

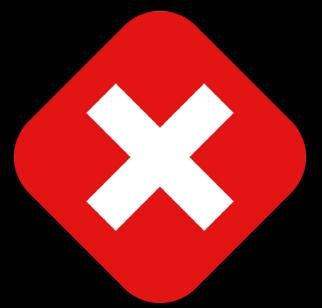
# Advanced Testing and Continuous Integration

Session 409

Zoltan Foley-Fisher Xcode Engineer  
Eric Dudiak Xcode Engineer









# Agenda

# Agenda

Testing Concepts

# Agenda

## Testing Concepts

### Xcode

- Crash Log Gathering

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### Xcode

- Crash Log Gathering

### Xcode Server

- Advanced Triggers
- Issue Tracking and Blame
- Configurable Integration User

# Agenda

## Testing Concepts

### Xcode

- Crash Log Gathering

### Xcode Server

- Advanced Triggers
- Issue Tracking and Blame
- Configurable Integration User

### xcodebuild

# Overview

# Overview





# XCTest

## Testing framework

# XCTest

## Testing framework

### Sources



TestClassA.m



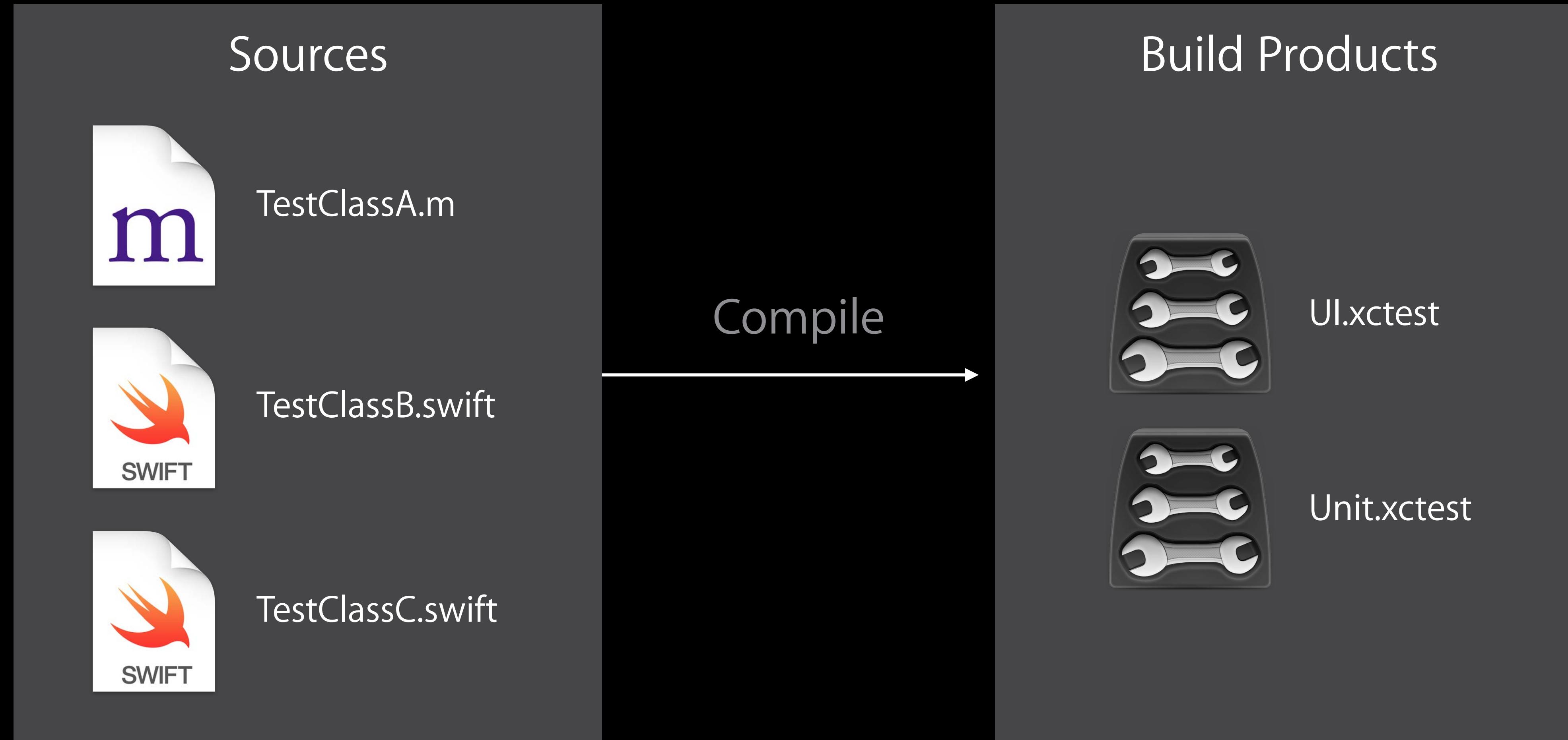
TestClassB.swift



TestClassC.swift

# XCTest

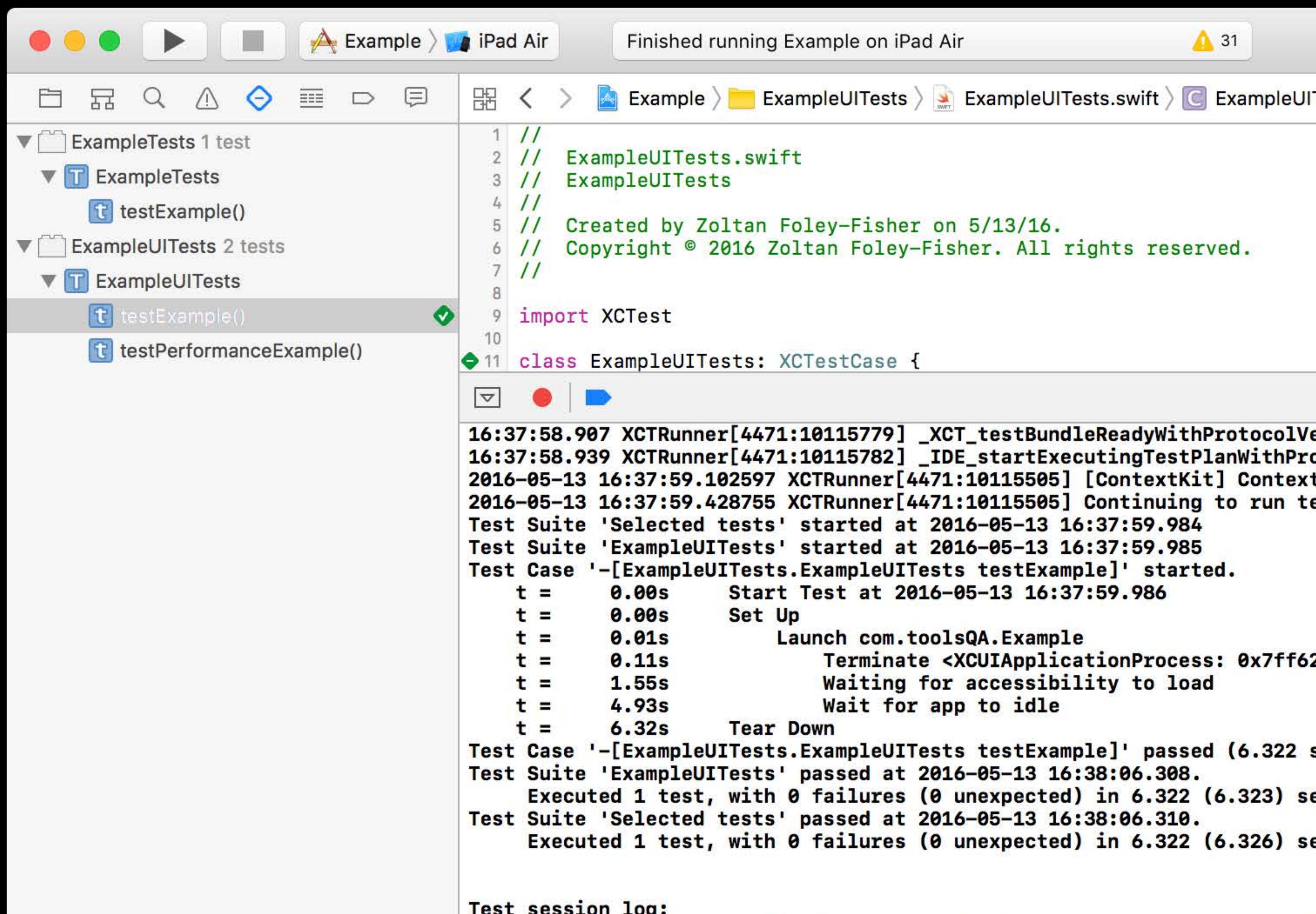
## Testing framework





# Xcode

## Test harness



The screenshot shows the Xcode interface with a project named "Example" targeting an "iPad Air". The "ExampleUITests" test target is selected in the left sidebar, showing two test cases: "testExample()" and "testPerformanceExample()". The "testExample()" case is currently selected and has a green checkmark icon next to it. The right pane displays the "ExampleUITests.swift" file, which contains the following code:

```
1 // ExampleUITests.swift
2 // ExampleUITests
3 // Created by Zoltan Foley-Fisher on 5/13/16.
4 // Copyright © 2016 Zoltan Foley-Fisher. All rights reserved.
5
6
7
8
9 import XCTest
10
11 class ExampleUITests: XCTestCase {
```

Below the code, the Xcode log window shows the execution of the test cases:

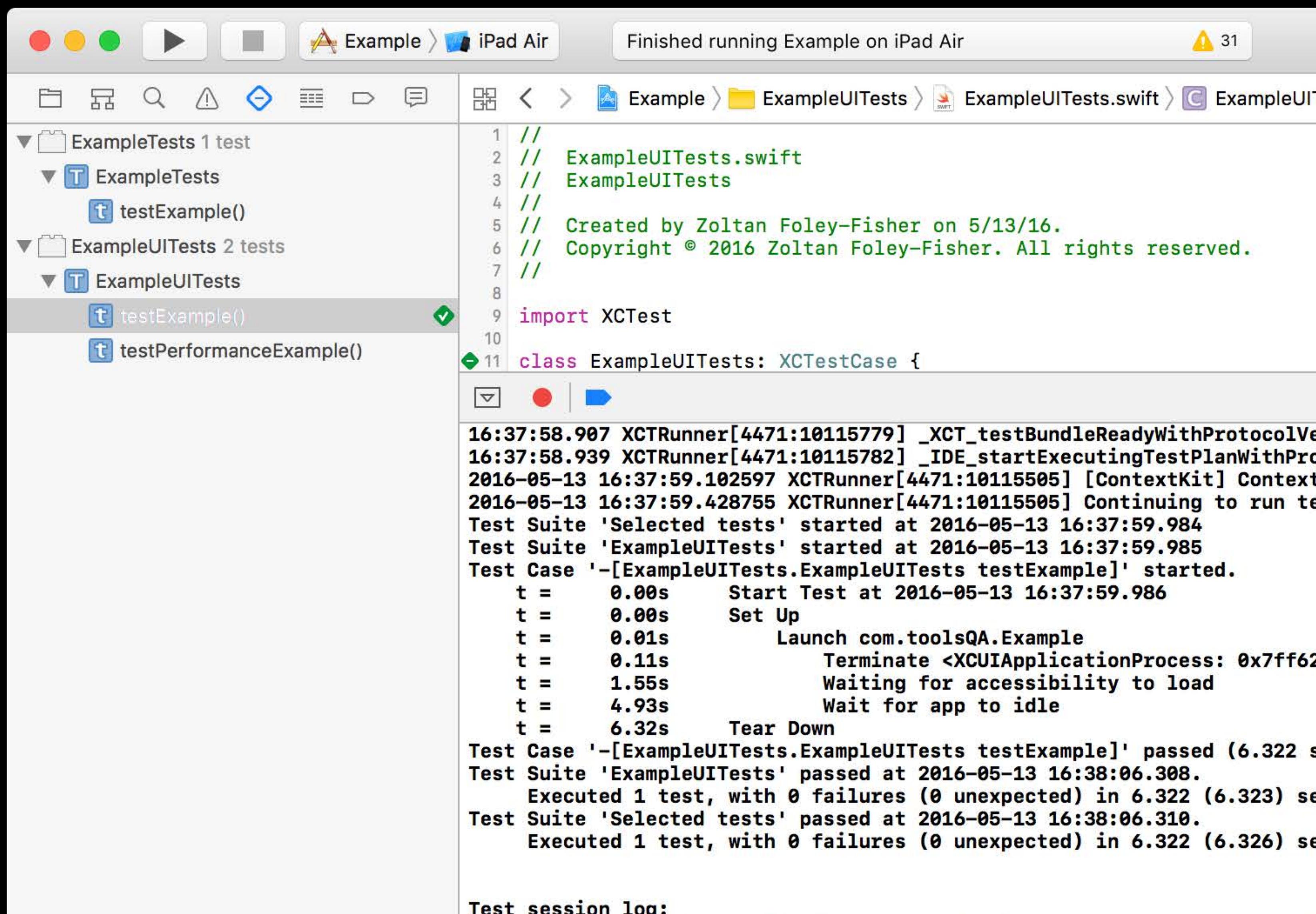
```
16:37:58.907 XCTRunner[4471:10115779] _XCT_testBundleReadyWithProtocolVersion
16:37:58.939 XCTRunner[4471:10115782] _IDE_startExecutingTestPlanWithProtocolVersion
2016-05-13 16:37:59.102597 XCTRunner[4471:10115505] [ContextKit] ContextKit initialized
2016-05-13 16:37:59.428755 XCTRunner[4471:10115505] Continuing to run tests
Test Suite 'Selected tests' started at 2016-05-13 16:37:59.984
Test Suite 'ExampleUITests' started at 2016-05-13 16:37:59.985
Test Case '-[ExampleUITests.ExampleUITests testExample]' started.
    t = 0.00s      Start Test at 2016-05-13 16:37:59.986
    t = 0.00s      Set Up
    t = 0.01s      Launch com.toolsQA.Example
    t = 0.11s      Terminate <XCUIApplicationProcess: 0x7ff62
    t = 1.55s      Waiting for accessibility to load
    t = 4.93s      Wait for app to idle
    t = 6.32s      Tear Down
Test Case '-[ExampleUITests.ExampleUITests testExample]' passed (6.322 seconds)
Test Suite 'ExampleUITests' passed at 2016-05-13 16:38:06.308.
    Executed 1 test, with 0 failures (0 unexpected) in 6.322 (6.323) seconds
Test Suite 'Selected tests' passed at 2016-05-13 16:38:06.310.
    Executed 1 test, with 0 failures (0 unexpected) in 6.322 (6.326) seconds
```

At the bottom, the text "Test session log:" is visible.

# Xcode

## Test harness

### Author tests



The screenshot shows the Xcode interface with the following details:

- Project Navigator:** Shows two test targets: "ExampleTests 1 test" and "ExampleUITests 2 tests".
- Code Editor:** Displays the `ExampleUITests.swift` file. The code includes a copyright notice and a test class definition:

```
1 // ExampleUITests.swift
2 // ExampleUITests
3 // Created by Zoltan Foley-Fisher on 5/13/16.
4 // Copyright © 2016 Zoltan Foley-Fisher. All rights reserved.
5
6 import XCTest
7
8
9 class ExampleUITests: XCTestCase {
```

- Log Navigator:** Shows the test execution log, indicating the test was successful:

```
16:37:58.907 XCTRunner[4471:10115779] _XCT_testBundleReadyWithProtocolVersion
16:37:58.939 XCTRunner[4471:10115782] _IDE_startExecutingTestPlanWithProtocolVersion
2016-05-13 16:37:59.102597 XCTRunner[4471:10115505] [ContextKit] ContextKit initialized
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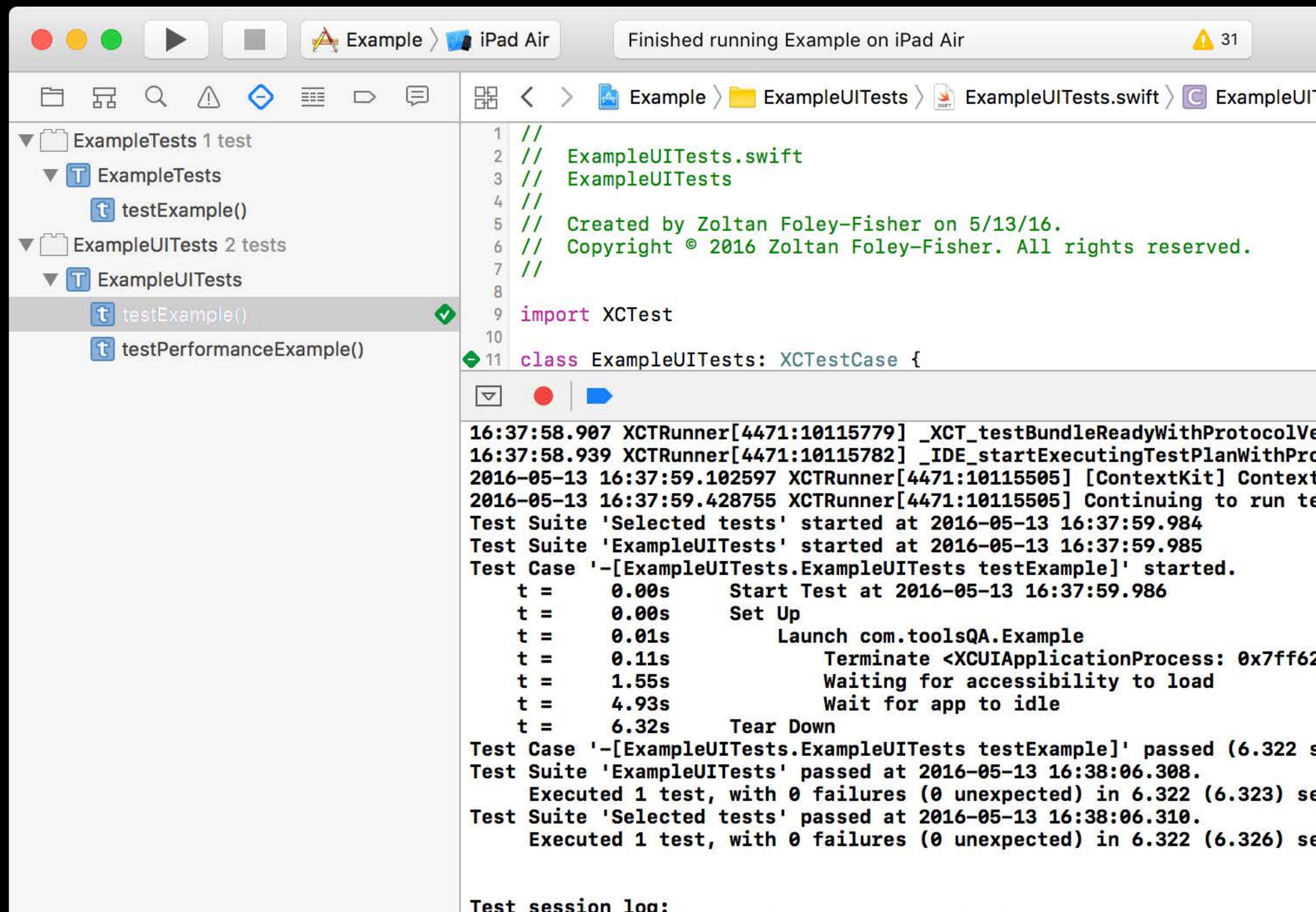
- Test Session Log:** Shows the test session log at the bottom of the log navigator.

# Xcode

## Test harness

Author tests

Execute tests



The screenshot shows the Xcode interface with the following details:

- Project Navigator:** Shows two test targets:
  - ExampleTests** (1 test): Contains a test case **testExample()**.
  - ExampleUITests** (2 tests): Contains test cases **testExample()** and **testPerformanceExample()**.
- Editor:** Displays the **ExampleUITests.swift** file content:

