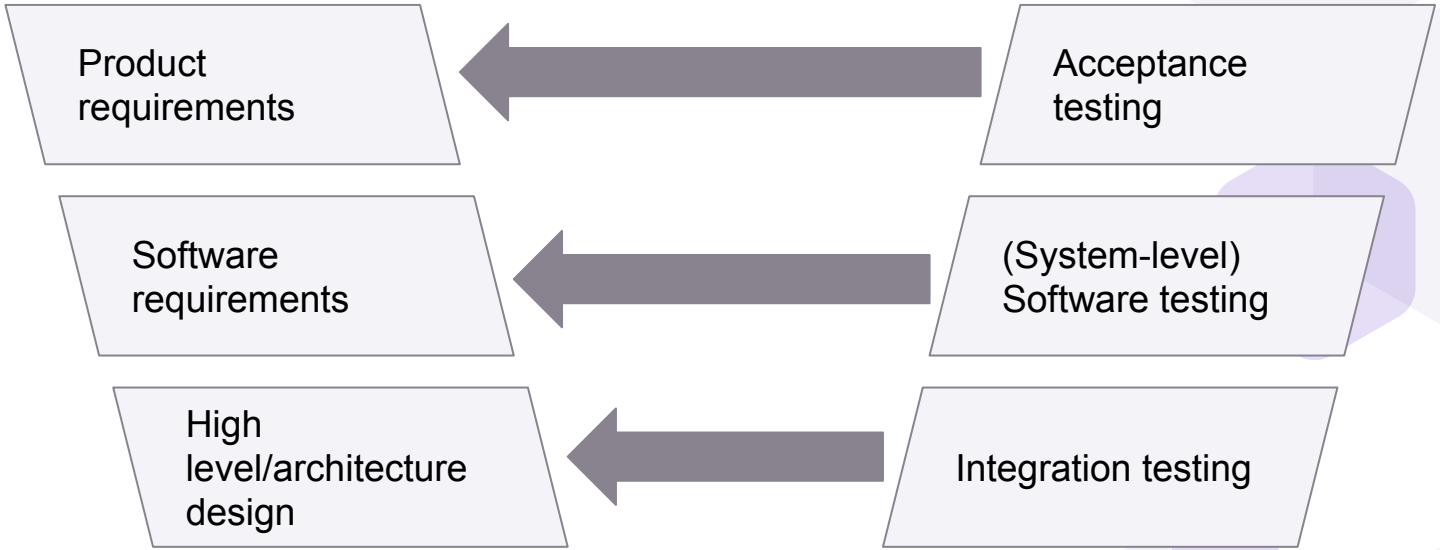
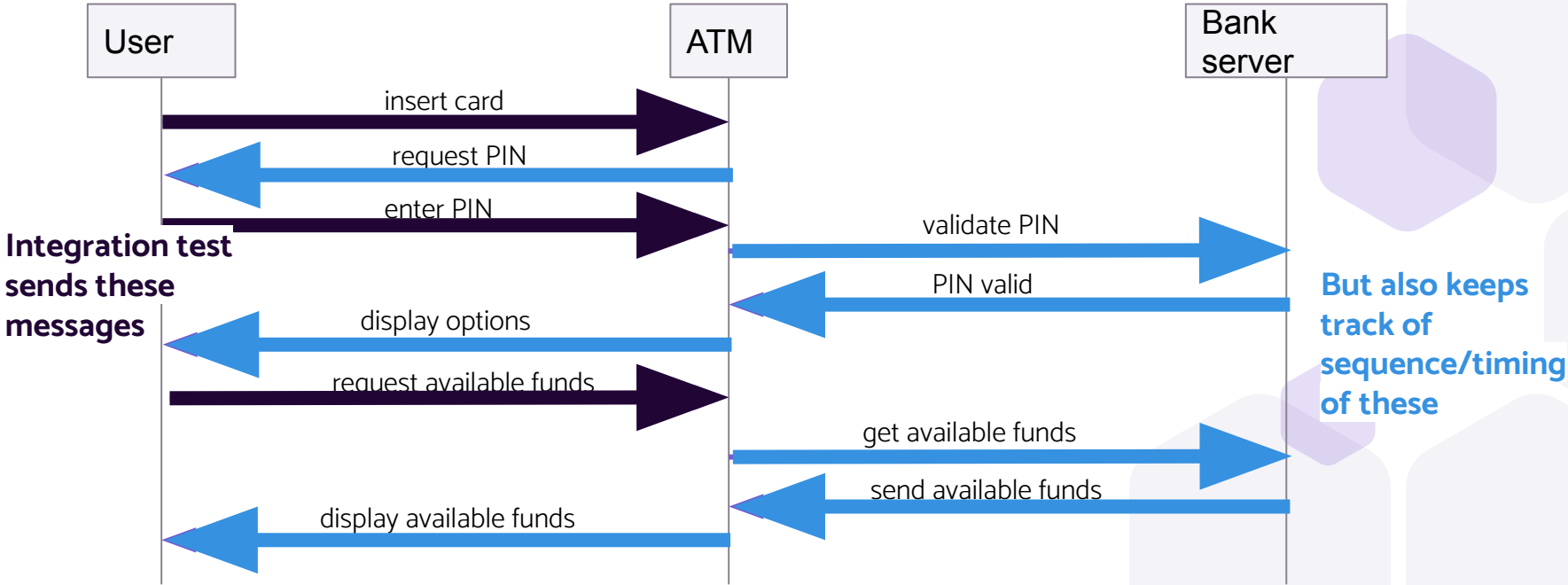
19: Beyond testing; debugging

