

CS 4530: Fundamentals of Software Engineering

Module 12.2: Beyond Unit Testing

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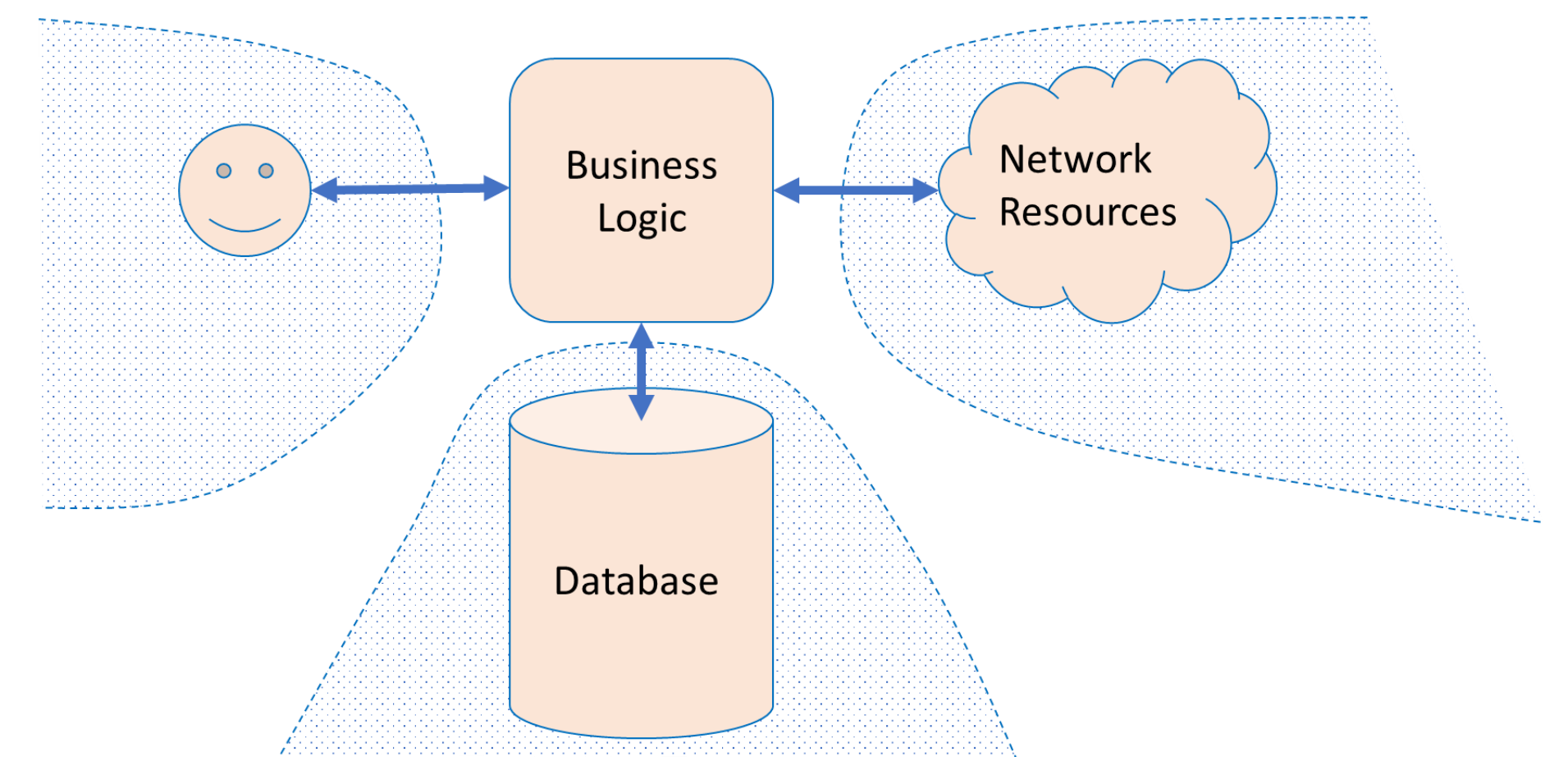
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Learning Objectives for this Lesson

- By the end of this lesson, you should be prepared to:
 - Explain why you might need tests that are larger than unit tests
 - Explain why you should or shouldn't use a mock in conjunction with these larger tests.
 - Explain how large, deployed systems lead to additional testing challenges

Large Systems are Hard to Test

- Database component
 - Contents may need to reflect/simulate real-world;
 - Data may be expensive/proprietary/confidential.
- Network connections
 - "Real" connections may be slow/flaky/disrupted;
 - Resources may have changed since test was written.
- Environment
 - Interactions with OS, locale or other software.
- Human actors
 - Ultimately unpredictable.
- Specifications are incomplete, and may change
 - Large systems -> many behaviors/interactions to consider
 - Specifications may evolve over time



Test doubles can help.