```
1 // ExampleUITests.swift
2 // ExampleUITests
3 // Created by Zoltan Foley-Fisher on 5/13/16.
4 // Copyright © 2016 Zoltan Foley-Fisher. All rights reserved.
5
6 import XCTest
7
8
9 class ExampleUITests: XCTestCase {
```
- Log Navigator:** Shows the test execution log:

```
16:37:58.907 XCTRunner[4471:10115779] _XCT_testBundleReadyWithProtocolVersion
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    t = 0.01s      Launch com.toolsQA.Example
    t = 0.11s      Terminate <XCUIApplicationProcess: 0x7ff62...
    t = 1.55s      Waiting for accessibility to load
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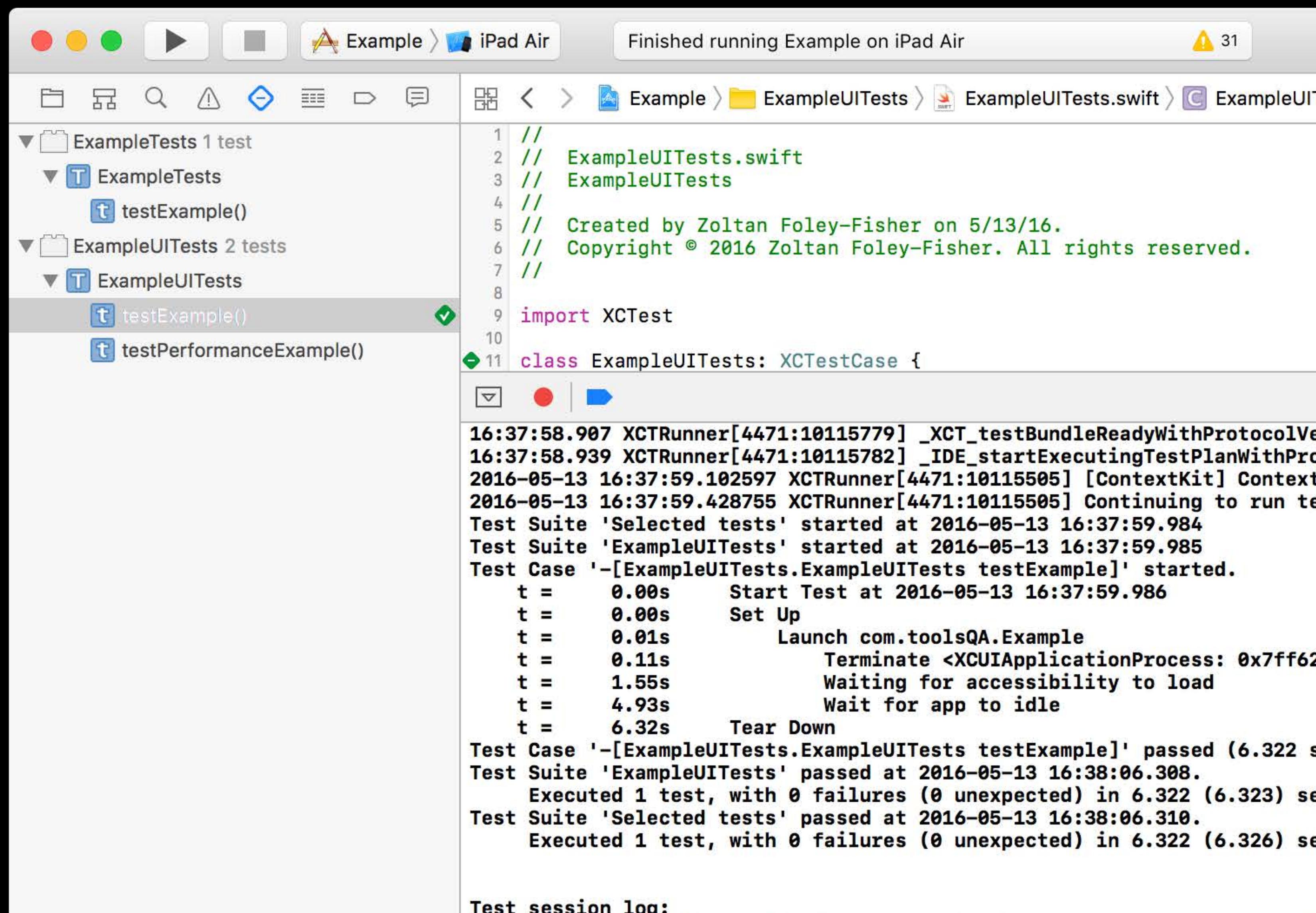
# Xcode

## Test harness

Author tests

Execute tests

Review reports



The screenshot shows the Xcode interface with the following details:

- Project Navigator:** Shows two test targets:
  - ExampleTests** (1 test): Contains a test case **testExample()**.
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- Editor:** Displays the **ExampleUITests.swift** file content:

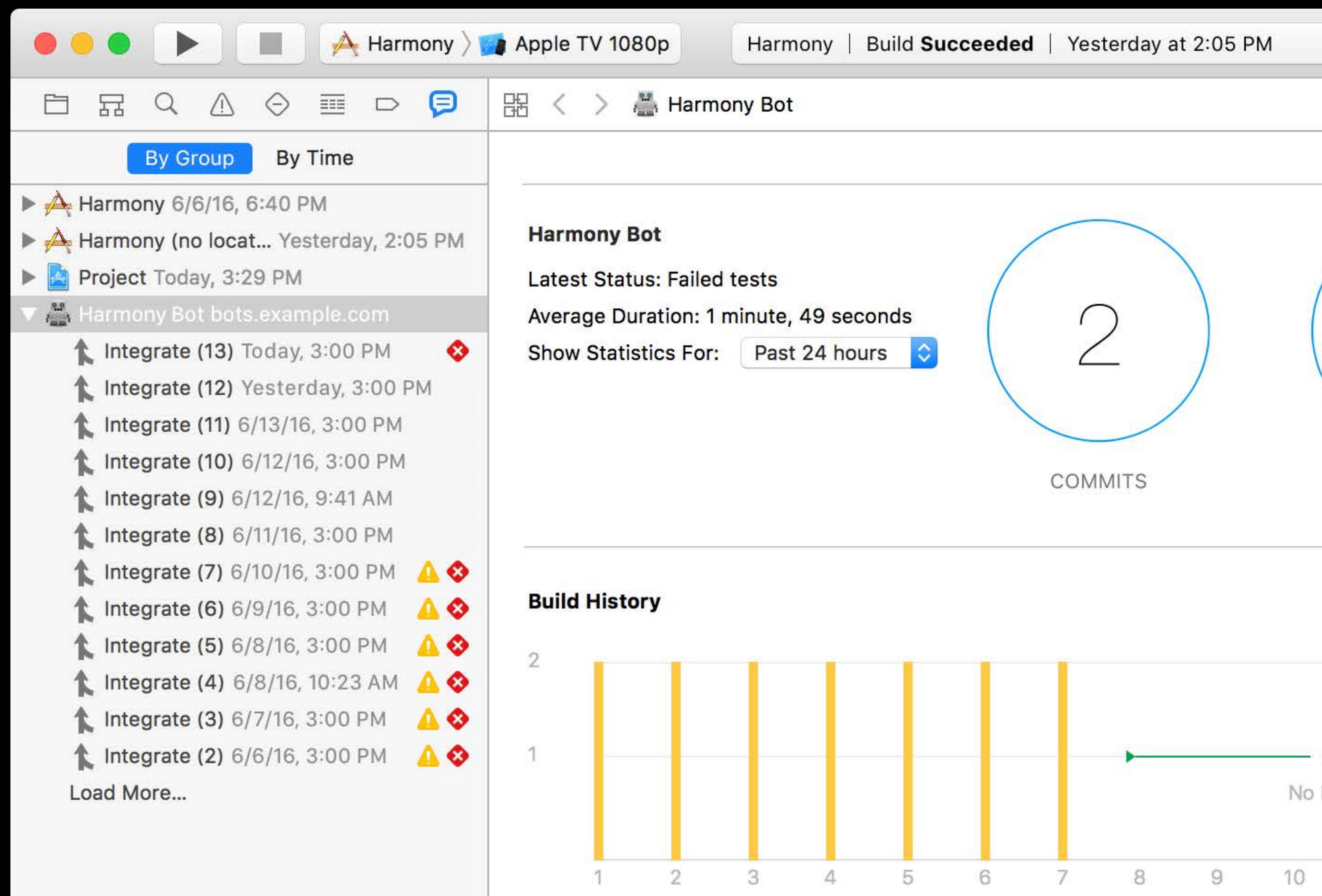
```
1 // ExampleUITests.swift
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8
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- Log Navigator:** Shows the test execution log:

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```



# Xcode Server

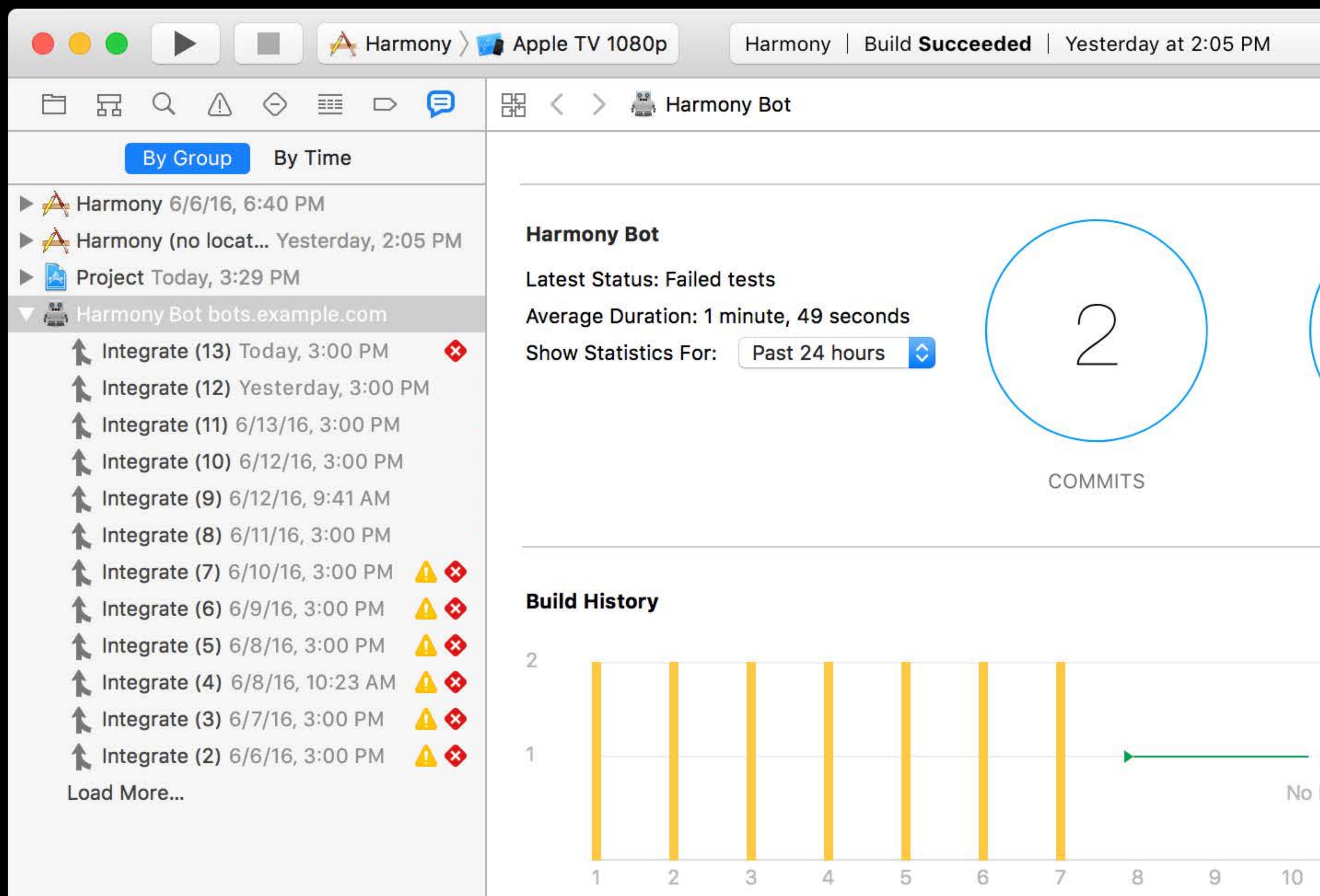
## Continuous Integration



# Xcode Server

## Continuous Integration

Schedules bot runs

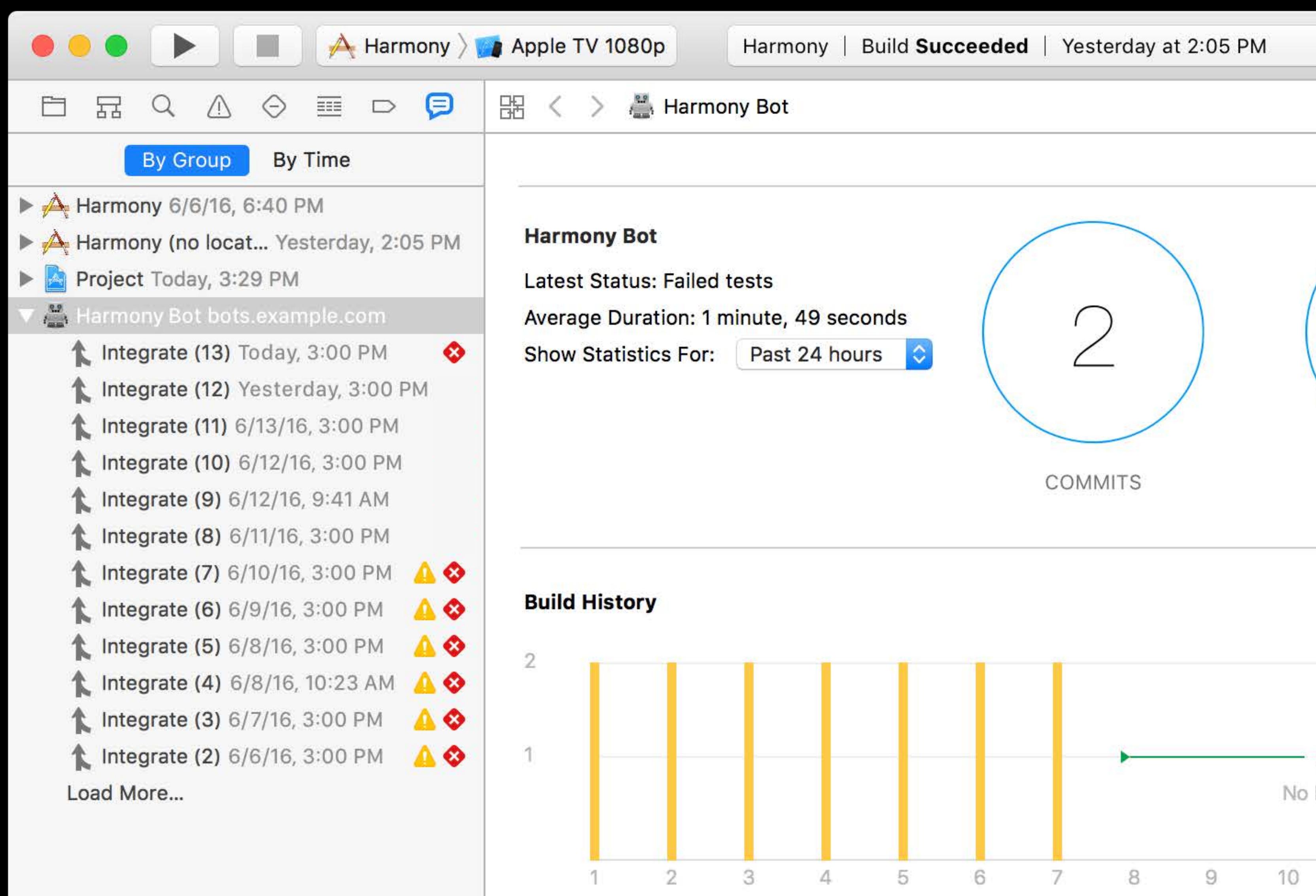


# Xcode Server

## Continuous Integration

Schedules bot runs

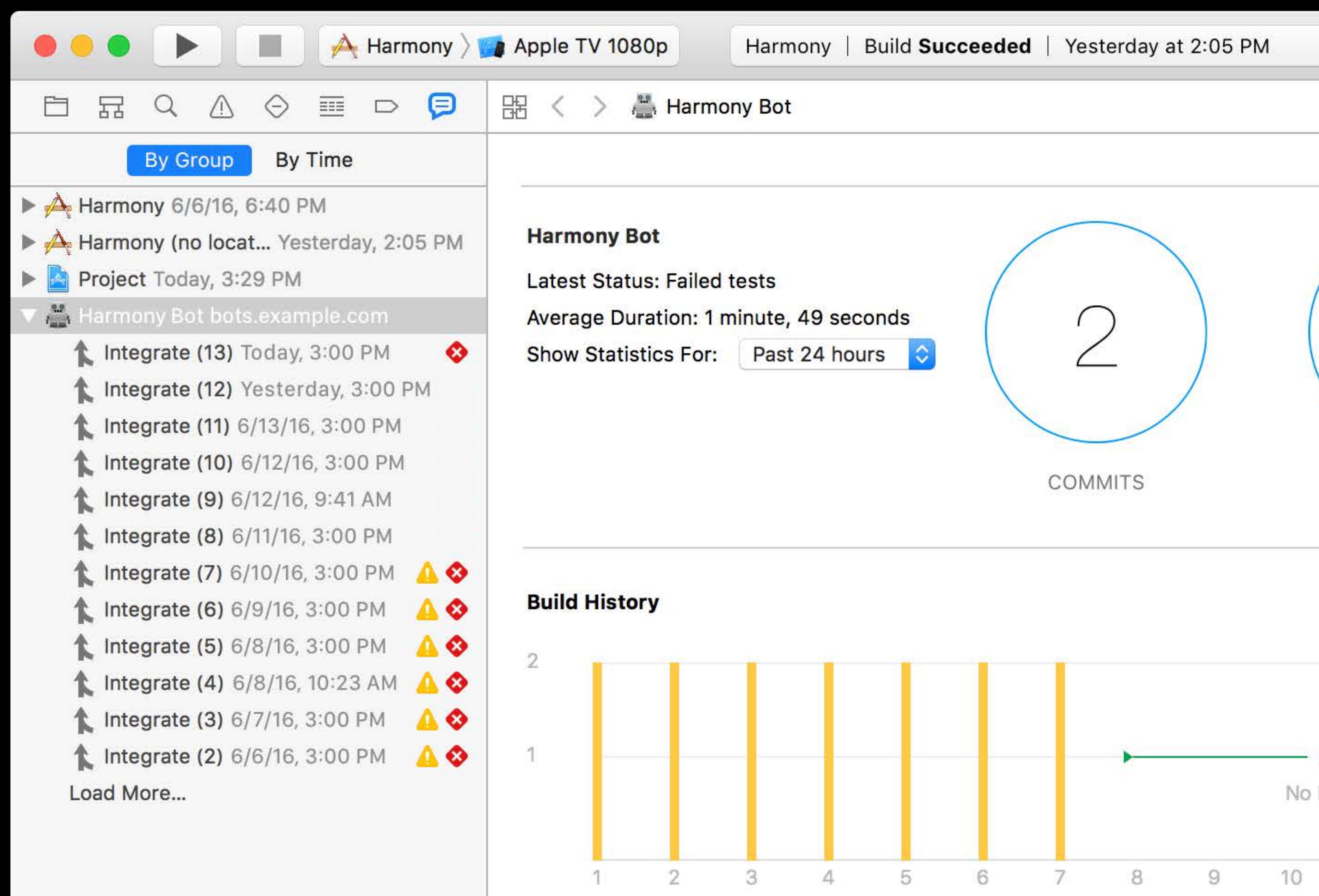
Generates reports



# Xcode Server

## Continuous Integration

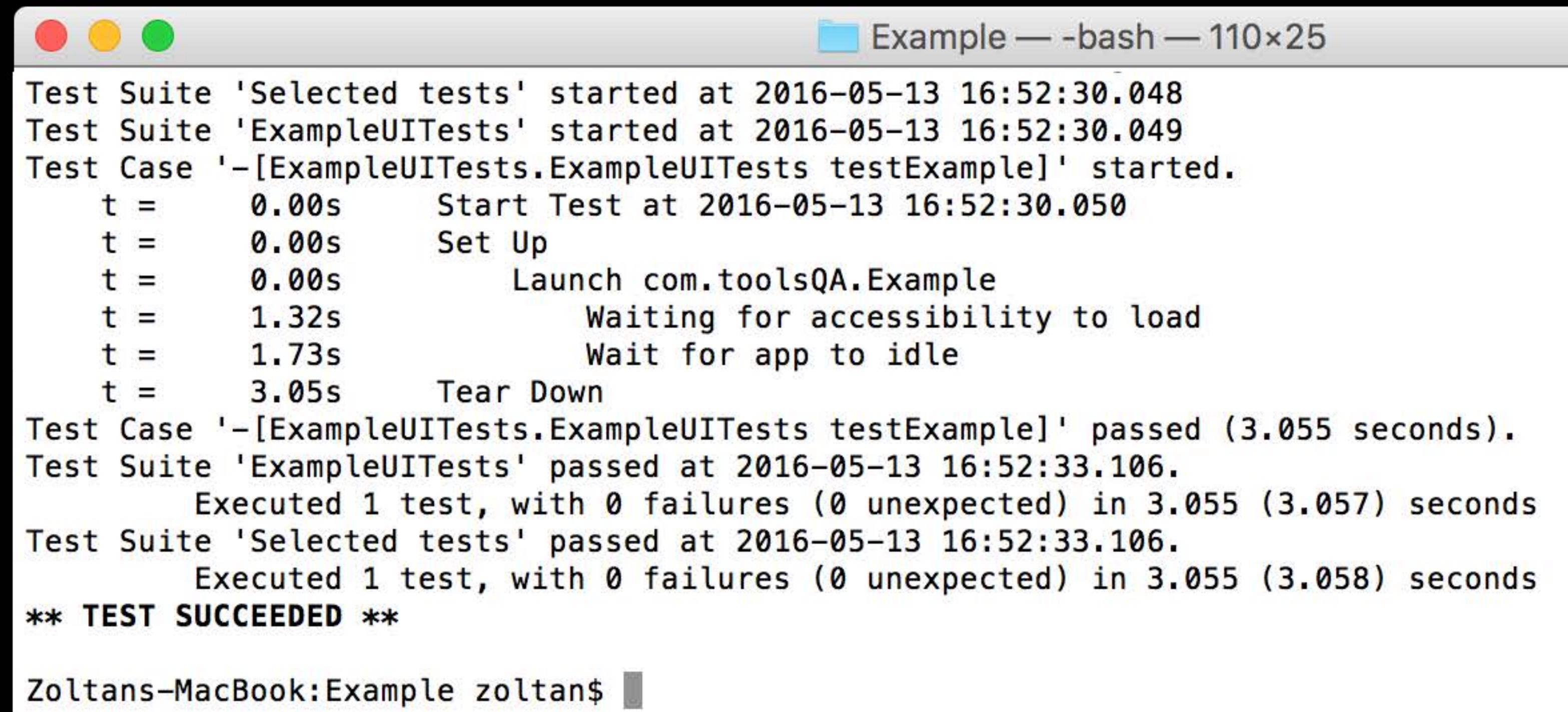
Schedules bot runs  
Generates reports  
Sends notifications





# xcodebuild

## Command line tool



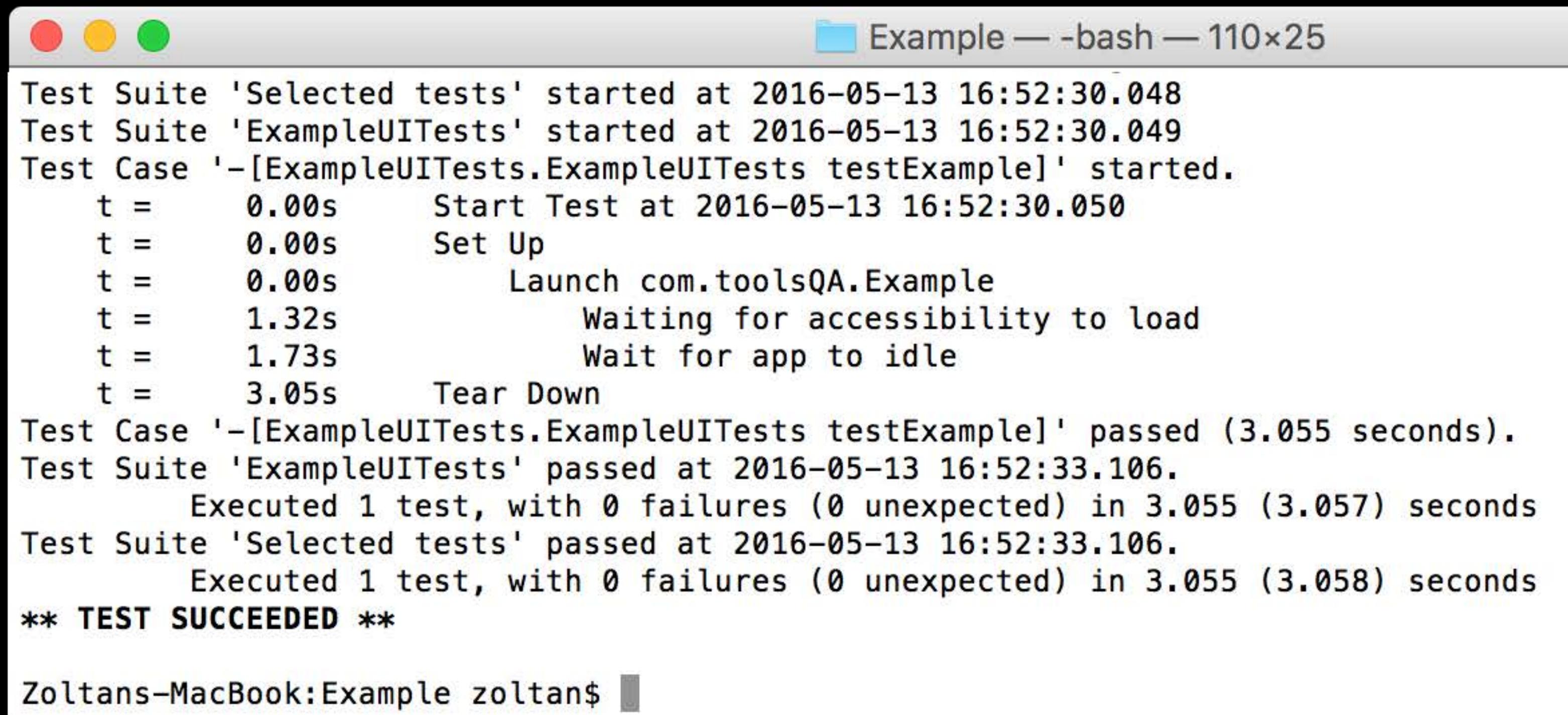
```
Test Suite 'Selected tests' started at 2016-05-13 16:52:30.048
Test Suite 'ExampleUITests' started at 2016-05-13 16:52:30.049
Test Case '-[ExampleUITests.ExampleUITests testExample]' started.
  t = 0.00s      Start Test at 2016-05-13 16:52:30.050
  t = 0.00s      Set Up
  t = 0.00s      Launch com.toolsQA.Example
  t = 1.32s      Waiting for accessibility to load
  t = 1.73s      Wait for app to idle
  t = 3.05s      Tear Down
Test Case '-[ExampleUITests.ExampleUITests testExample]' passed (3.055 seconds).
Test Suite 'ExampleUITests' passed at 2016-05-13 16:52:33.106.
  Executed 1 test, with 0 failures (0 unexpected) in 3.055 (3.057) seconds
Test Suite 'Selected tests' passed at 2016-05-13 16:52:33.106.
  Executed 1 test, with 0 failures (0 unexpected) in 3.055 (3.058) seconds
** TEST SUCCEEDED **