Rest of the V


Product requirements
Acceptance testing
Software requirements
(System-level) Software testing
High level/architecture design
Integration testing

Sequence diagram test example

Scenario: check available funds at ATM



Message formats

Messages are data structures with multiple fields

Example: message to validate pin may have fields

- Message header (message #, timestamp, origin ID, etc)
- Message type (“validate” encoded into bits)
- (Encrypted) user ID
- (Encrypted) PIN
- Checksum

Part of integration testing is checking that message formats are consistent between sender/receiver

What are some coverage criteria for integration tests?

System testing

Tests all system requirements

- Tests entire system: do inputs at external interfaces cause the correct overall behavior?

Software testing: tests from software POV

Acceptance testing: tests from customer POV

Expensive to instrument, very expensive to repair

Other styles/kinds of testing

Smoke testing - *turn the system on and see if the system works at all (way to check if rest of the system is worth testing)*

Exploratory testing - *skilled tester exercises the system by hand*

Beta test - *product tested by a representative group of users*

Regression test - *did bug fix introduce new bugs?*

Robustness test - *does system hold up to invalid inputs?*

Security test - *can an attacker compromise the system?*

Performance test - *bandwidth, speed, data usage...*

Testing plans

What should be tested?

- What level(s) of testing? (unit, integration, system)
- What kind(s) of testing for each level?

How should it be tested?

- Define testing frameworks, mock functions
- Make an argument for sufficient isolation from interference

How thoroughly should you test?

- Define coverage goals

Accountability

Testing plan should be written *before* testing

Failing tests should be reported, with a plan to triage/address them

> Diagnosing and fixing failing tests is an art in itself *(but good methodology/defects caught at unit level/clean and intentional testing helps!)*

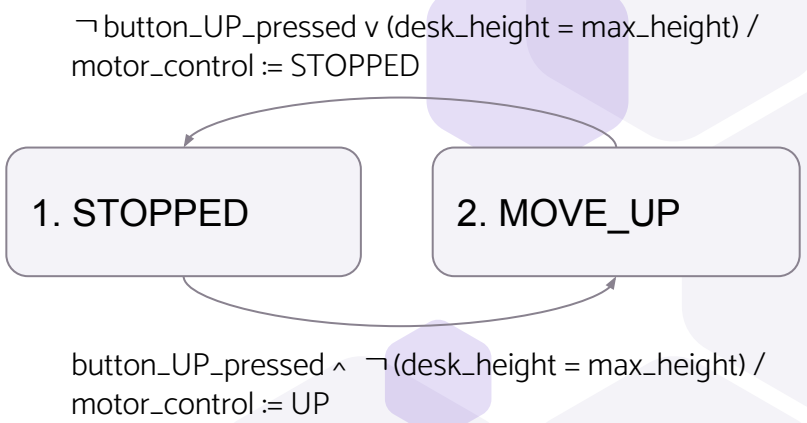
How do you know testing matches design at each level?