- To create "small" tests that are faster and less flaky
 - Example: Testing a unit that processes result of an external API call; only interested in testing what happens *after* the external call returns
- When the real thing is unavailable
 - Example: Integrating with external vendors
- When testing for unusual or exceptional cases that are hard to make happen in practice
 - Example: when external service fails in the middle of a transaction


Mocks and fakes can sometimes help.

- Sometimes called a *fake*, these mocks have an implementation of the object being replaced
 - A *low-fidelity* fake implements things partially
 - Enough to work for the test.
 - A *high-fidelity* fake implements most aspects:
 - Usually all functional aspects;
 - Usually not as efficiently or as scalable.
- The purpose of this mock is to avoid processes/network/cost, but still perform some activities
- Create fakes in Jest with *mock.mockImplementation(...)*

Fake has
"semi-real
implementation"

Test Doubles Have Weaknesses

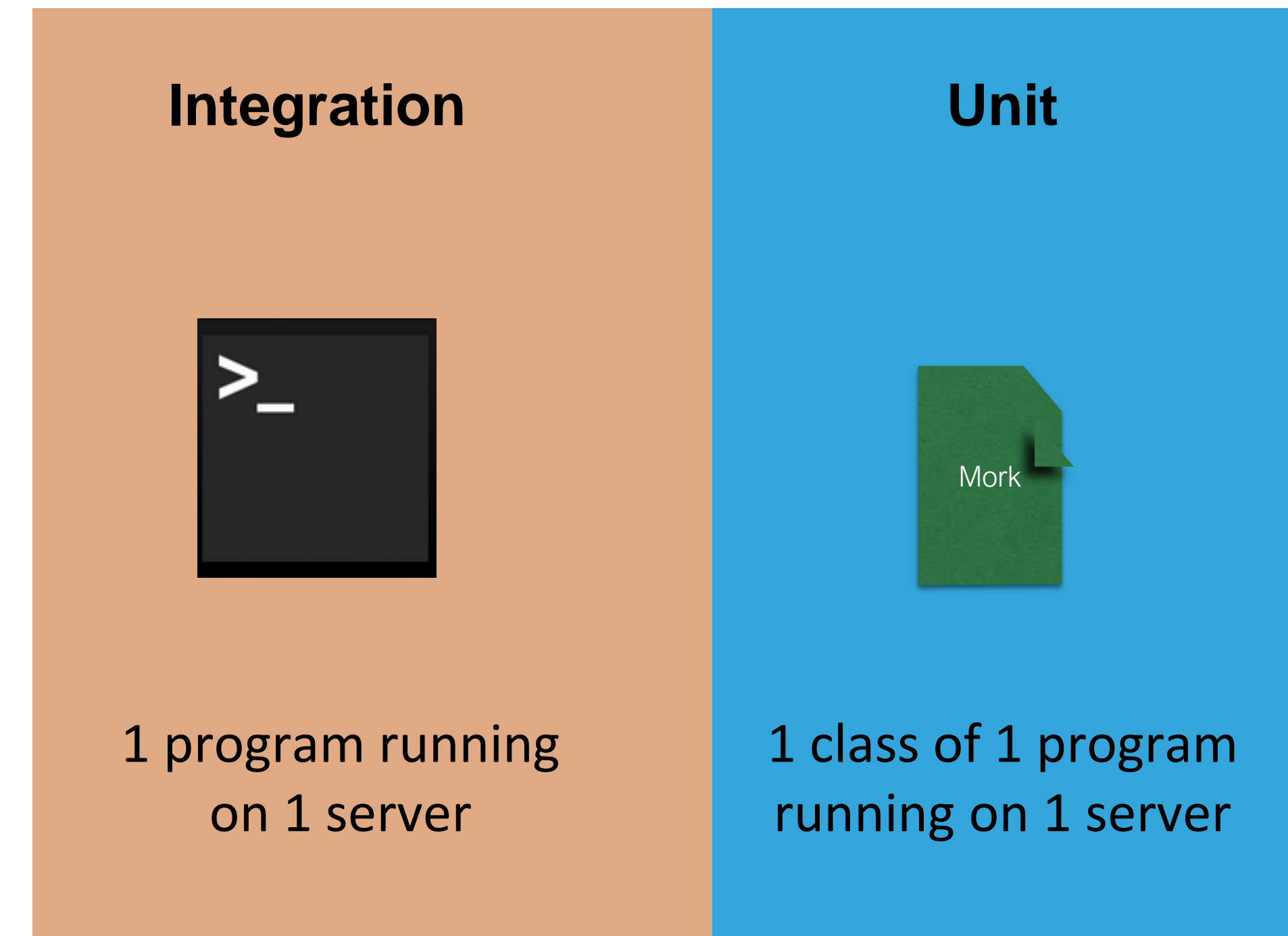
- Some failures may occur purely at the integration between components:
 - The test may assume wrong behavior (wrongly encoded by mock)
 - Higher fidelity mocks can help, but still just a snapshot of the real world
- Test doubles can be brittle:
 - Spies expect a particular usage of the test double;
 - The test is "brittle" because it depends on internal behavior of SUT;
- Potential maintenance burden: as SUT evolves, mocks must evolve.