Zoltans-MacBook:Example zoltan$
```

# xcodebuild

## Command line tool

Used by Xcode Server



```
Test Suite 'Selected tests' started at 2016-05-13 16:52:30.048
Test Suite 'ExampleUITests' started at 2016-05-13 16:52:30.049
Test Case '-[ExampleUITests.ExampleUITests testExample]' started.
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  Executed 1 test, with 0 failures (0 unexpected) in 3.055 (3.058) seconds
** TEST SUCCEEDED **

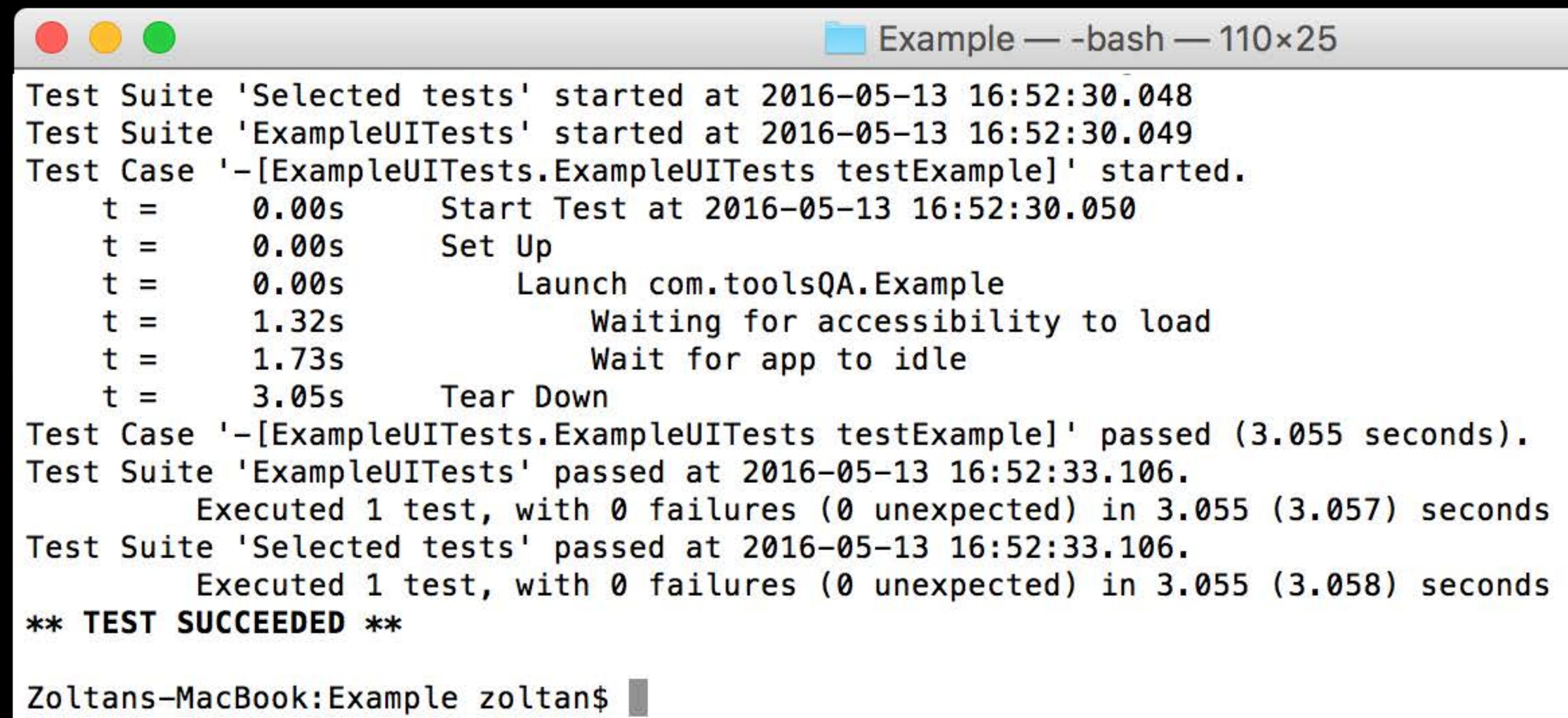
Zoltans-MacBook:Example zoltan$
```

# xcodebuild

## Command line tool

Used by Xcode Server

Build and execute tests



A terminal window titled "Example — bash — 110×25" showing the output of an xcodebuild test command. The output details the execution of a test suite, including the start time, test cases, and duration. It concludes with a success message and the user's name.

```
Test Suite 'Selected tests' started at 2016-05-13 16:52:30.048
Test Suite 'ExampleUITests' started at 2016-05-13 16:52:30.049
Test Case '-[ExampleUITests.ExampleUITests testExample]' started.
  t = 0.00s      Start Test at 2016-05-13 16:52:30.050
  t = 0.00s      Set Up
  t = 0.00s      Launch com.toolsQA.Example
  t = 1.32s      Waiting for accessibility to load
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Test Case '-[ExampleUITests.ExampleUITests testExample]' passed (3.055 seconds).
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Test Suite 'Selected tests' passed at 2016-05-13 16:52:33.106.
  Executed 1 test, with 0 failures (0 unexpected) in 3.055 (3.058) seconds
** TEST SUCCEEDED **

Zoltans-MacBook:Example zoltan$
```

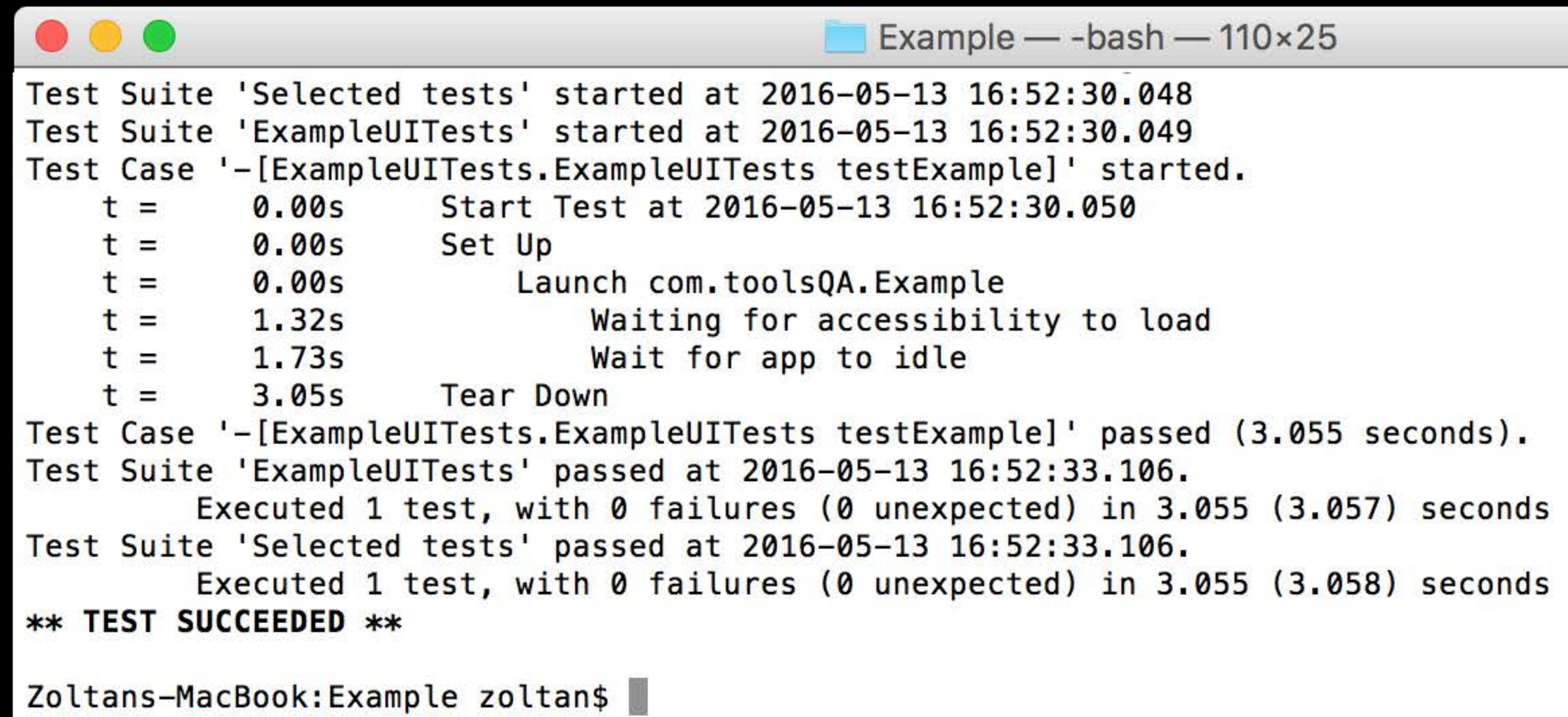
# xcodebuild

## Command line tool

Used by Xcode Server

Build and execute tests

For custom CI systems



The terminal window title is "Example — bash — 110×25". The output shows the execution of a test suite:

```
Test Suite 'Selected tests' started at 2016-05-13 16:52:30.048
Test Suite 'ExampleUITests' started at 2016-05-13 16:52:30.049
Test Case '-[ExampleUITests.ExampleUITests testExample]' started.
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  t = 0.00s      Launch com.toolsQA.Example
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Test Case '-[ExampleUITests.ExampleUITests testExample]' passed (3.055 seconds).
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Test Suite 'Selected tests' passed at 2016-05-13 16:52:33.106.
  Executed 1 test, with 0 failures (0 unexpected) in 3.055 (3.058) seconds
** TEST SUCCEEDED **