Traceability applies to tests too!

	1--	1-2	2--	2-1
Test 1	x			
Test 2			x	
Test 3		x		

Example: trace unit test to FSM

- Number each test - put each number in row of traceability matrix
- Put each transition (and non-transition!) in columns of traceability matrix
- Make sure each column has at least one x

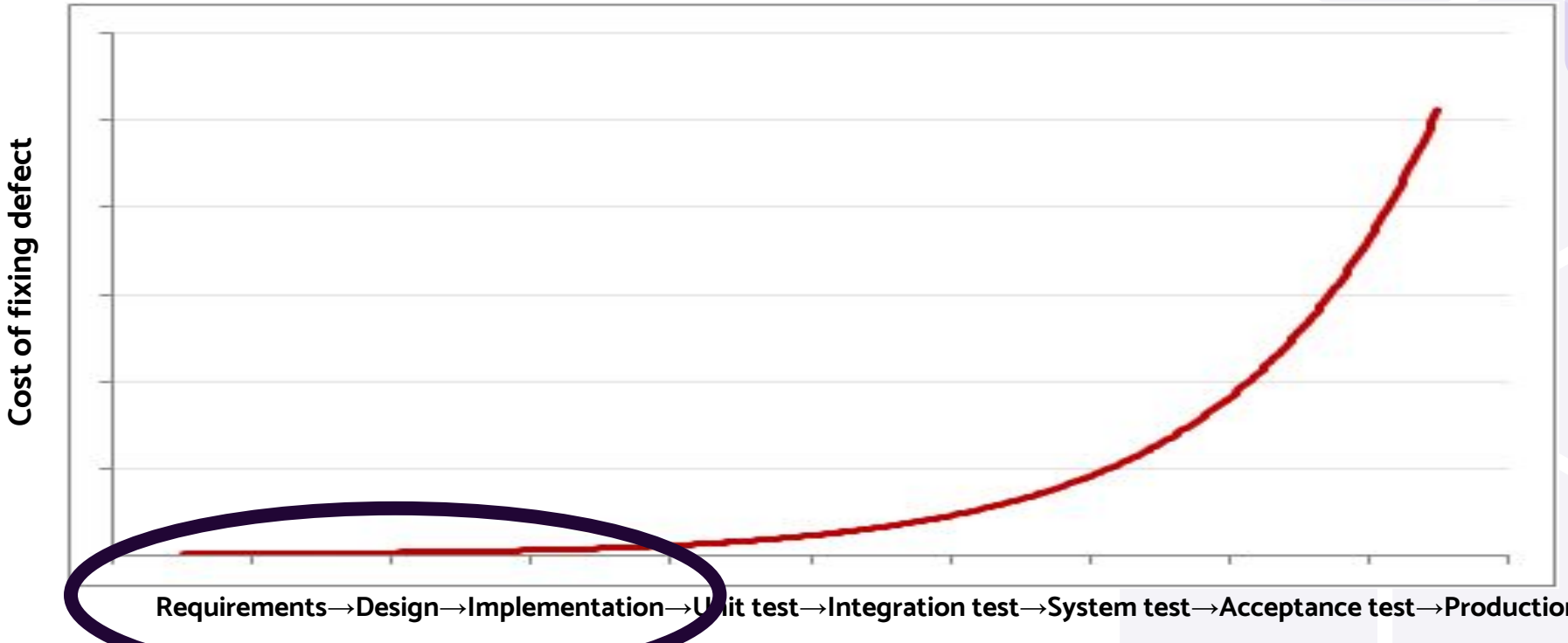


Failed tests as process red flags

- Testing is not done in a vacuum – it is one part of a **thorough design process**
- Finding a bug during system testing probably means:
  - 🚩 Unit/integration tests missed it
  - 🚩 Documentation was not thorough
  - 🚩 Code style guides were not being followed
  - 🚩 Traceability was not complete/correct
  - 🚩 Requirements were incomplete/incorrect

Koopman reading from HW9 (23.3.2) has a great and detailed explanation of this

What about this part of the chart?