We already saw
this in the
preceding lesson

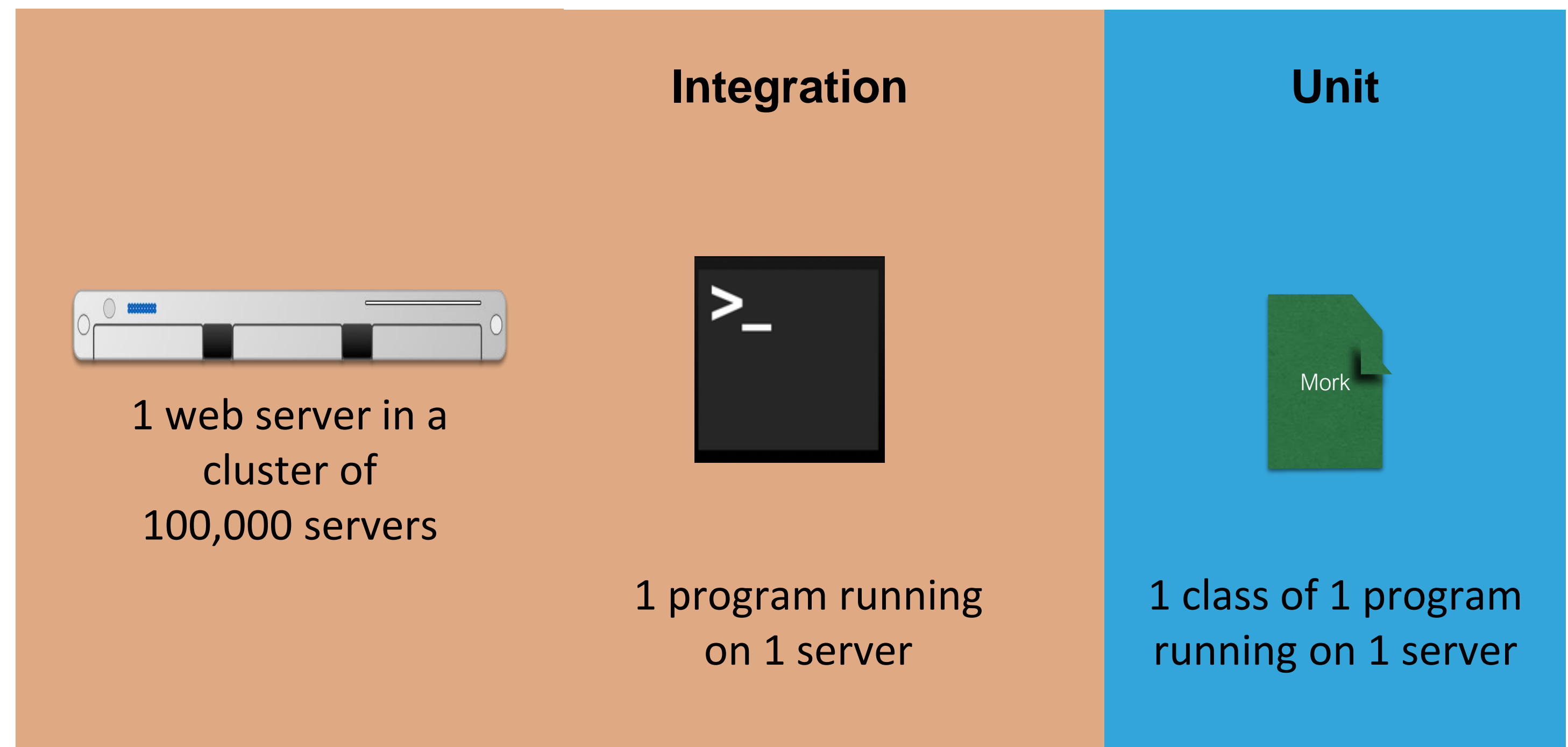
But some bugs are observable only when multiple components interact.