Zoltans-MacBook:Example zoltan$
```

# Previous Years' Sessions

---

Testing with Xcode 6

---

WWDC 2014

Continuous Integration with Xcode 6

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WWDC 2014

UI Testing in Xcode

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WWDC 2015

CI and Code Coverage in Xcode

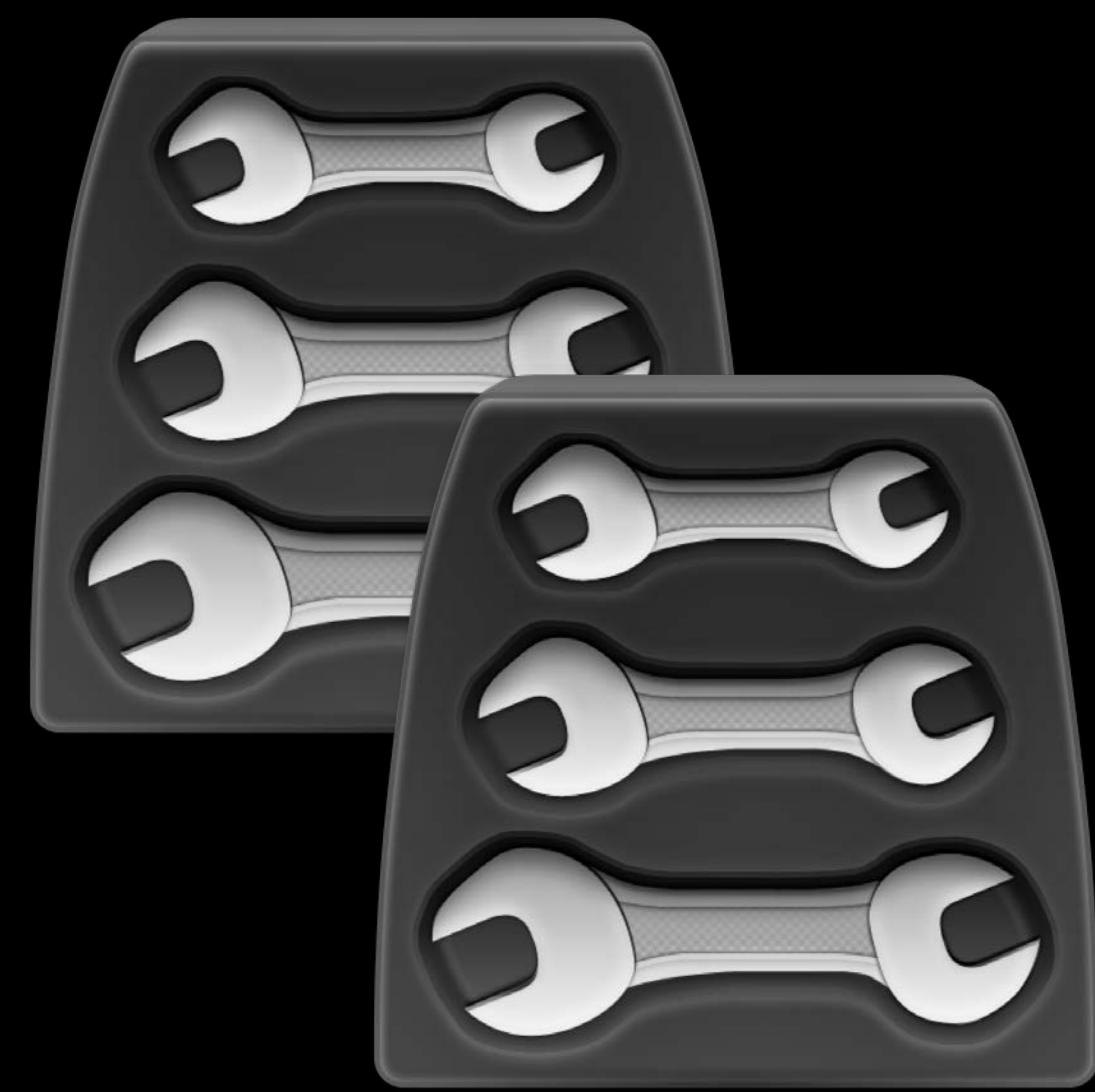
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WWDC 2015

# Testing Concepts

# How Testing Works

Behind the scenes



MyTests.xctest



MyApp.app

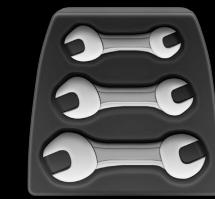
# Testing Timeline

## Fundamental concepts

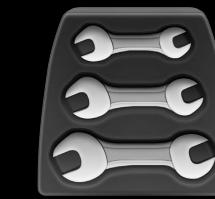


# Test Hosting

## How testing starts



Unit Tests

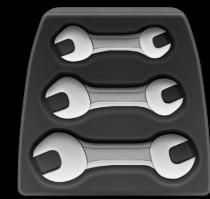


UI Tests

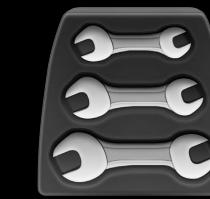
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# Test Hosting

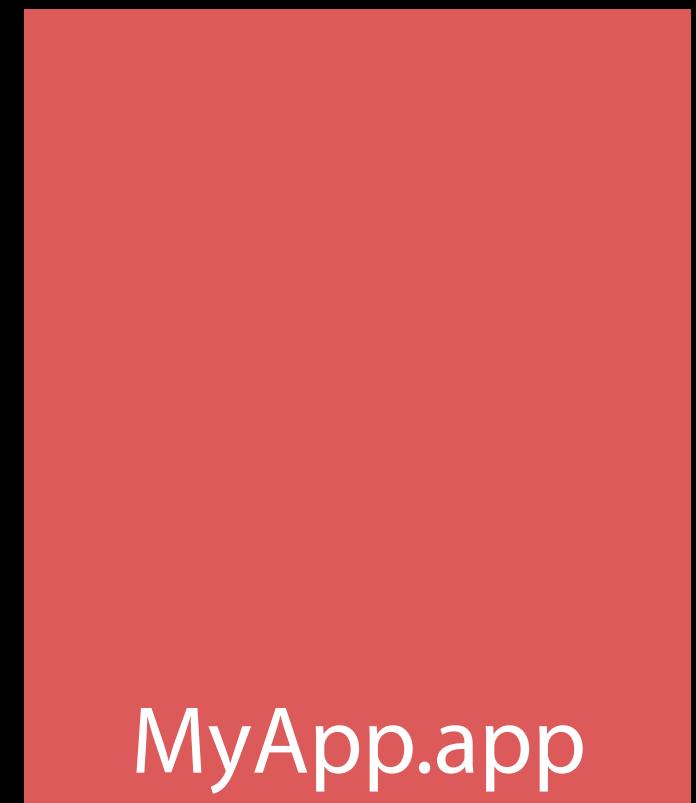
## How testing starts



Unit Tests



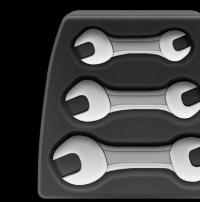
UI Tests



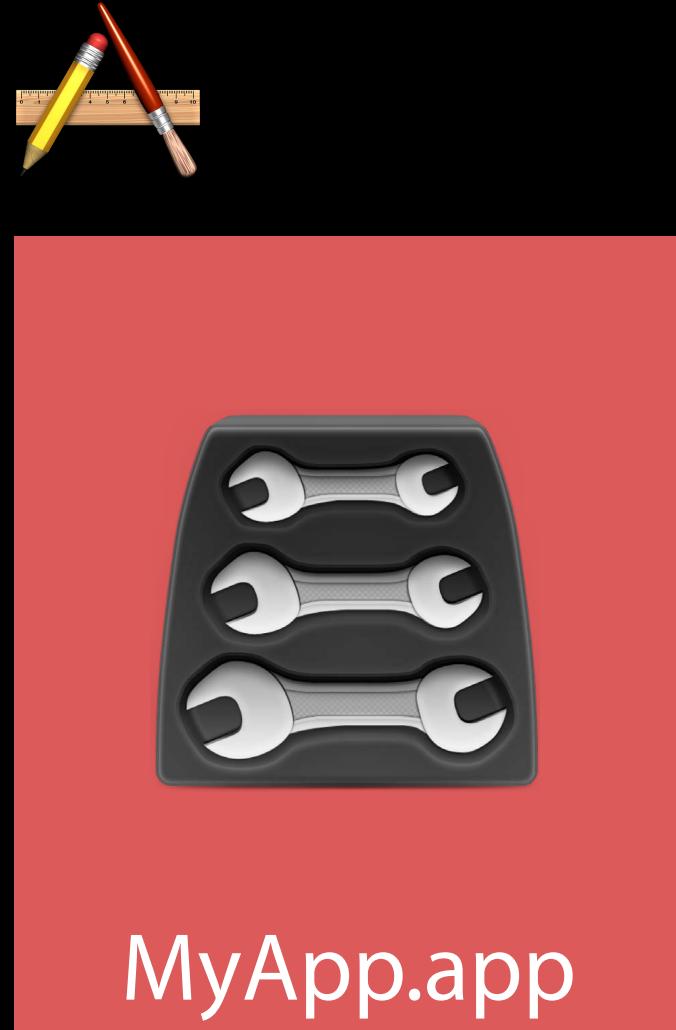
# Test Hosting

## How testing starts

Unit Tests



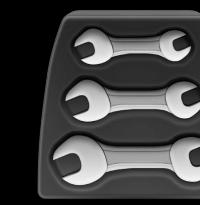
UI Tests



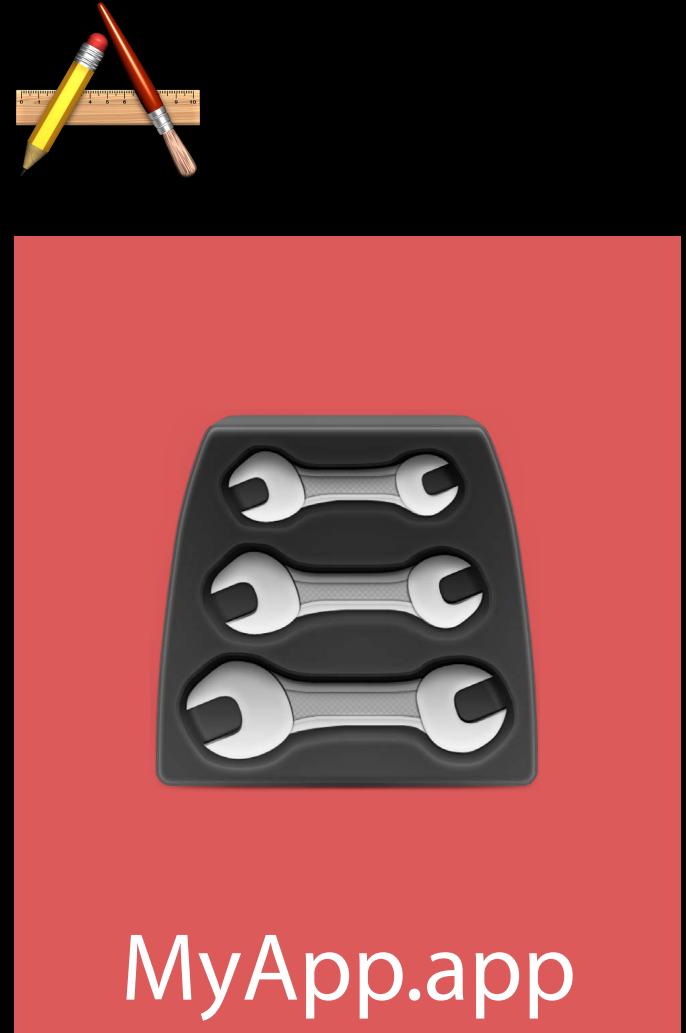
# Test Hosting

## How testing starts

Unit Tests



UI Tests

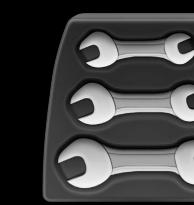


Host Application

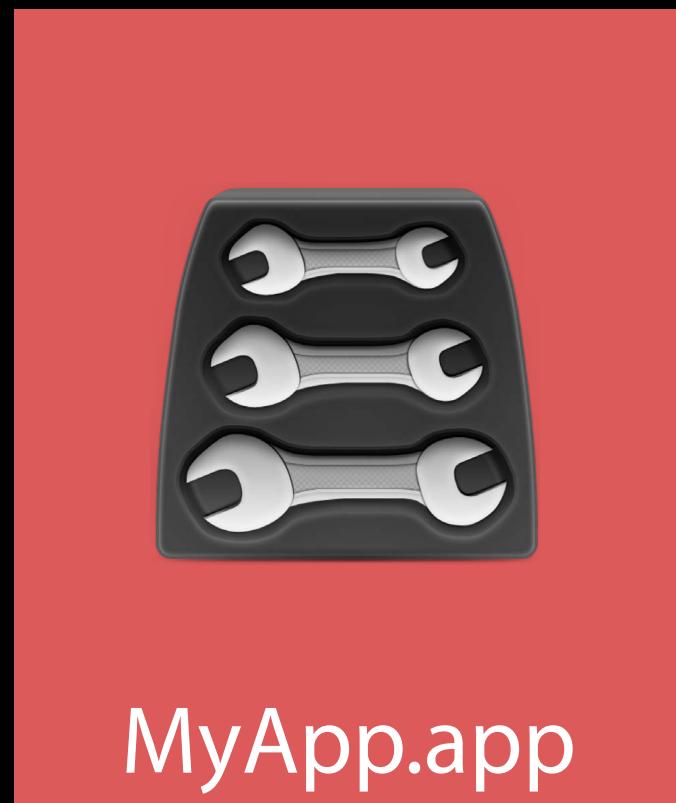
# Test Hosting

## How testing starts

Unit Tests



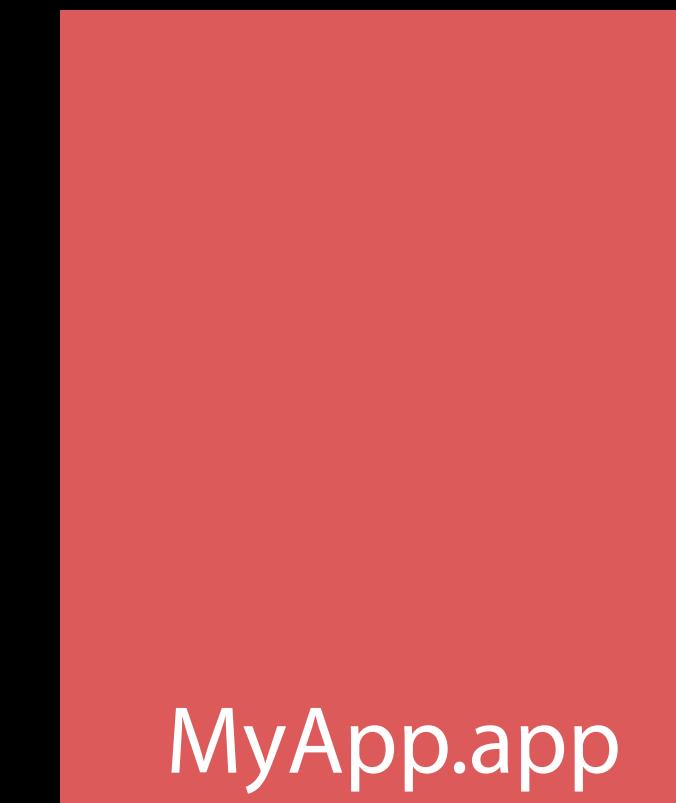
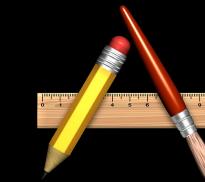
UI Tests



MyApp.app



UI Test Runner



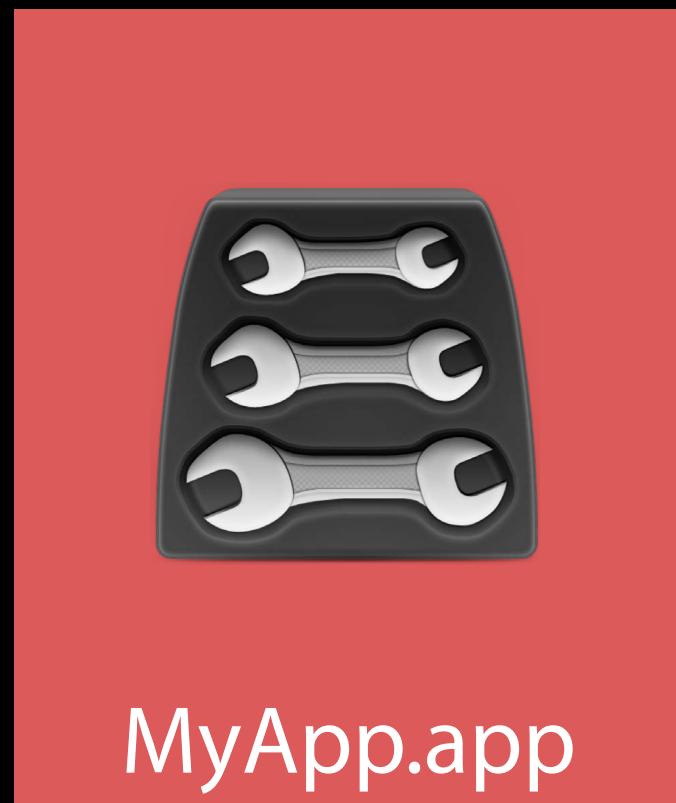
MyApp.app

Host Application

# Test Hosting

## How testing starts

Unit Tests



Host Application

UI Tests



UI Test Runner

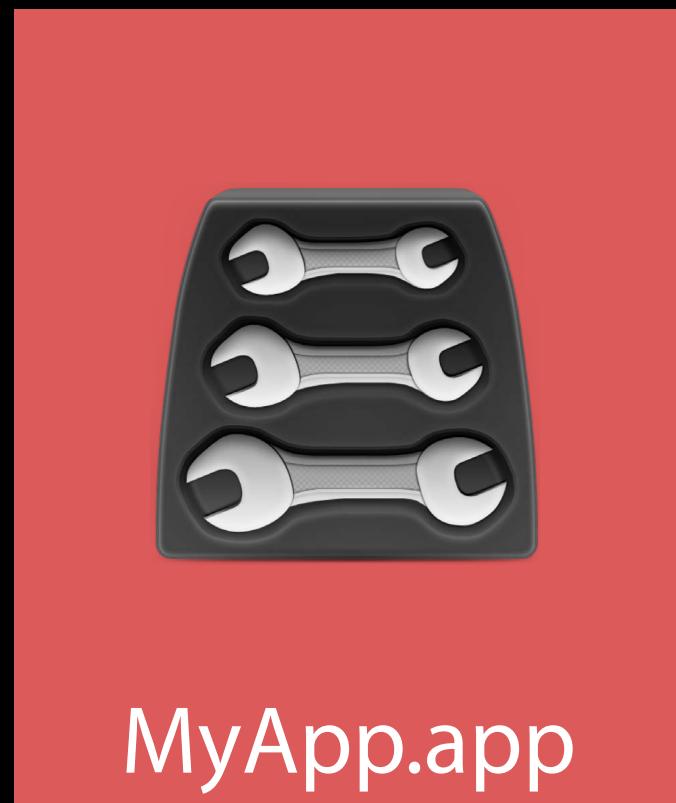


MyApp.app

# Test Hosting

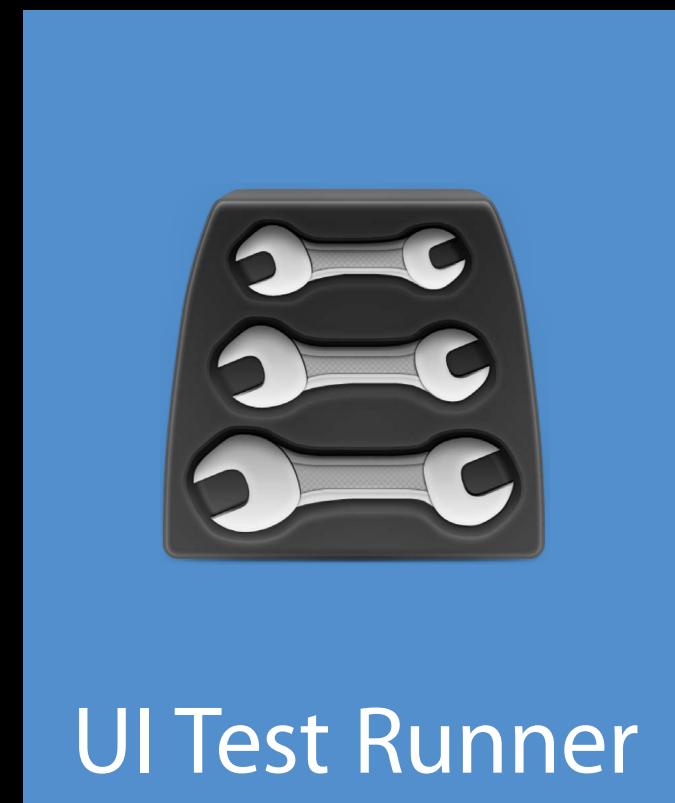
## How testing starts

Unit Tests

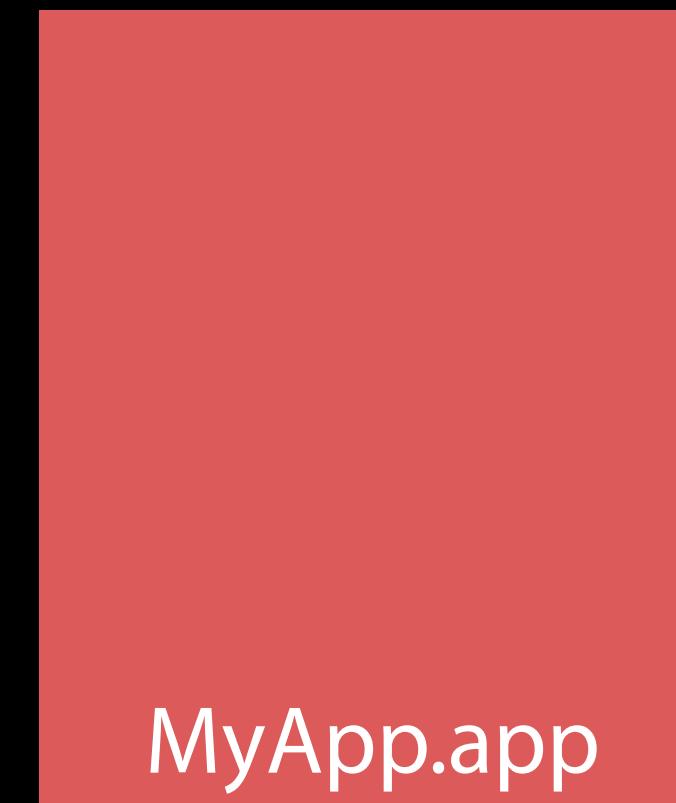
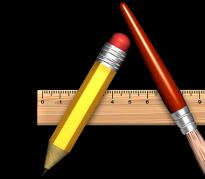


Host Application

UI Tests



UI Test Runner



MyApp.app

Target Application

# Test Hosting Comparison

## Unit Tests

Direct access to host app data and APIs

## UI Tests

Uses Accessibility to access target app