Peer reviews

Structured meetings for people to review artifacts

Catch defects/discrepancies early

Can be done at every stage (requirements, design, implementation, test plan)

Healthy projects find more than half of all defects in peer review!

What are some anti-patterns (things you shouldn't do) for peer reviews?

Fagan-style inspections

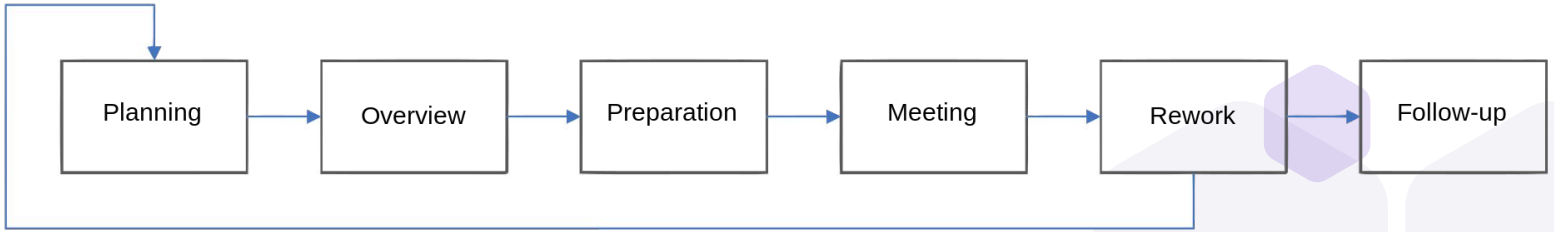
Participants have familiarity with project

Producer explains artifact but is not present for review

Roles assigned (reader, moderator, recorder)

Identify defect and move on

Give list of defects to producer and rework



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Peer review best practices

Review the artifact, not the producer

Limit meeting length (<2 hours)

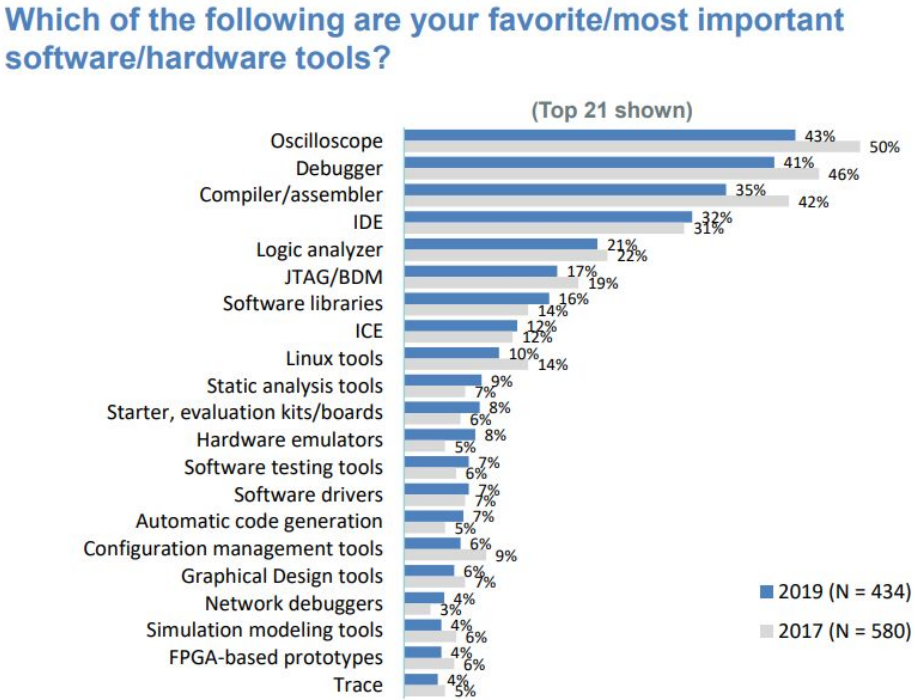
Have clear roles

Have set goals (checklist); agreed upon beforehand

Do not fix problems

Inspect early and often

Bonus: what about debugging?