- These are usually because one module has made incorrect assumptions about some other module
- Unit tests won't reveal such bugs
- Mocks won't help, either (since they may incorporate our incorrect assumptions)
- So you really need integration tests

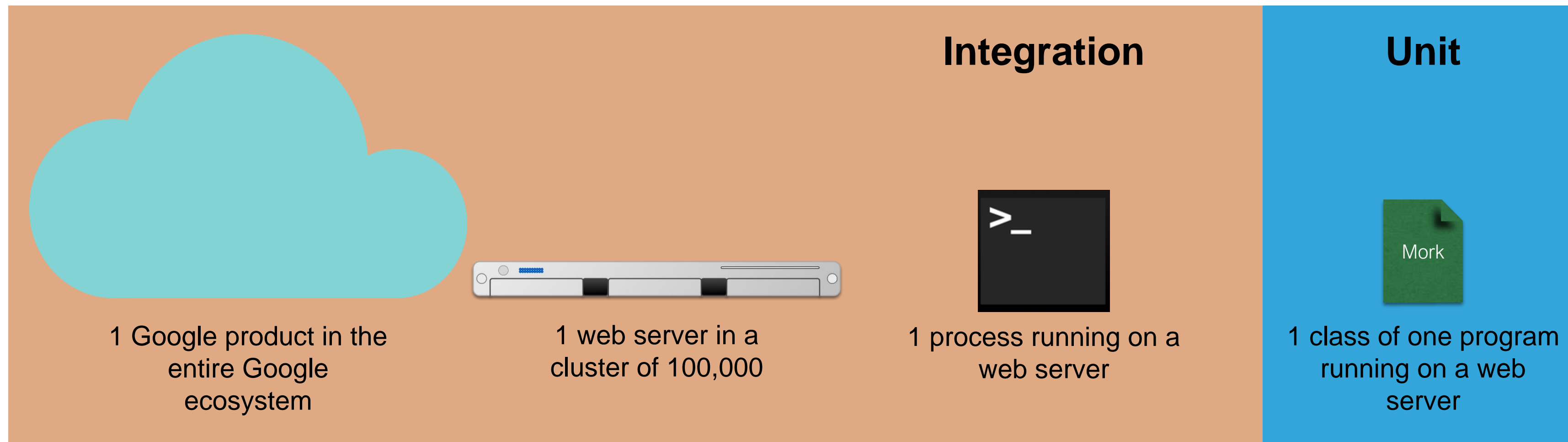


Integration tests may be larger

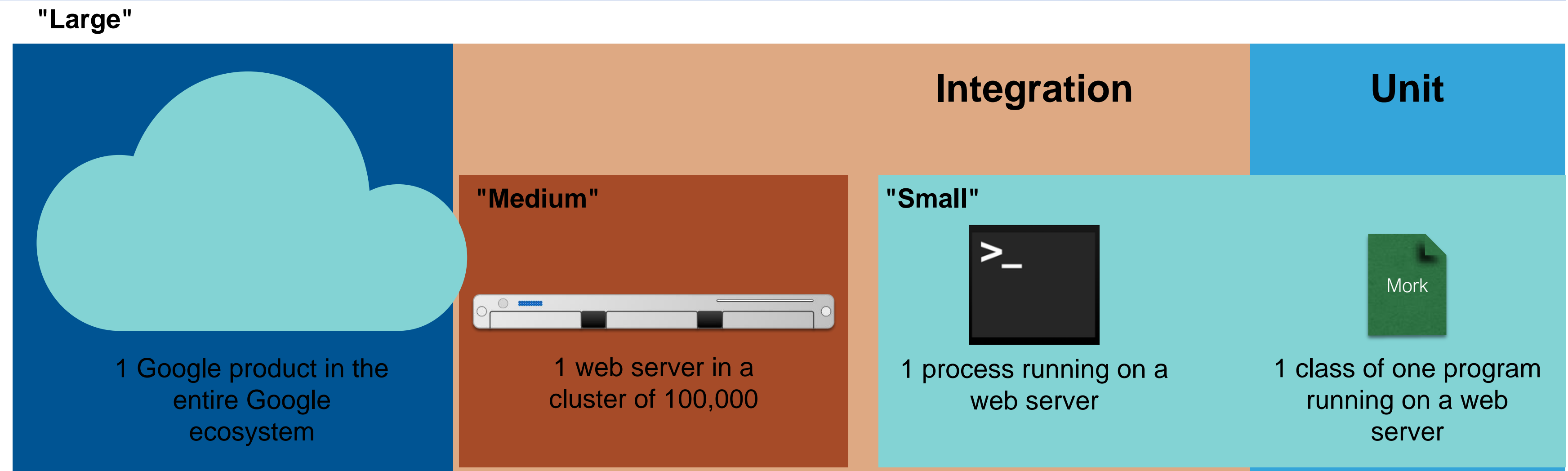
- Does the presence of other jobs on our server change the behavior of our program?
- Does the presence of the other servers change the behavior of our program?



Some Tests are Enormous



Google classifies tests by “size”