# Test Hosting Comparison

## Unit Tests

Direct access to host app data and APIs

All tests run in single app launch

## UI Tests

Uses Accessibility to access target app

Tests launch app for every test case

# Testing Timeline

## Fundamental concepts



# Testing Timeline

## Fundamental concepts



# Test Observation

## Test case structure

# Test Observation

## Test case structure

Test Case 1      Test Case 2



# Test Observation

## Test case structure

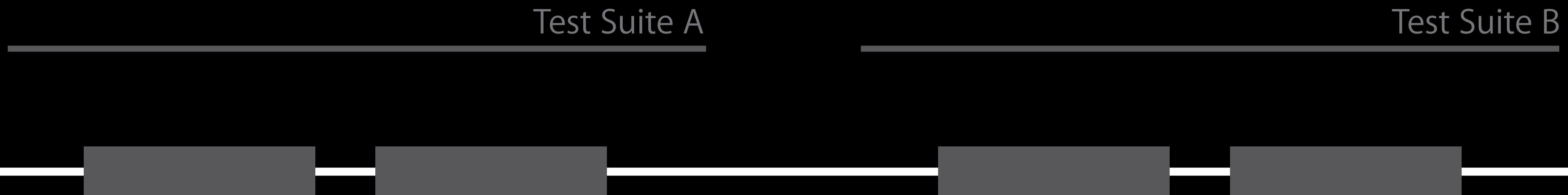
Test Suite A

---



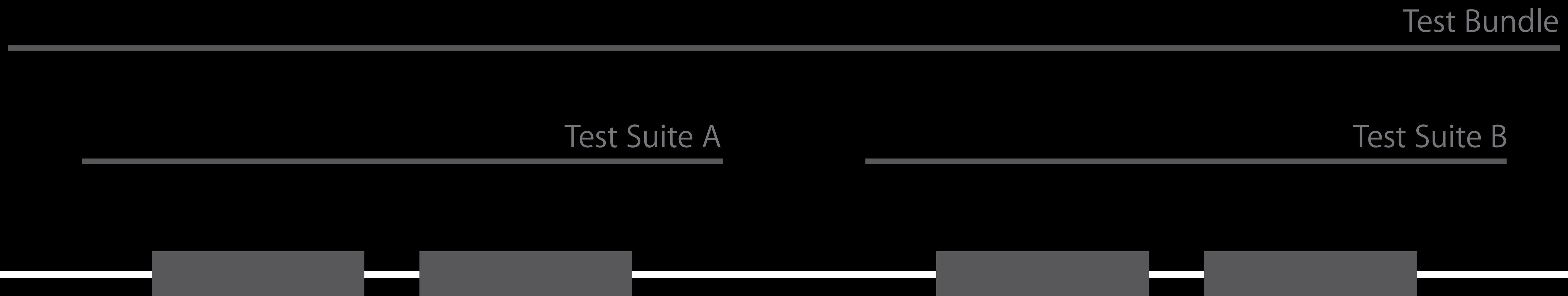
# Test Observation

## Test case structure



# Test Observation

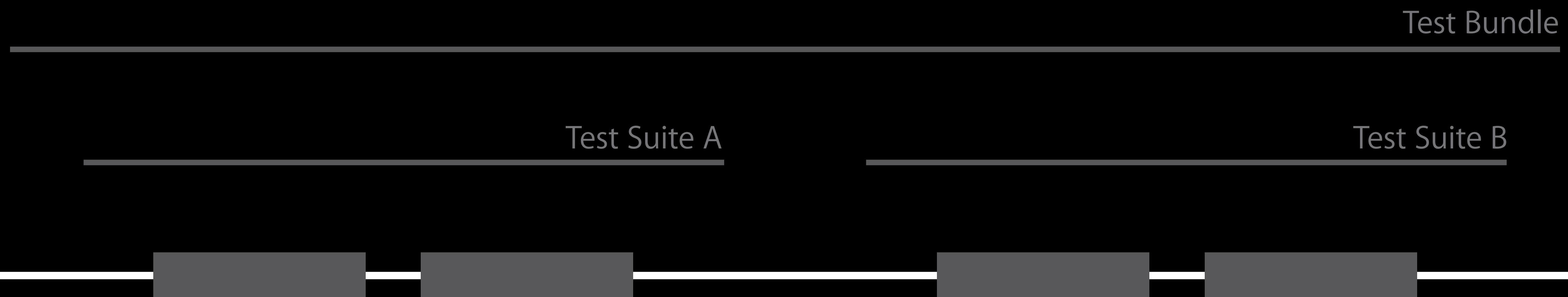
## Test case structure



# Test Observation

## Test case structure

Setup or tear down work

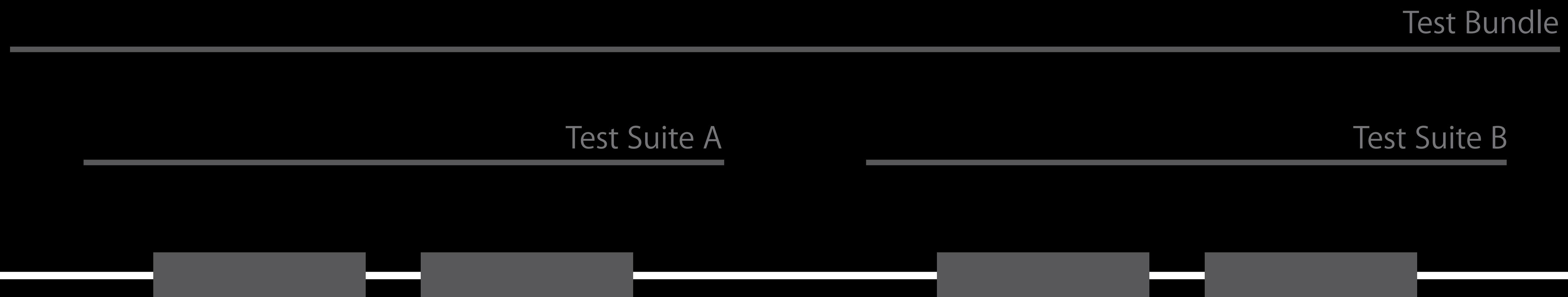


# Test Observation

## Test case structure

Setup or tear down work

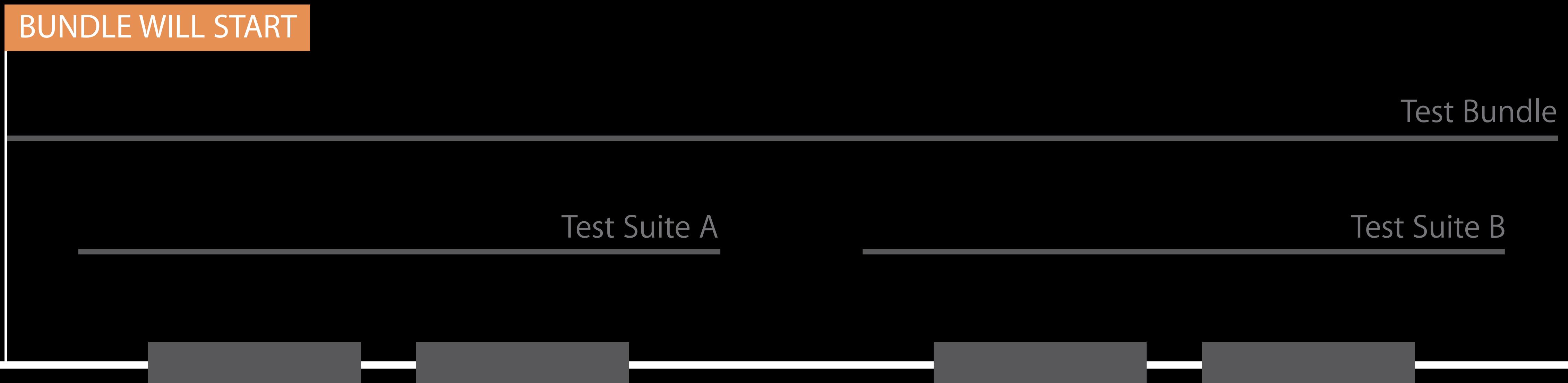
Custom logging



# Test Observation

## XCTestObservation Protocol

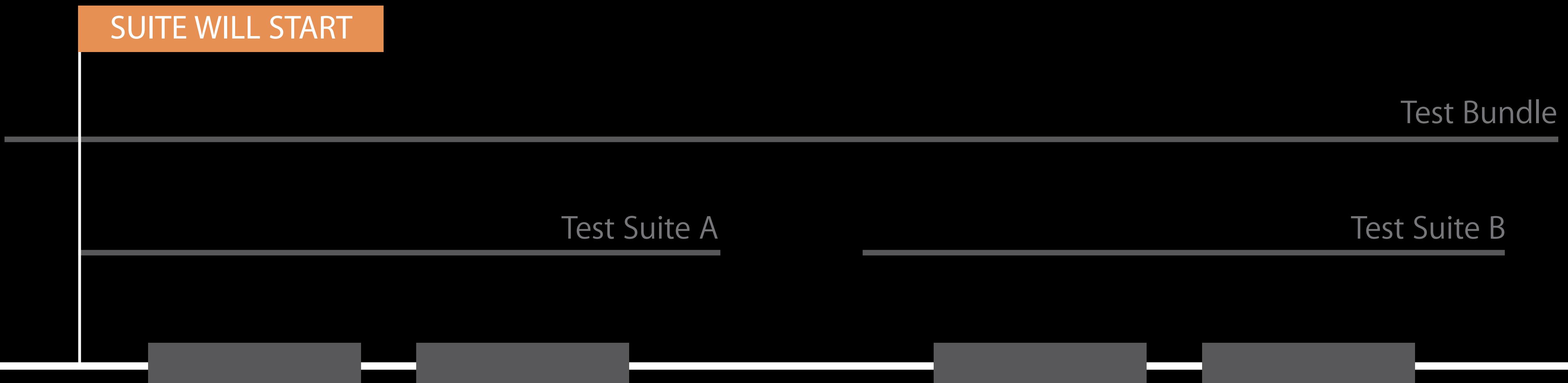
```
optional public func testBundleWillStart(_ testBundle: AnyObject!)
```



# Test Observation

## XCTestObservation Protocol

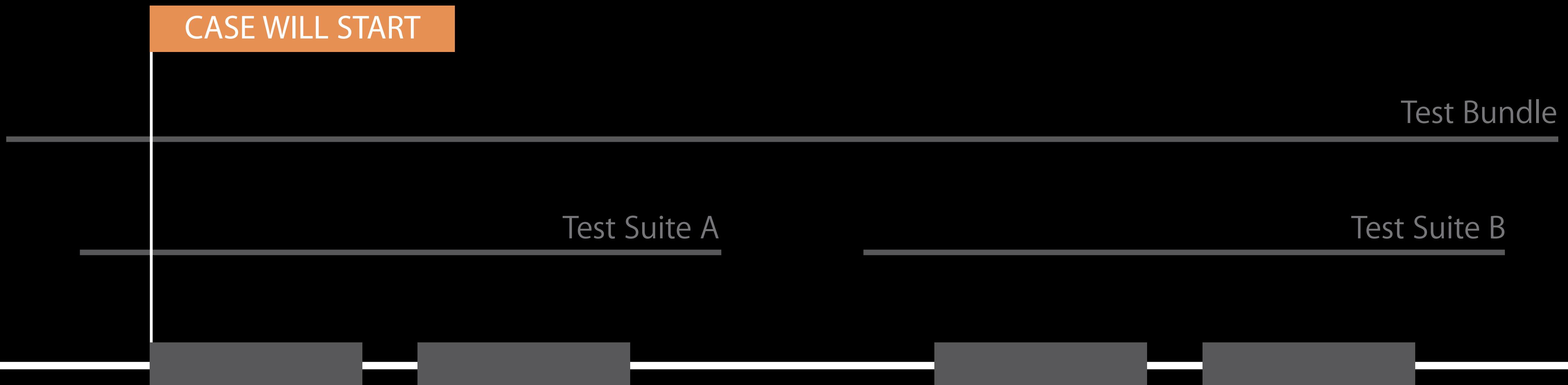
```
optional public func testSuiteWillStart(_ testSuite: AnyObject!)
```



# Test Observation

## XCTestObservation Protocol

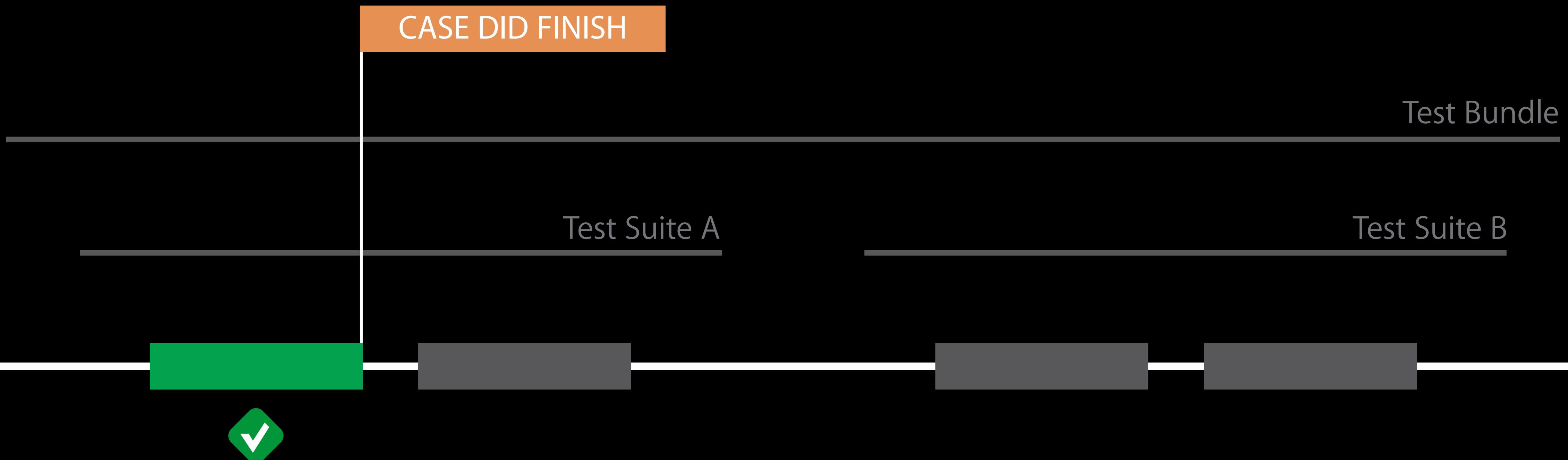
```
optional public func testCaseWillStart(_ testCase: AnyObject!)
```



# Test Observation

## XCTestObservation Protocol

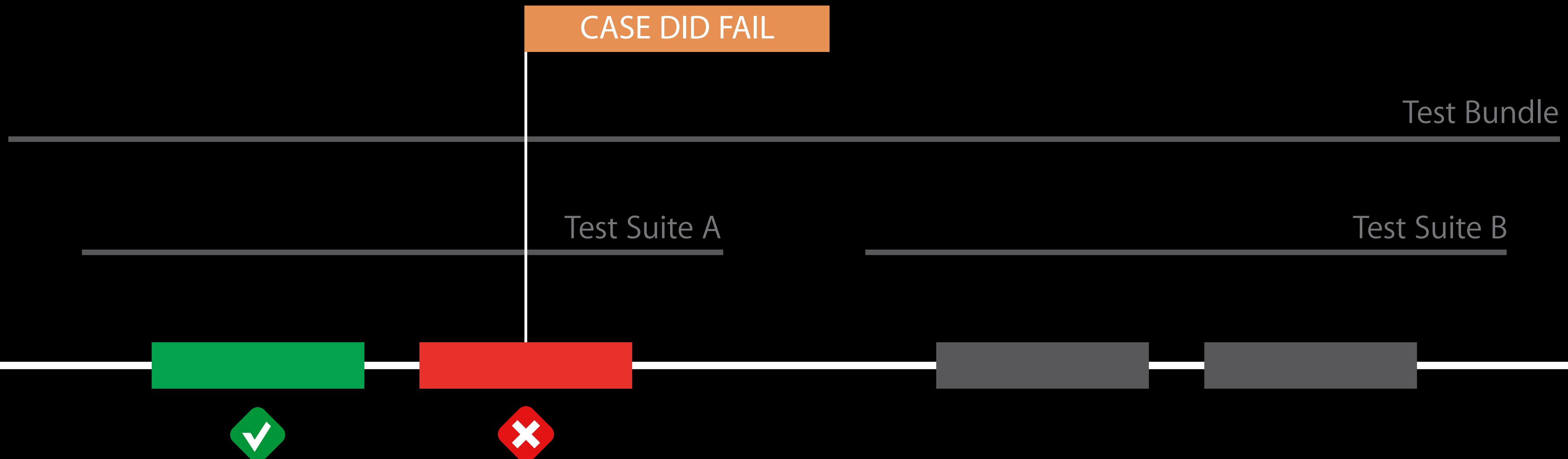
```
optional public func testCaseDidFinish(_ testCase: AnyObject!)
```



# Test Observation

## XCTestObservation Protocol

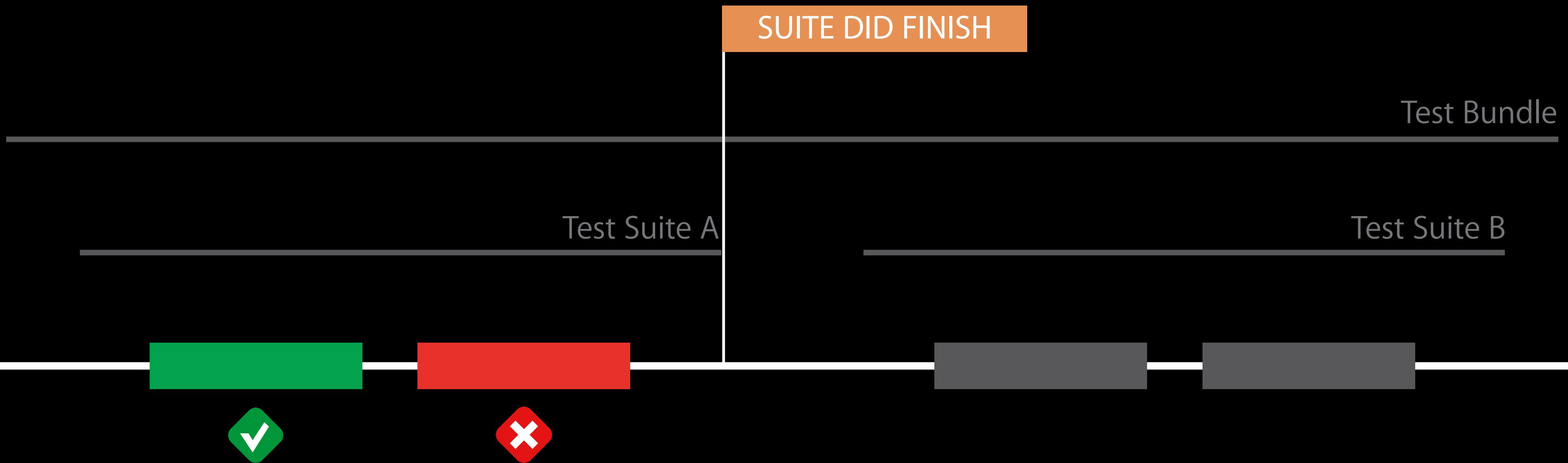
```
optional public func testCase(_ testCase: AnyObject!, didFailWithDescription  
description: AnyObject!, inFile filePath: AnyObject!, atLine lineNumber: AnyObject!)
```



# Test Observation

## XCTestObservation Protocol

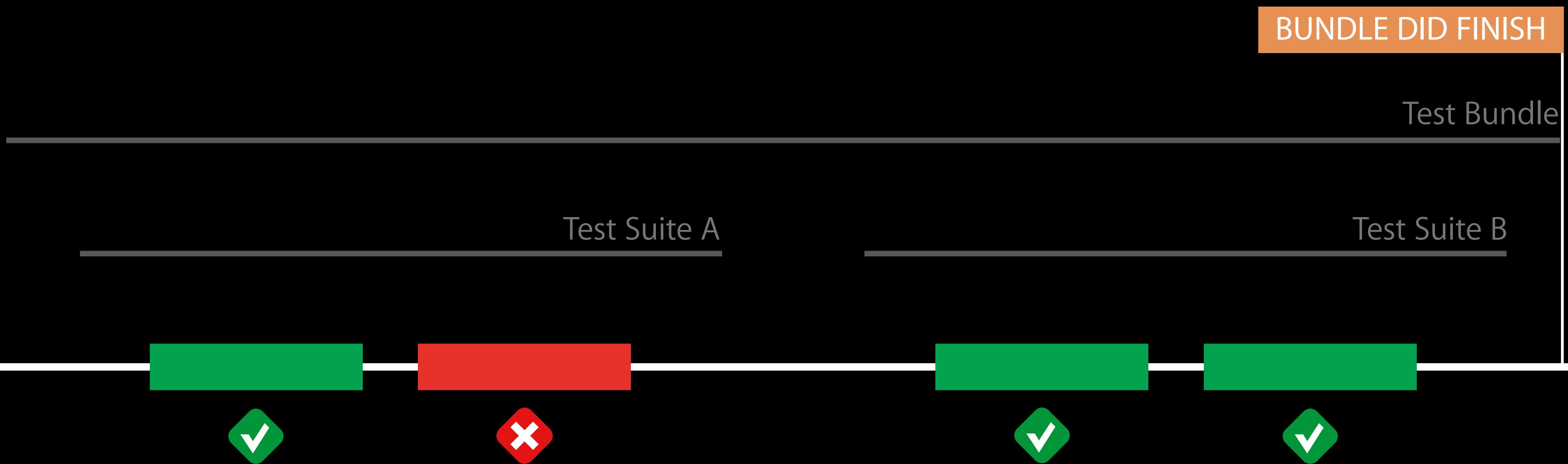
```
optional public func testSuiteDidFinish(_ testSuite: AnyObject!)
```



# Test Observation

## XCTestObservation Protocol