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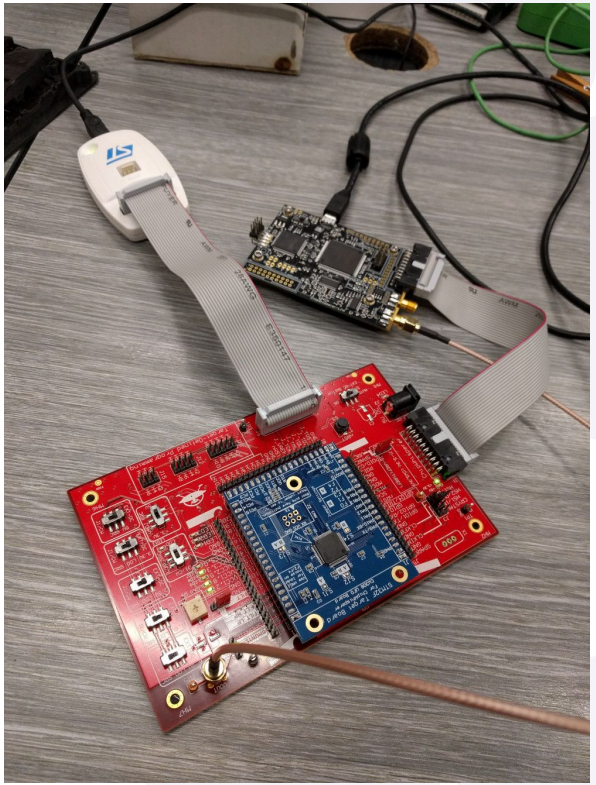
At a high level, how does a debugger (GDB, IDE debuggers, etc) work?

Hardware debuggers

Run a GDB (or similar) server

Connect directly to pins of chip for access to stack/memory/registers



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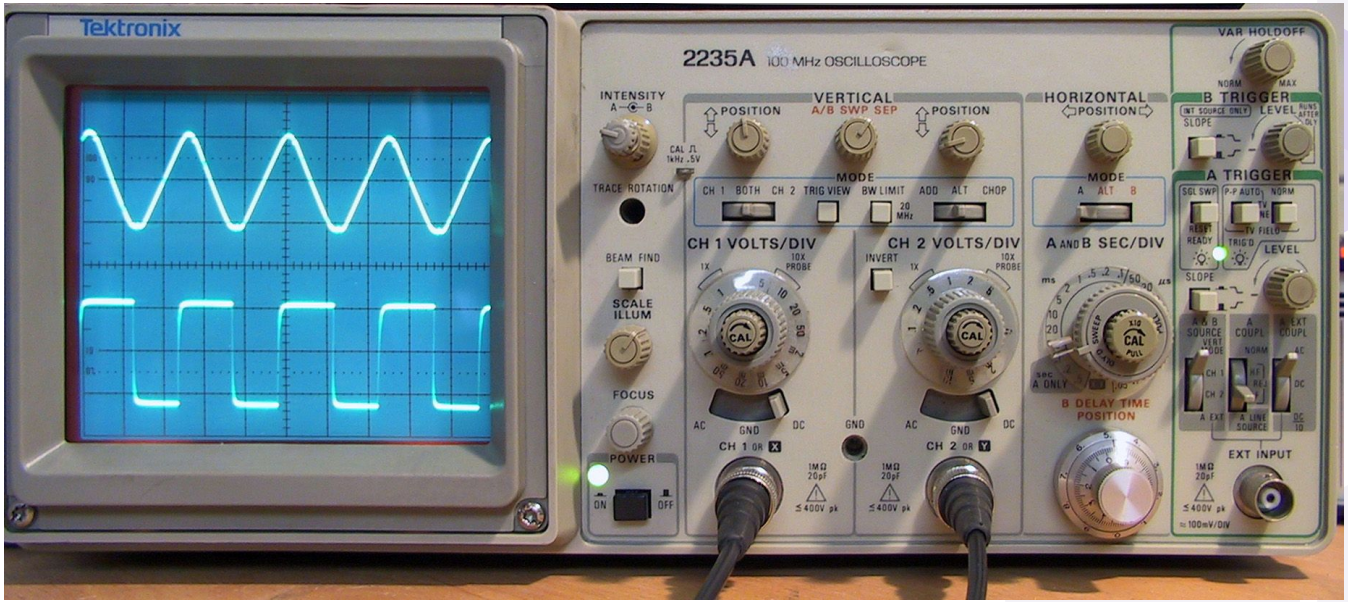
Oscilloscopes