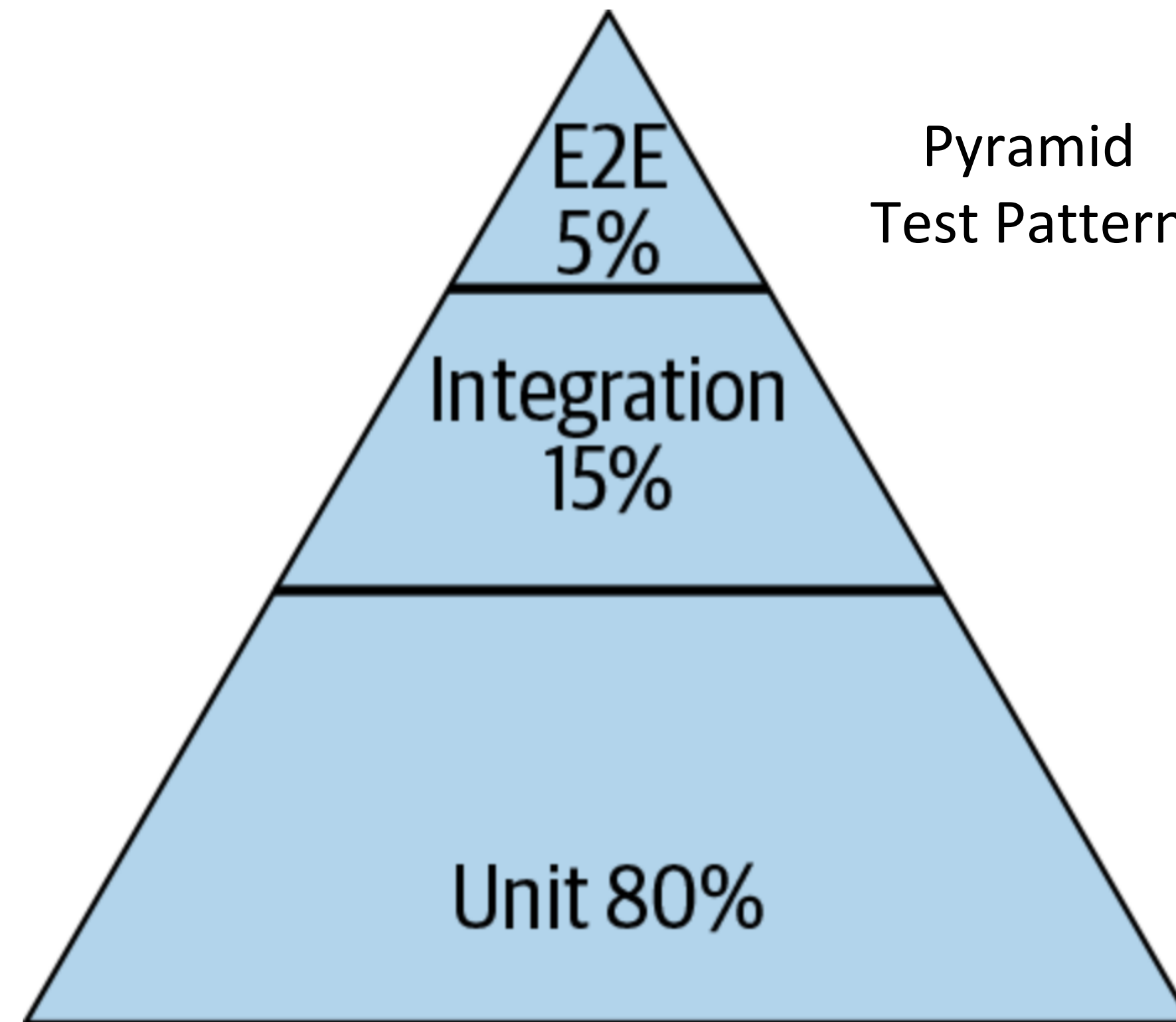
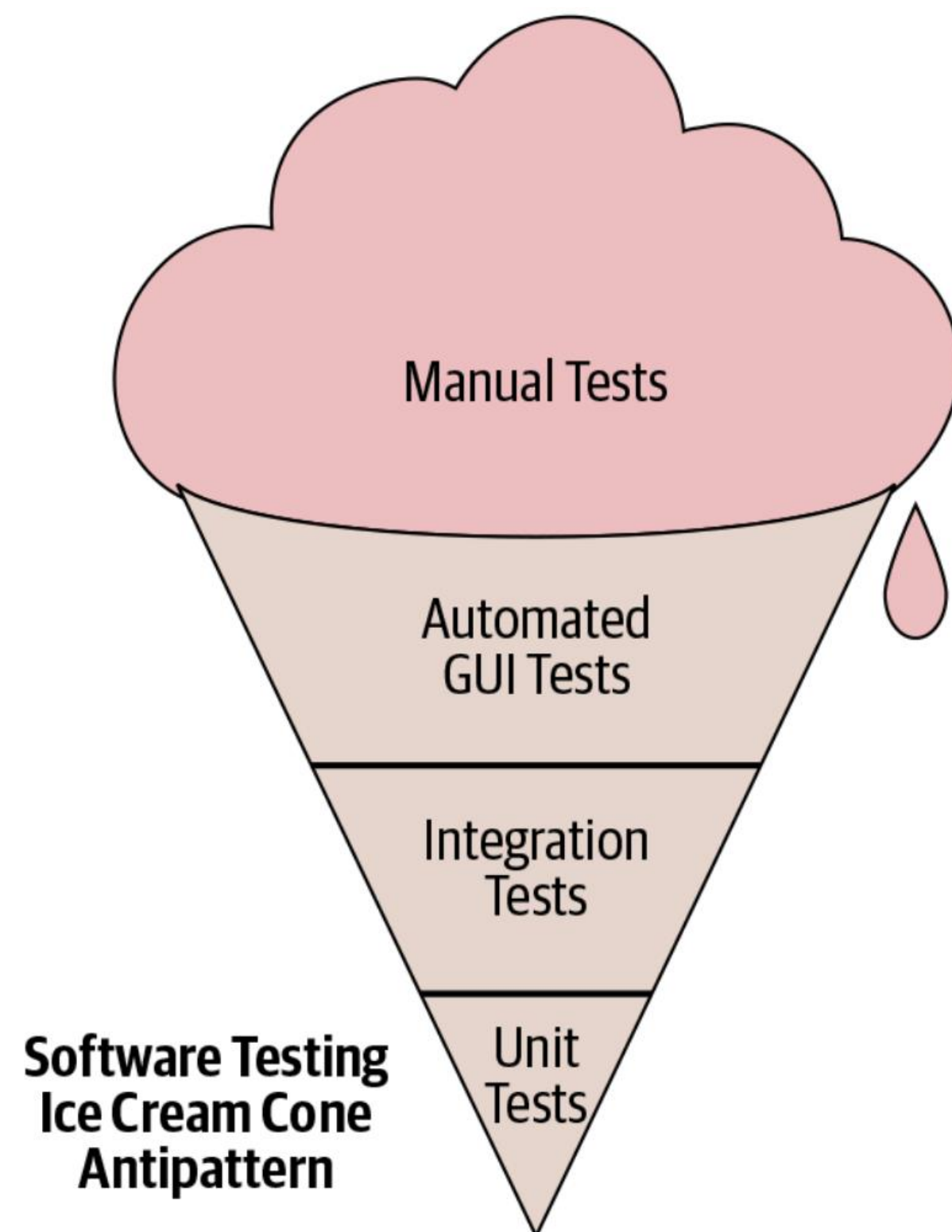


- “small” = single process
- “medium” = single machine
- “large” = bigger than that.