```
optional public func testBundleDidFinish(_ testBundle: AnyObject!)
```



```
// Test Observation
// Example LoggingObserver

class LoggingObserver: NSObject, XCTestObservation {

}

}
```

```
// Test Observation
// Example LoggingObserver

class LoggingObserver: NSObject, XCTestObservation {

    override init() {
        super.init()
        let sharedCenter = XCTestObservationCenter.shared()
        sharedCenter.addTestObserver(self)
    }

}
```

```
// Test Observation
// Example LoggingObserver

class LoggingObserver: NSObject, XCTestObservation {

    override init() {
        super.init()
        let sharedCenter = XCTestObservationCenter.shared()
        sharedCenter.addTestObserver(self)
    }

    internal func testBundleWillStart(_ testBundle: Bundle) {
        print("Lights down, show is about to start")
    }
}
```

```
// Test Observation
// Example LoggingObserver

class LoggingObserver: NSObject, XCTestObservation {

    override init() {
        super.init()
        let sharedCenter = XCTestObservationCenter.shared()
        sharedCenter.addTestObserver(self)
    }

    internal func testBundleWillStart(_ testBundle: Bundle) {
        print("Lights down, show is about to start")
    }

    internal func testCase(_ testCase: AnyObject!, didFailWithDescription
        description: AnyObject!, inFile filePath: AnyObject!, atLine lineNumber: AnyObject!)
        print("That sounds off key...")
    }

}
```

```
// Test Observation
// Example LoggingObserver

class LoggingObserver: NSObject, XCTestObservation {

    override init() {
        super.init()
        let sharedCenter = XCTestObservationCenter.shared()
        sharedCenter.addTestObserver(self)
    }

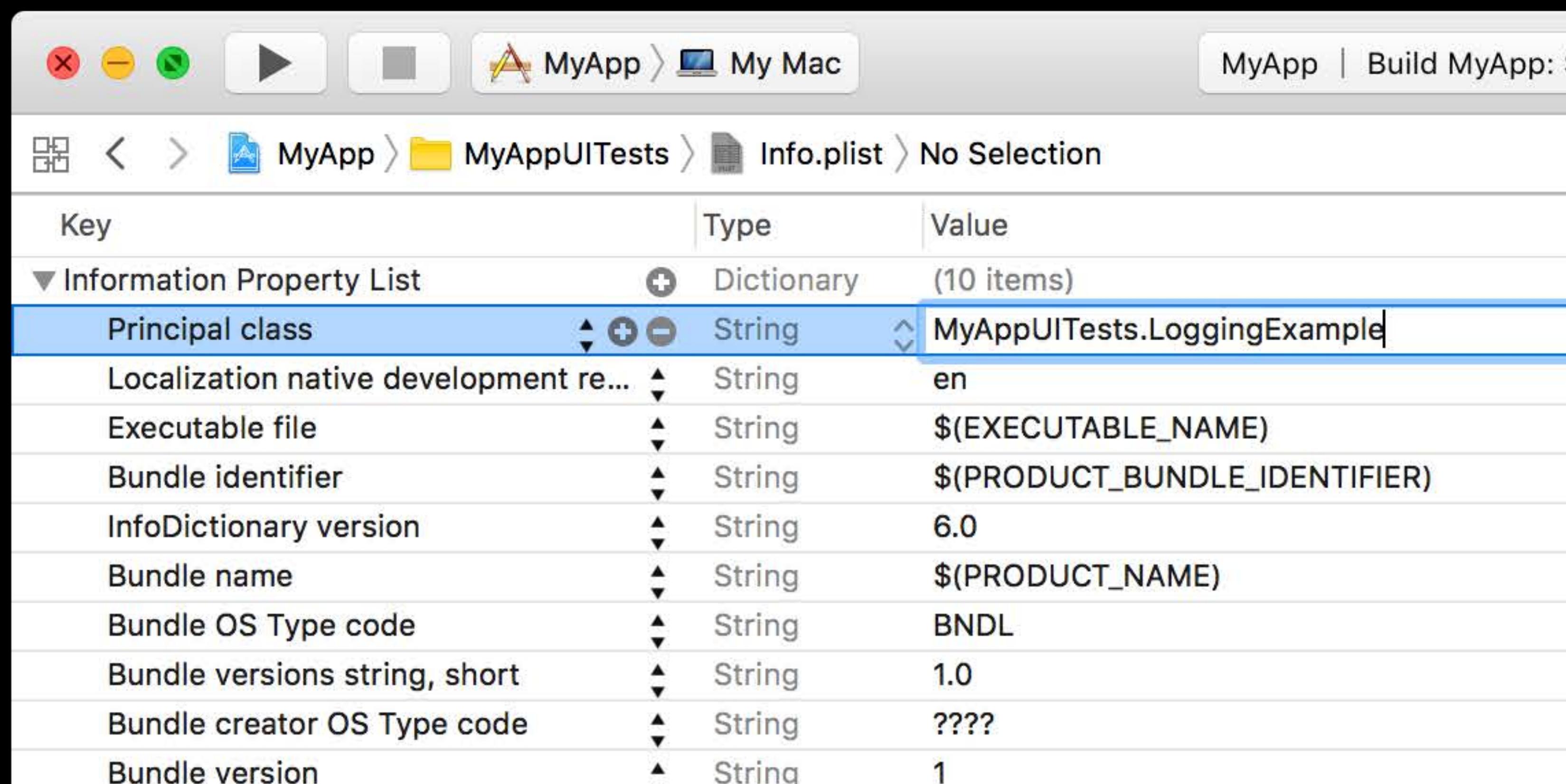
    internal func testBundleWillStart(_ testBundle: Bundle) {
        print("Lights down, show is about to start")
    }

    internal func testCase(_ testCase: AnyObject!, didFailWithDescription
        description: AnyObject!, inFile filePath: AnyObject!, atLine lineNumber: AnyObject!)
        print("That sounds off key...")
    }