View and analyze electrical signals



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Logic analyzers

View and analyze digital signals

Often have advanced features (decoding common communication protocols)

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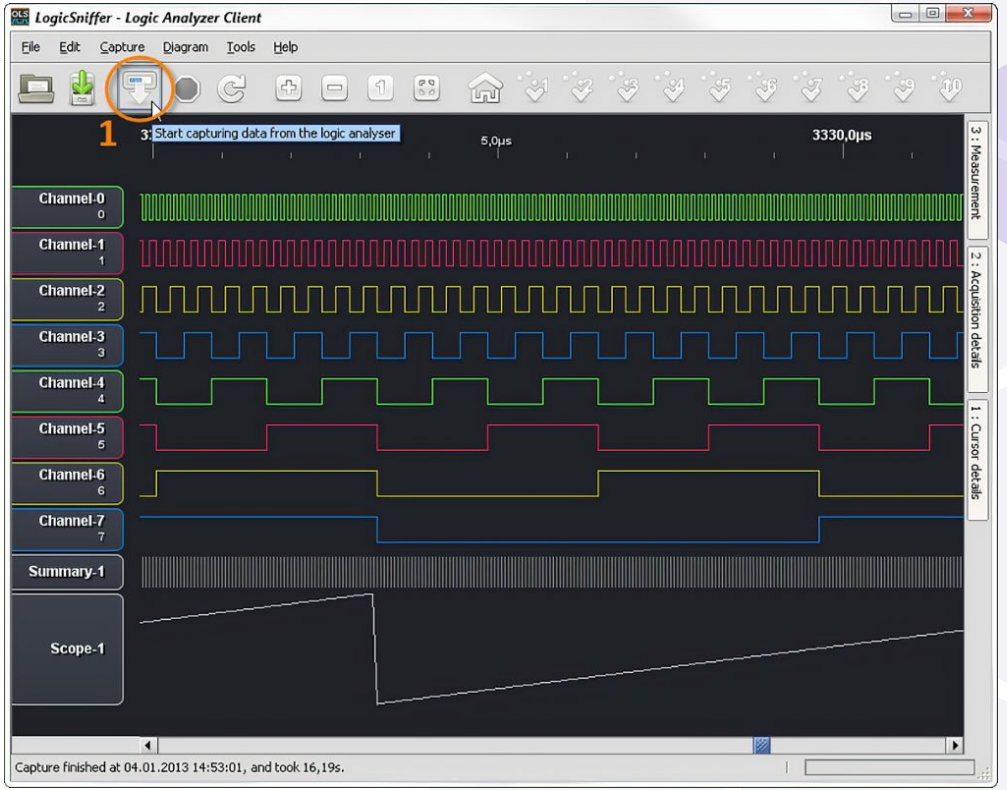

Summary

Testing should be done for every level of the V model; should trace back to left side

Coverage helps set goals for how much to test

The earlier the testing, the cheaper (and peer reviews are the cheapest of all!)