How big is my test?

- Small: run in a single thread, can't sleep, perform I/O or make blocking calls
- Medium: run on single computer, can use processes/threads, perform I/O, but only contact localhost
- Large: Everything else

Testing Distribution (How much of each kind of testing we should do?)



From SoftEng @ Google Chapter 11

- https://learning.oreilly.com/library/view/software-engineering-at/9781492082781/ch11.html#testing_overview

Deployed systems create even more testing challenges

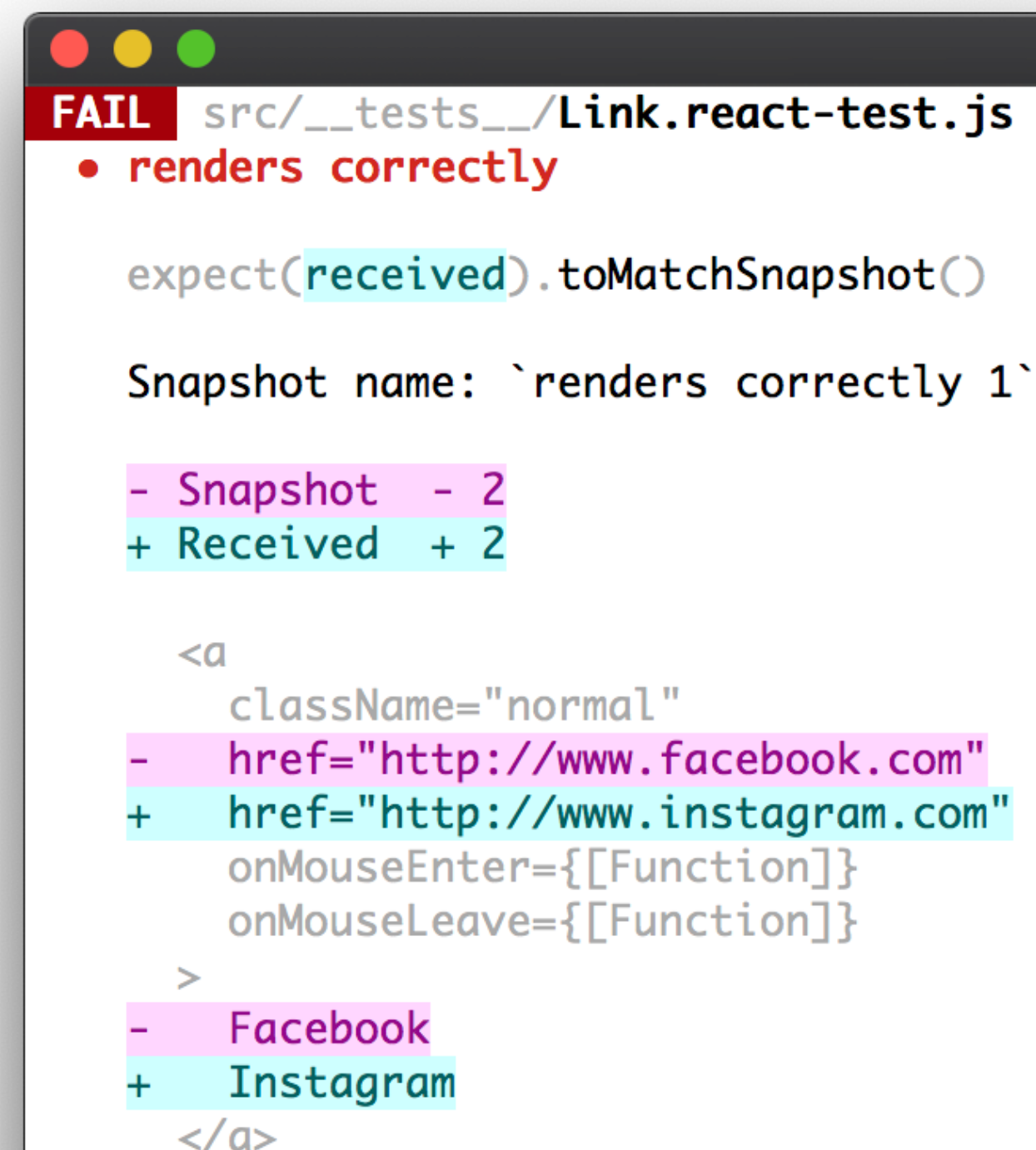
- Clients believe “how it is now is right”,
 - Not “how the API intended it to be is right”
 - Writing thorough test suite is even harder, less useful
 - What is a “breaking change”?
- Still: vital to detect breaking changes
- Examples:
 - Detailed layout of GUIs
 - Side-effects of APIs, particularly under corner-cases