    internal func testBundleDidFinish(_ testBundle: Bundle) {
        print("Lights up, don't forget your coat!")
    }
}
```

# Test Observation

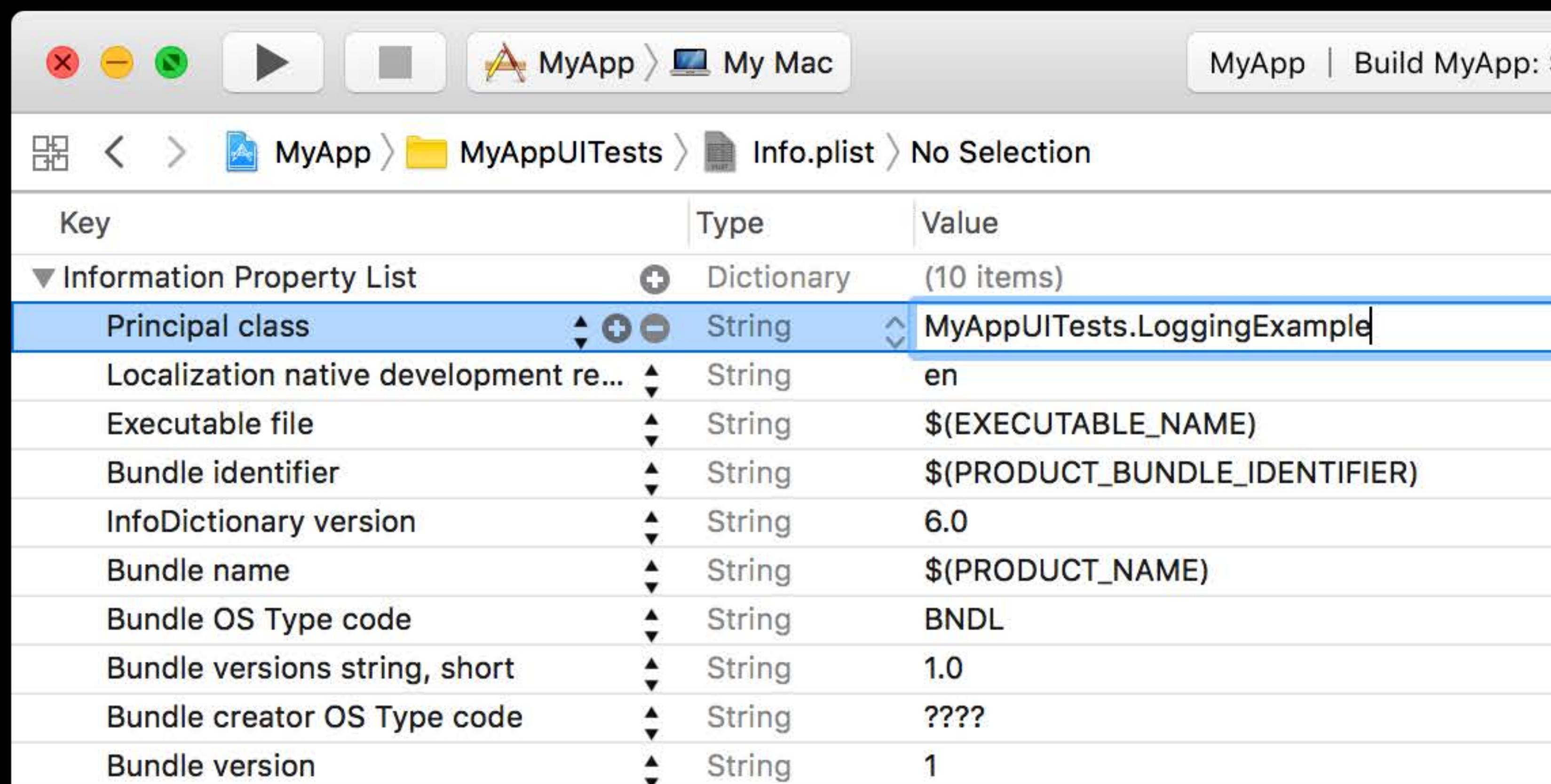
## Use NSPrincipalClass



# Test Observation

## Use NSPrincipalClass

Test Bundle Info.plist

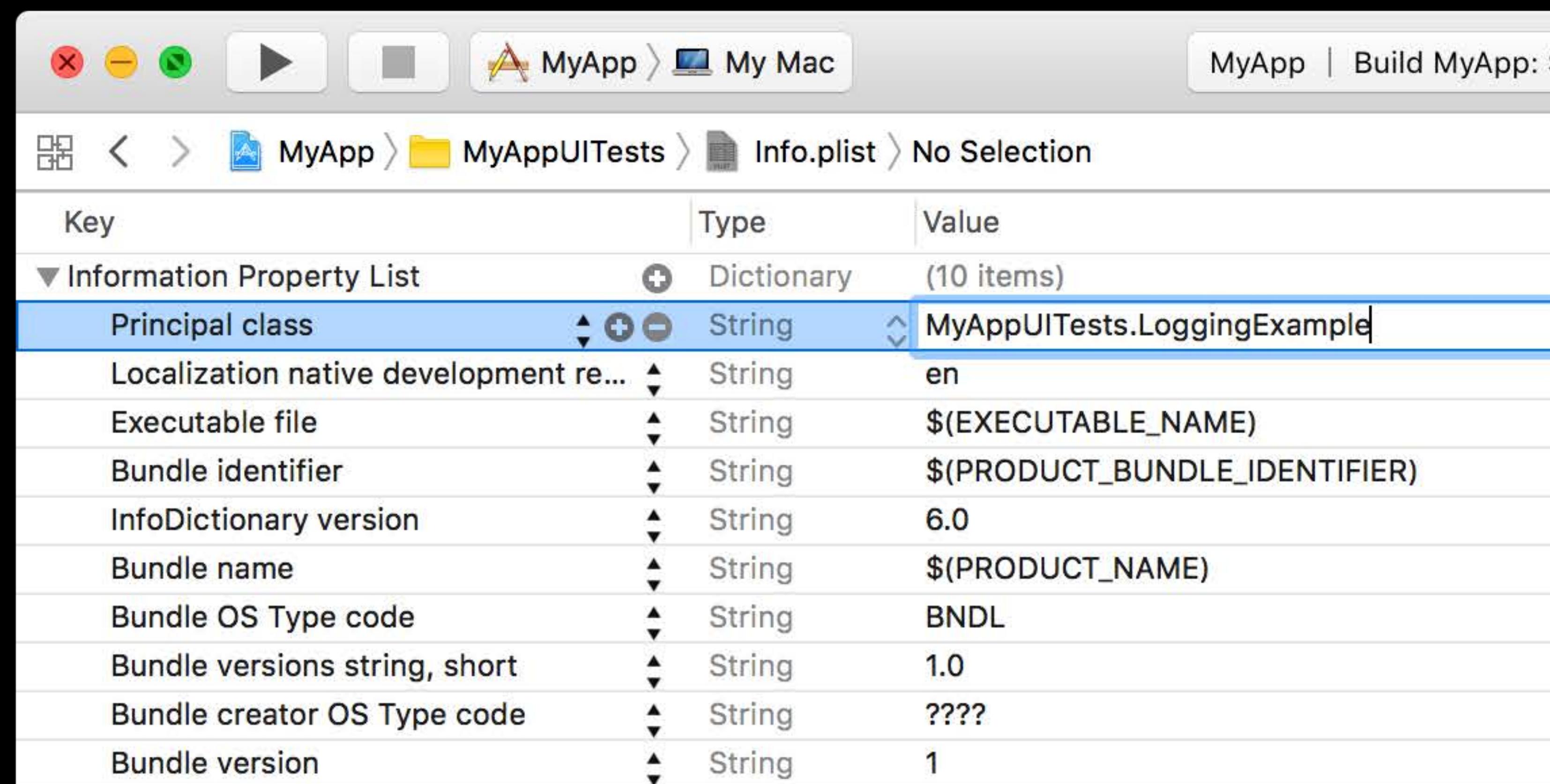


# Test Observation

## Use NSPrincipalClass

Test Bundle Info.plist

Test specific instantiation



The screenshot shows the Xcode interface with the Info.plist editor open. The title bar reads "MyApp" and "My Mac". The navigation bar shows the path: MyApp > MyAppUITests > Info.plist > No Selection. The main table lists various keys and their values, with the "Principal class" key highlighted. The "Principal class" key is of type String and has a value of "MyAppUITests.LoggingExample".

Key	Type	Value
Principal class	String	MyAppUITests.LoggingExample
Localization native development re...	String	en
Executable file	String	\$(EXECUTABLE_NAME)
Bundle identifier	String	\$(PRODUCT_BUNDLE_IDENTIFIER)
InfoDictionary version	String	6.0
Bundle name	String	\$(PRODUCT_NAME)
Bundle OS Type code	String	BNDL
Bundle versions string, short	String	1.0
Bundle creator OS Type code	String	????
Bundle version	String	1

# Testing Concepts

## Summary



# Crash Log Gathering

# Crash Log Gathering

Crashes during testing

# Crash Log Gathering

Crashes during testing



# Crash Log Gathering

Crashes during testing

Test host or target application may crash



# Crash Log Gathering

Crashes during testing

Test host or target application may crash

Xcode completes test suite



# Crash Log Gathering

Crashes during testing

Test host or target application may crash

Xcode completes test suite

But how to resolve the crash?



# Crash Log Gathering

Improved test reports

NEW



# Crash Log Gathering

Improved test reports

NEW



# Crash Log Gathering

Improved test reports

NEW

For Unit and UI tests



# Crash Log Gathering

Improved test reports

NEW

For Unit and UI tests

Local and Xcode Server crash logs



# Crash Log Gathering

Improved test reports

NEW

For Unit and UI tests

Local and Xcode Server crash logs

Logs included in test report



# Crash Log Gathering

## Improved test reports

NEW

For Unit and UI tests

Local and Xcode Server crash logs

Logs included in test report

View crashes in Xcode's Debug Navigator