Snapshot Tests Can Detect GUI Changes

- The first time the test runs, it saves a "snapshot" of the rendered GUI
- Subsequent runs will fail if the snapshot changes

```
import renderer from 'react-test-renderer';
import Link from '../Link';

it('renders correctly', () => {
  const tree = renderer
    .create(<Link
page="http://www.facebook.com">Facebook</Link>)
    .toJSON();
  expect(tree).toMatchSnapshot();
});
```



```
FAIL src/__tests__/Link.react-test.js
  • renders correctly

expect(received).toMatchSnapshot()

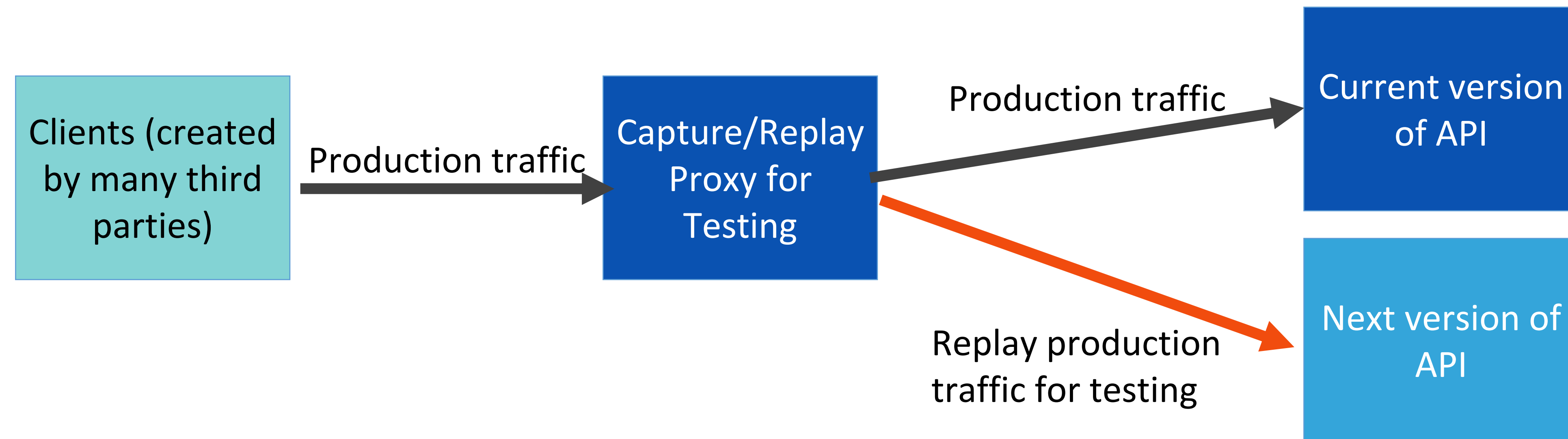
Snapshot name: `renders correctly 1`

- Snapshot - 2
+ Received + 2

<a
  className="normal"
- href="http://www.facebook.com"
+ href="http://www.instagram.com"
  onMouseEnter={[[Function]]}
  onMouseLeave={[[Function]]}
>
- Facebook
+ Instagram
</a>
```


Capture/replay can detect breaking changes in API endpoints

- Record the API requests and responses that clients make
- Test new versions of the API by identifying requests that result in different responses ("breaking changes")



Review: Learning Objectives for this Lesson

- You should now be able to:
 - Explain why you might need tests that are larger than unit tests
 - Explain why you should or shouldn't use a mock in conjunction with these larger tests.
 - Explain how large, deployed systems lead to additional testing challenges