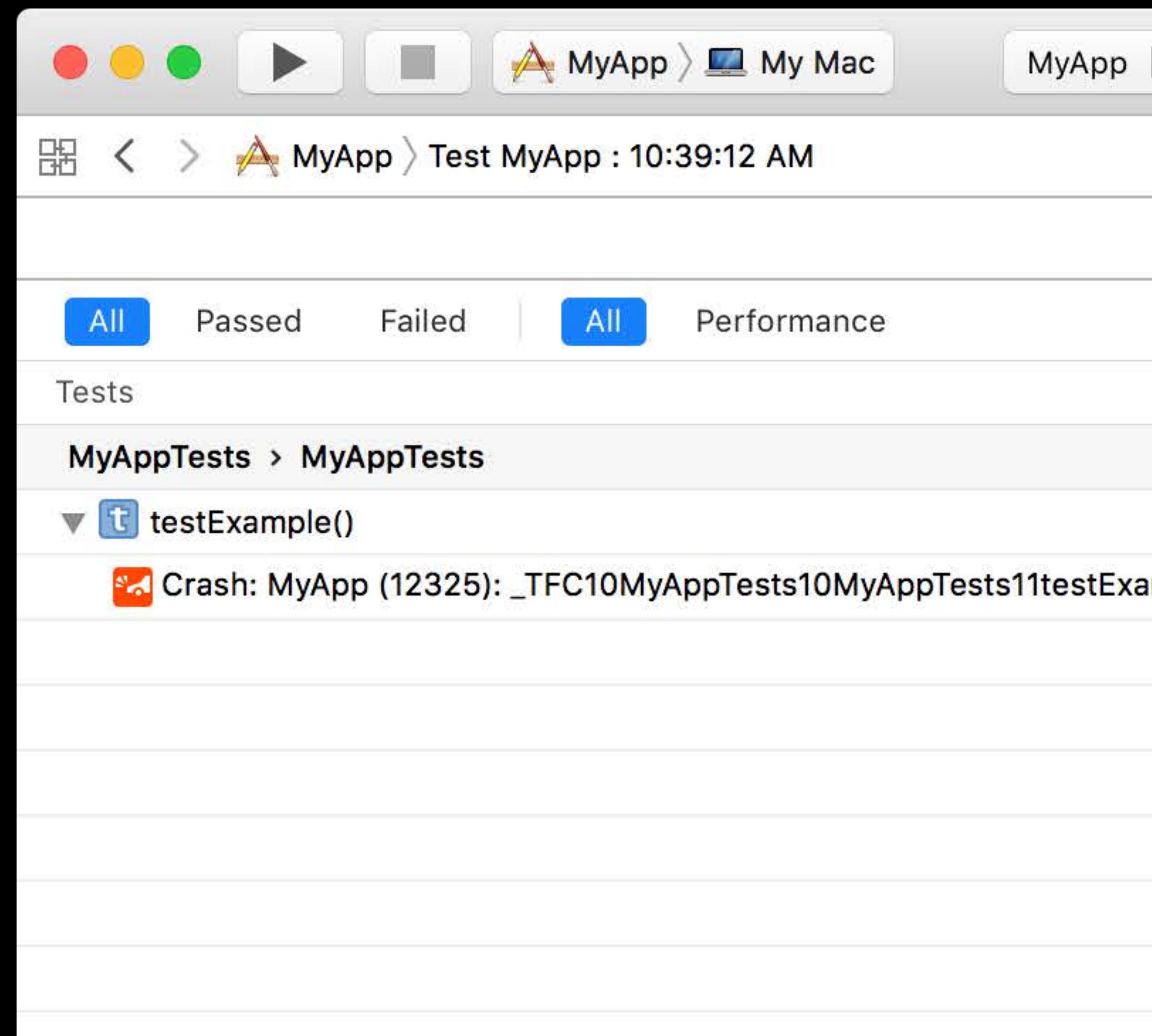


*Demo*

Crash Log Gathering

# Crash Log Gathering

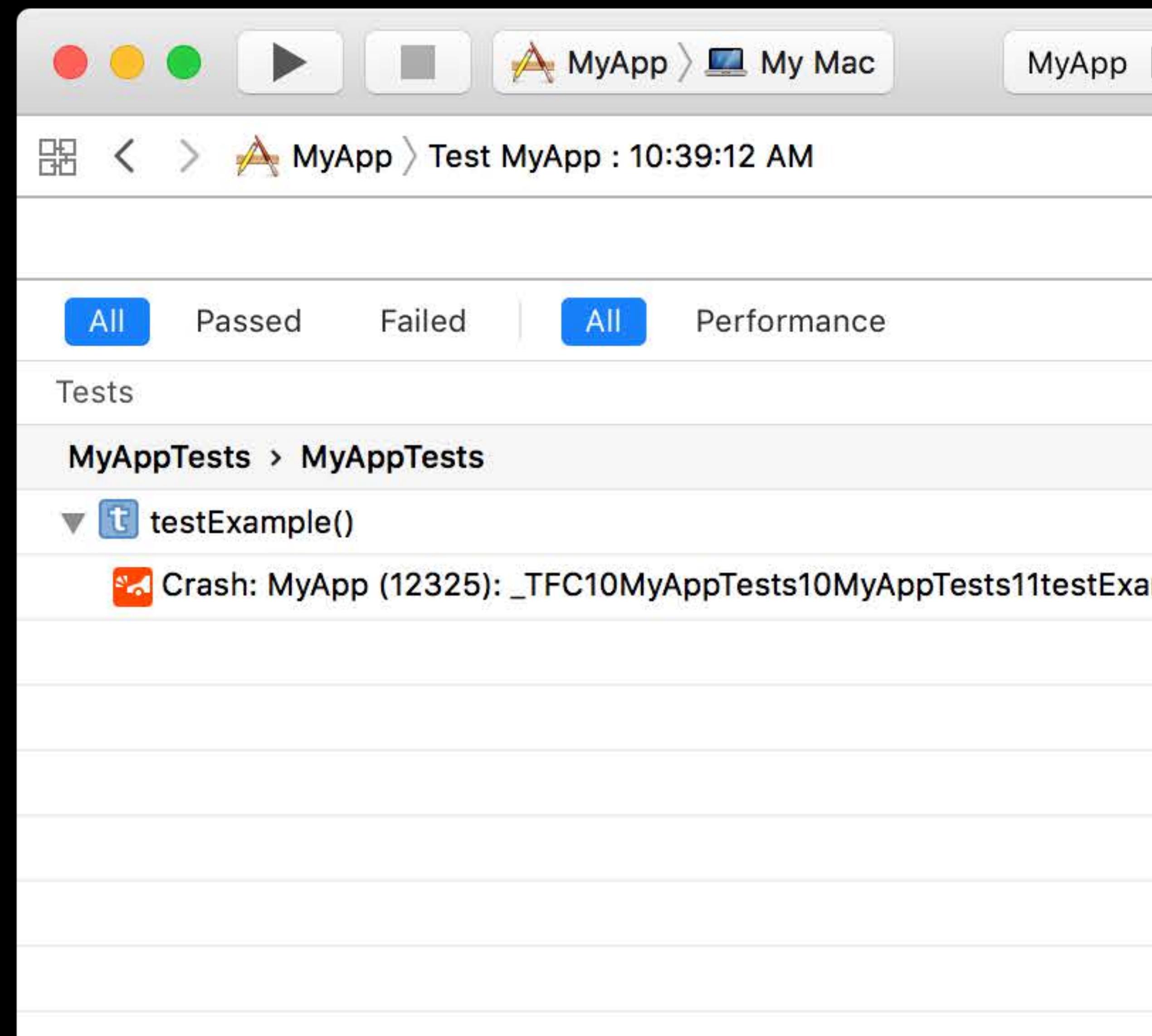
Improved test reports



# Crash Log Gathering

## Improved test reports

Crash logs gathered in test reports

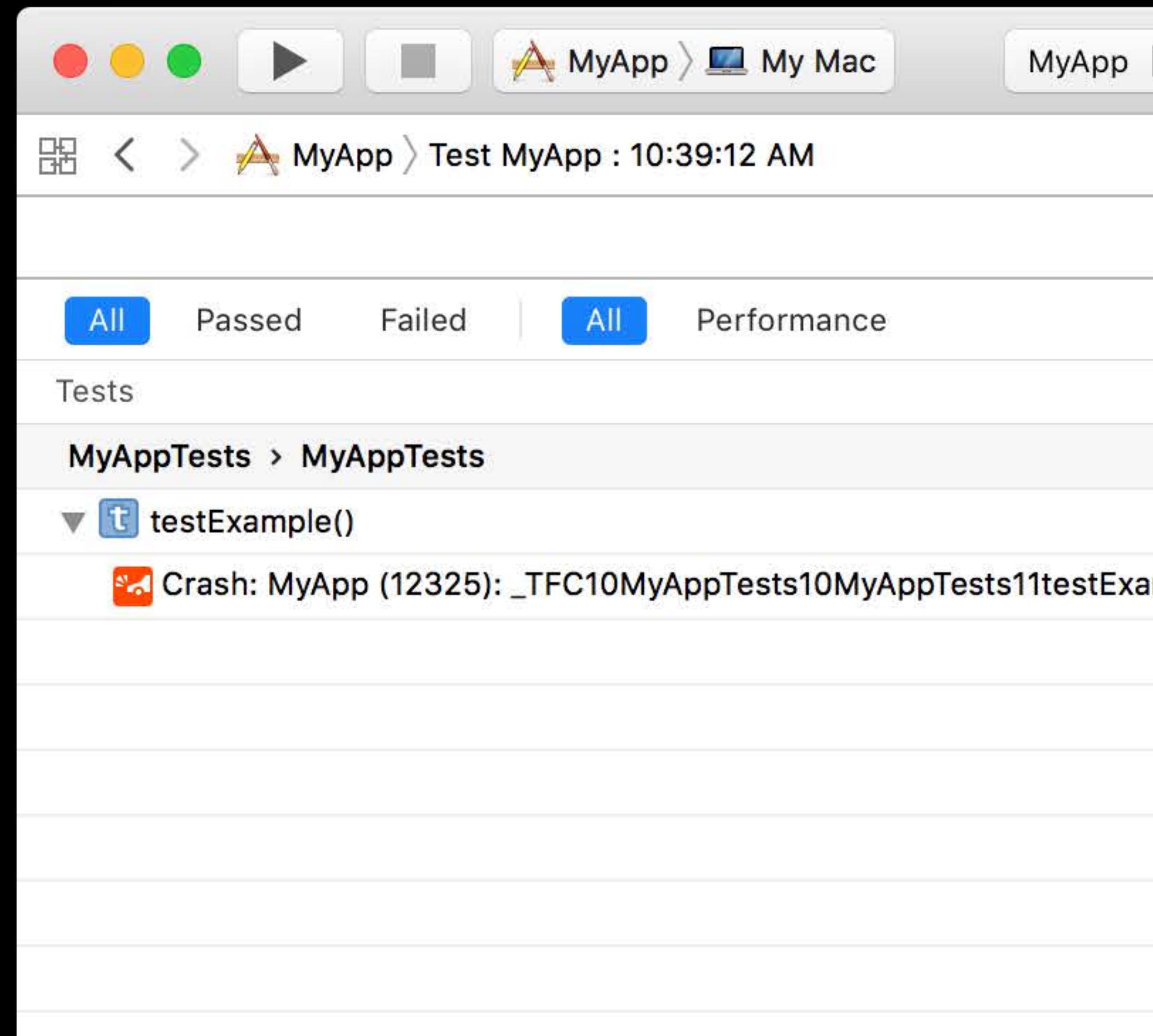


# Crash Log Gathering

## Improved test reports

Crash logs gathered in test reports

View crashes in Xcode's Debug Navigator



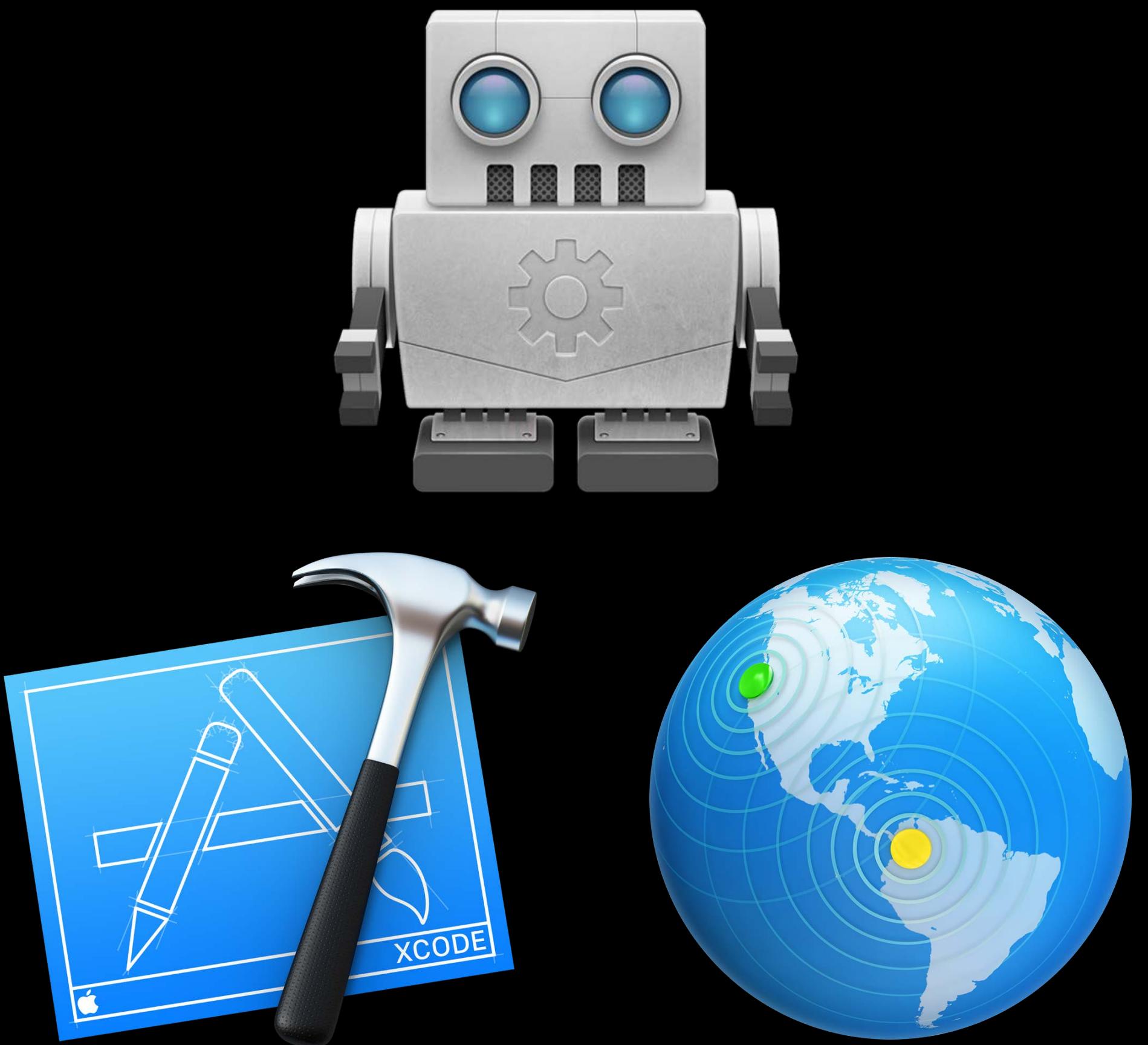
# Xcode Server

## Continuous Integration in Xcode

Eric Dudiak  
Xcode Engineer

# Xcode Server

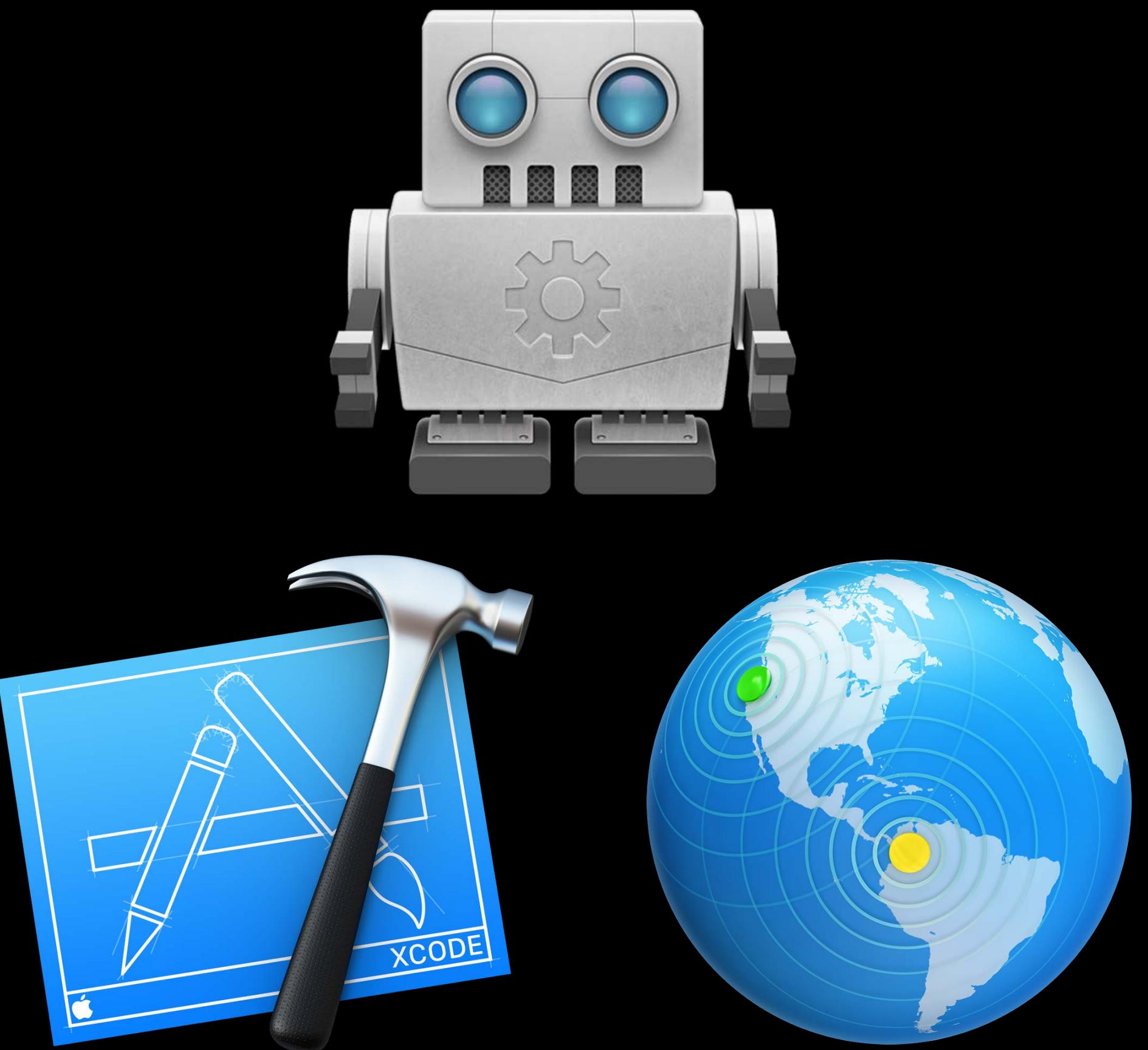
## Overview



# Xcode Server

## Overview

Custom environment variables

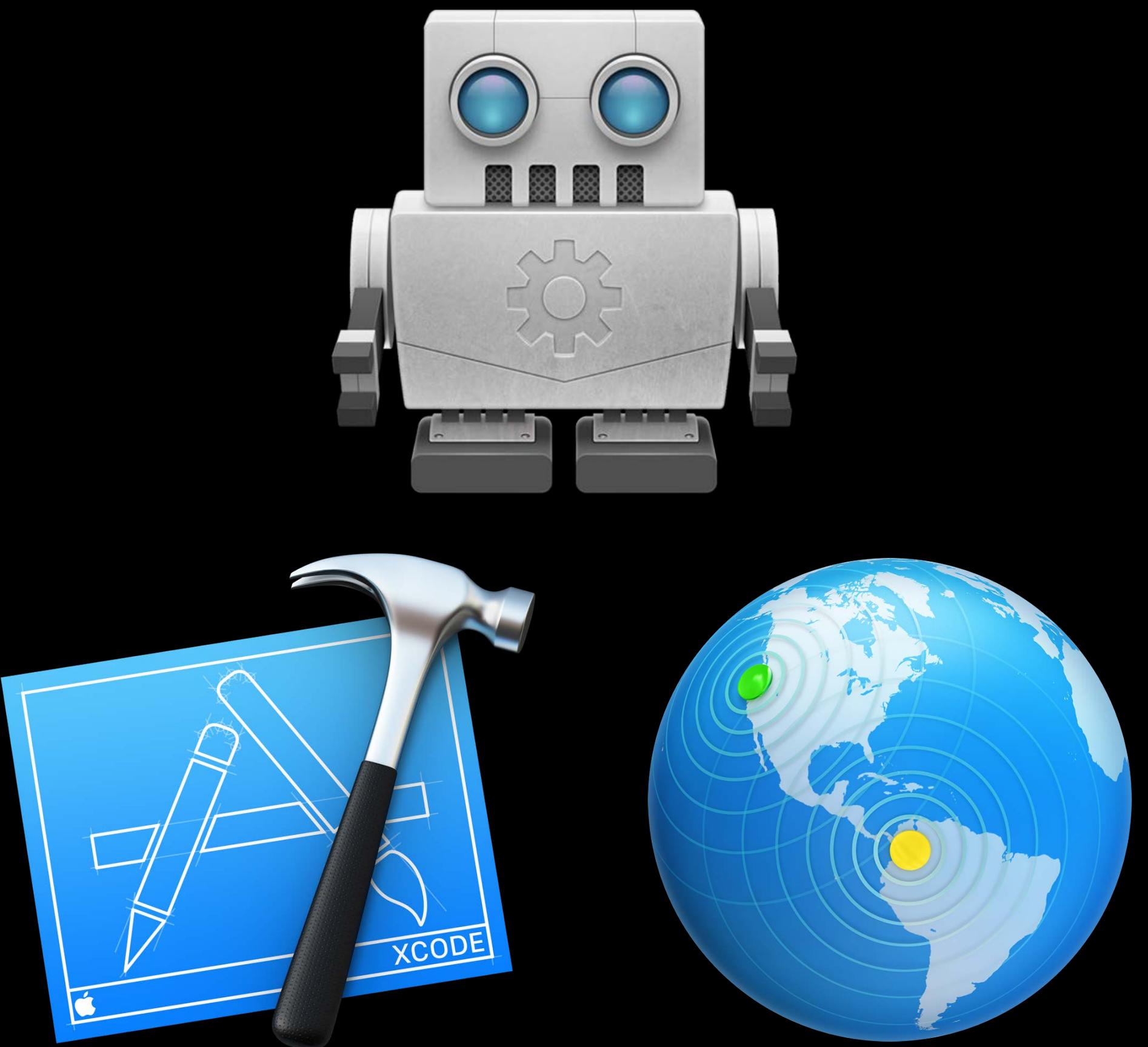


# Xcode Server

## Overview

Custom environment variables

Advanced trigger editing



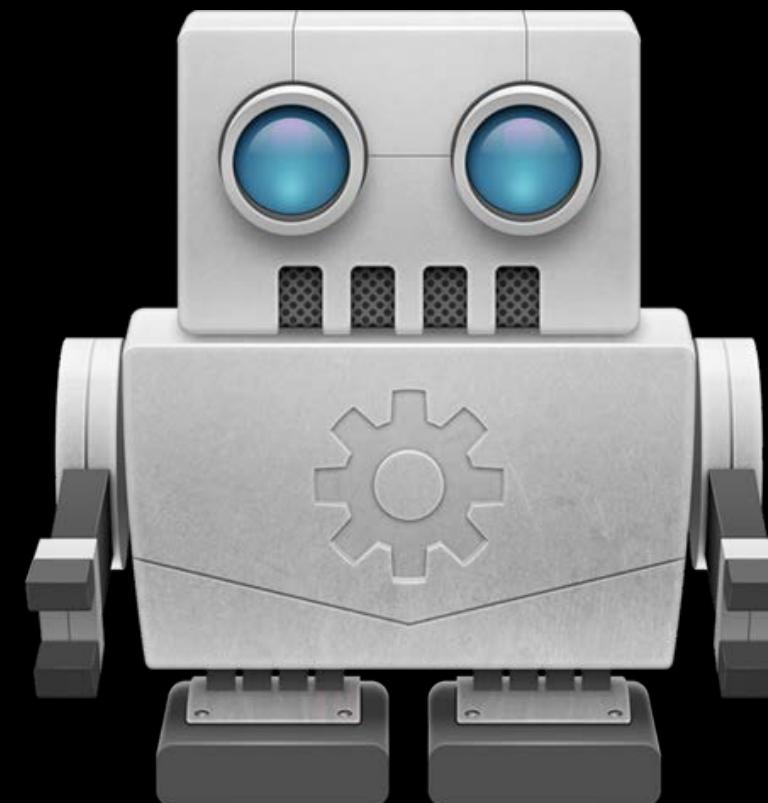
# Xcode Server

## Overview

Custom environment variables

Advanced trigger editing

Issue tracking and blame



# Xcode Server

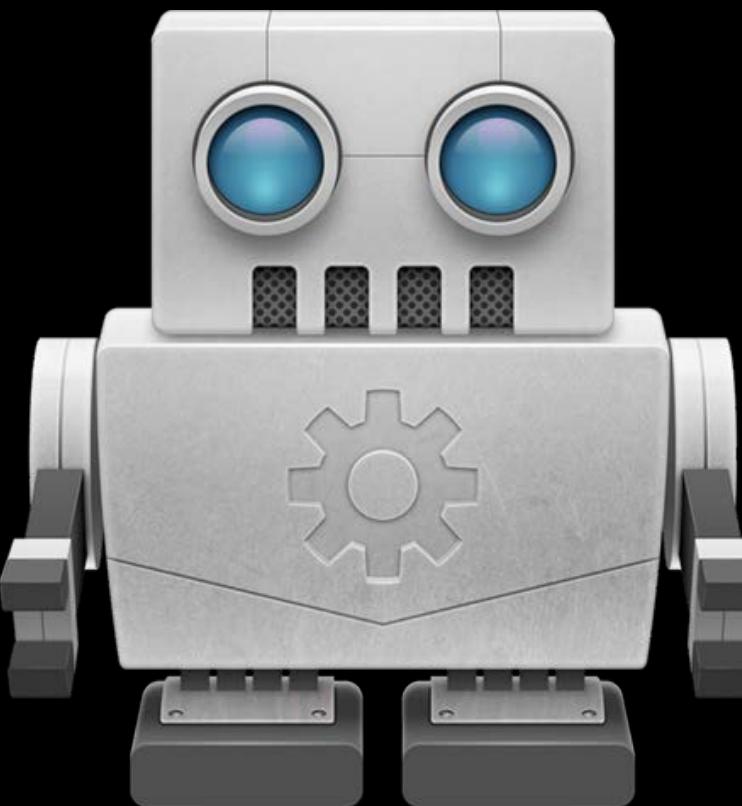
## Overview

Custom environment variables

Advanced trigger editing

Issue tracking and blame

Upgrade integrations



# Xcode Server

## Overview

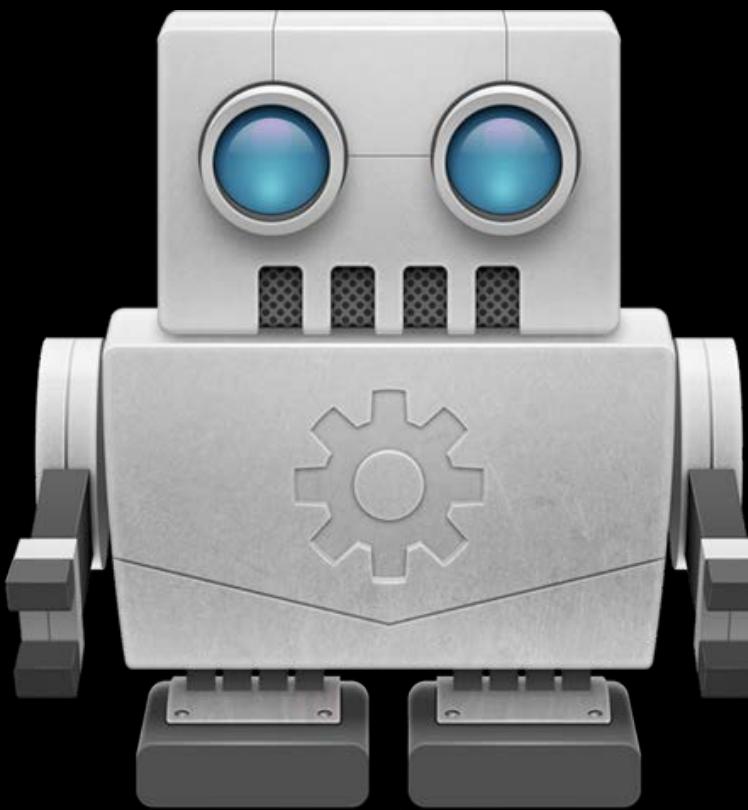
Custom environment variables

Advanced trigger editing

Issue tracking and blame

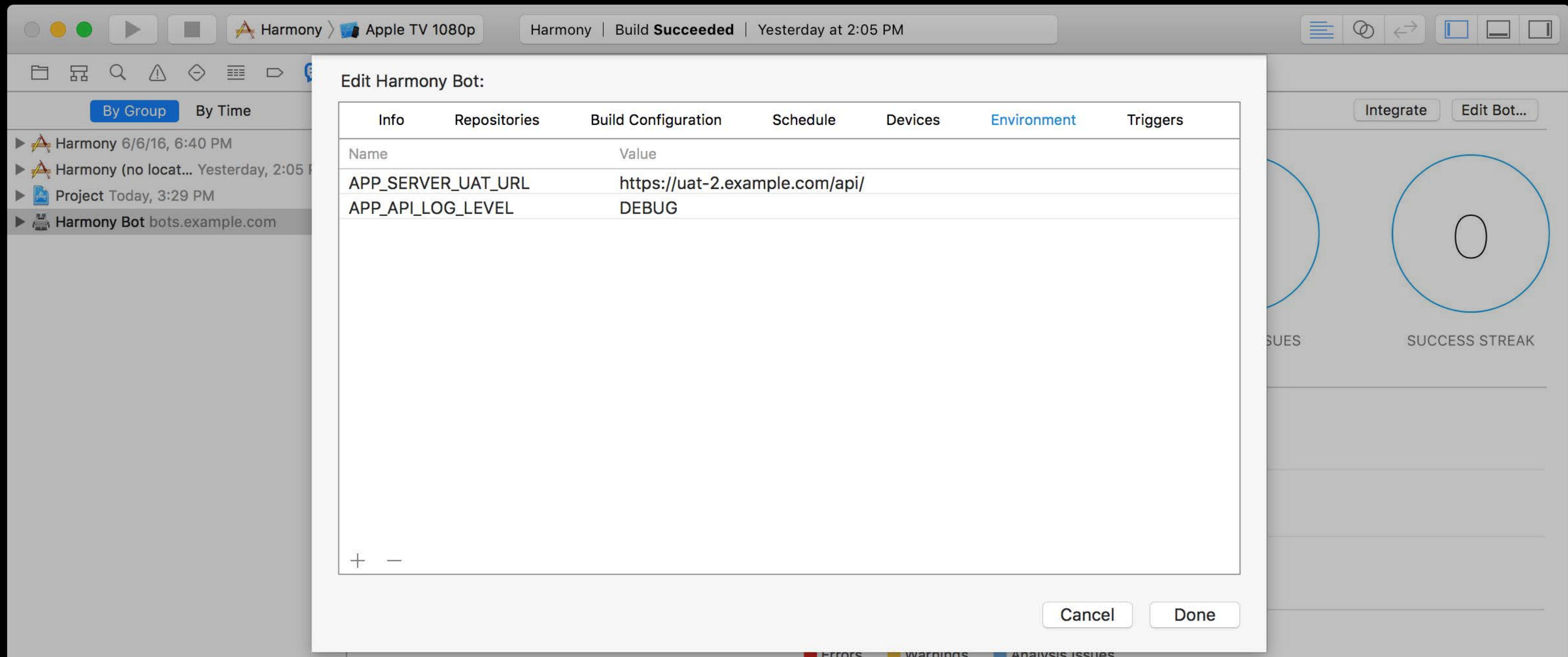
Upgrade integrations

Configurable integration user



# Custom Environment Variables

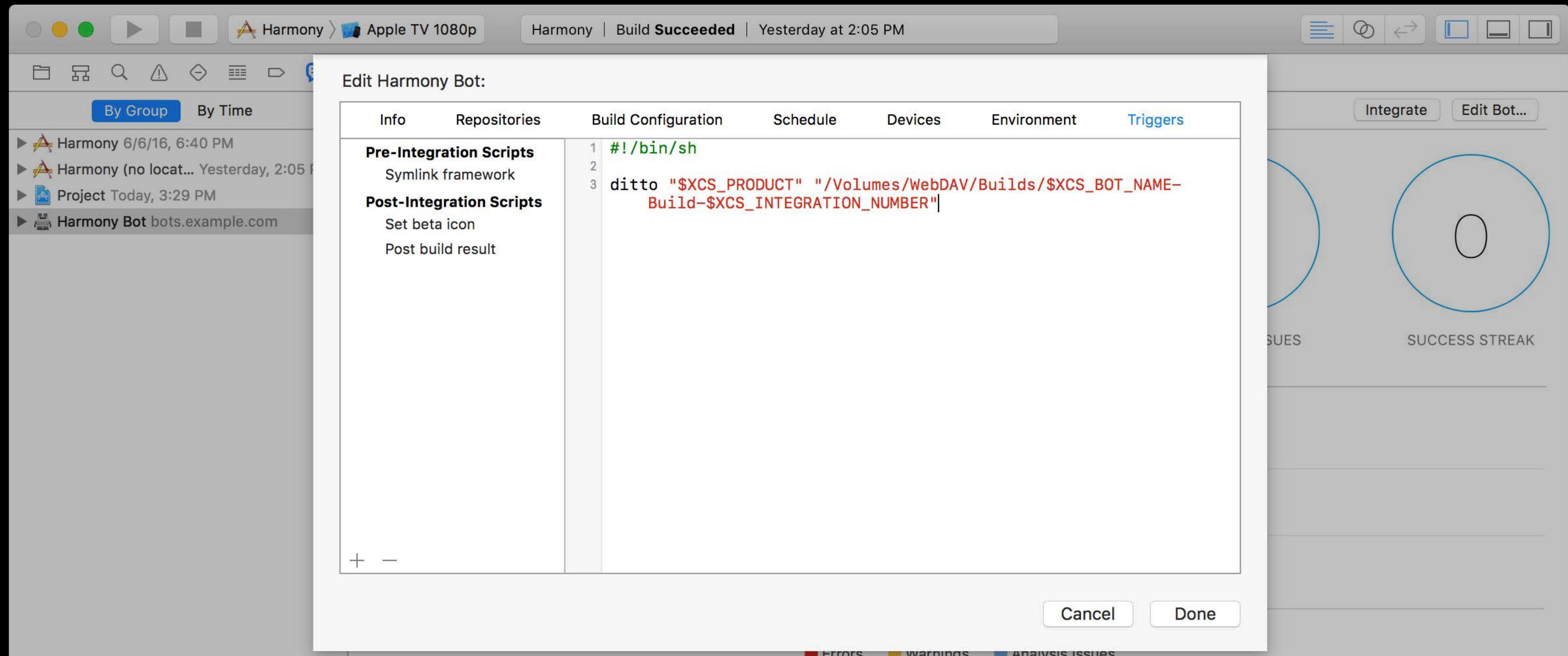
New in Xcode 7.3



# Advanced Triggers

NEW

## Integration scripts

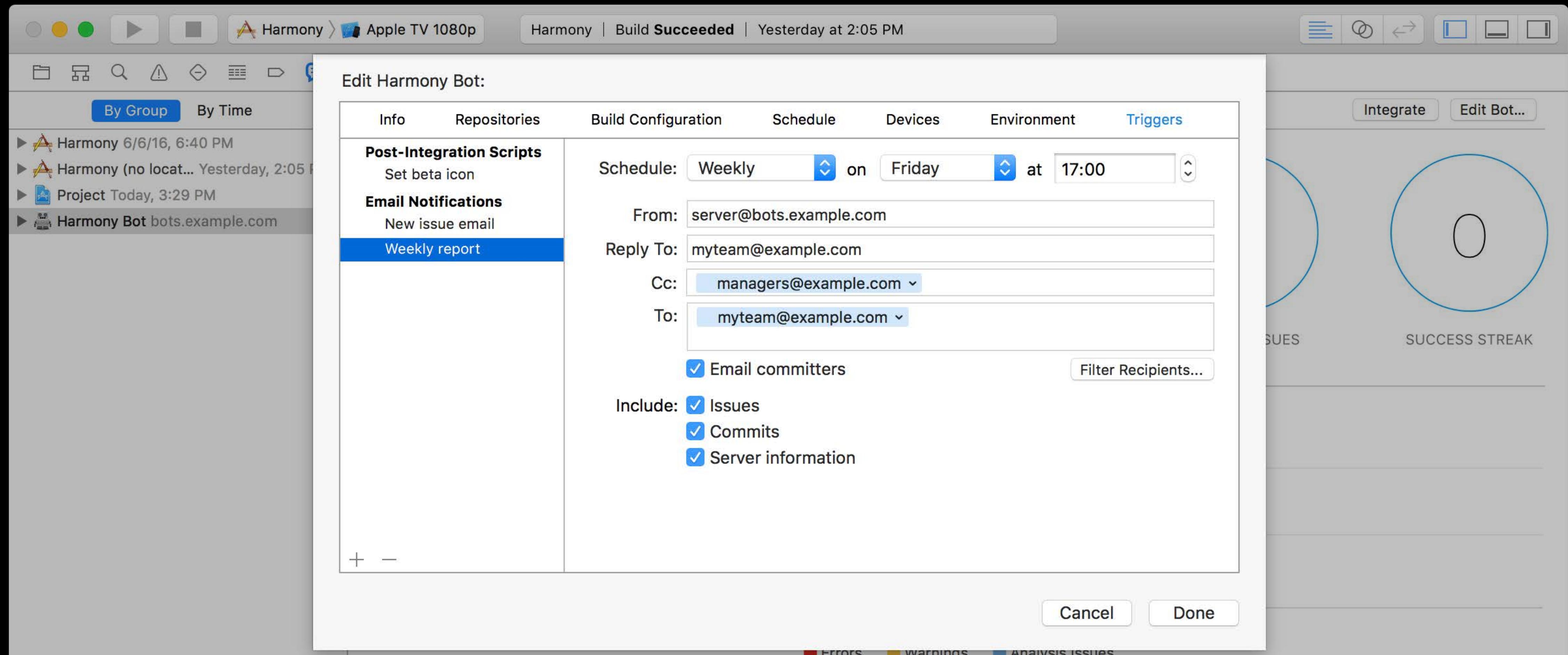


### Test History

# Advanced Triggers

NEW

## Email notifications



The screenshot shows the Harmony application interface. The main window title is "Harmony > Apple TV 1080p" with the subtitle "Harmony | Build Succeeded | Yesterday at 2:05 PM". The interface includes a toolbar with various icons, a sidebar with a list of recent builds, and a central panel for editing a bot. The "Edit Harmony Bot" dialog is open, showing the "Triggers" tab. The "Email Notifications" section is selected, and the "Weekly report" option is highlighted. The configuration includes:

- Schedule:** Weekly, on Friday at 17:00
- From:** server@bots.example.com
- Reply To:** myteam@example.com
- Cc:** managers@example.com
- To:** myteam@example.com
- Email committers:** Checked
- Include:** Issues, Commits, Server information

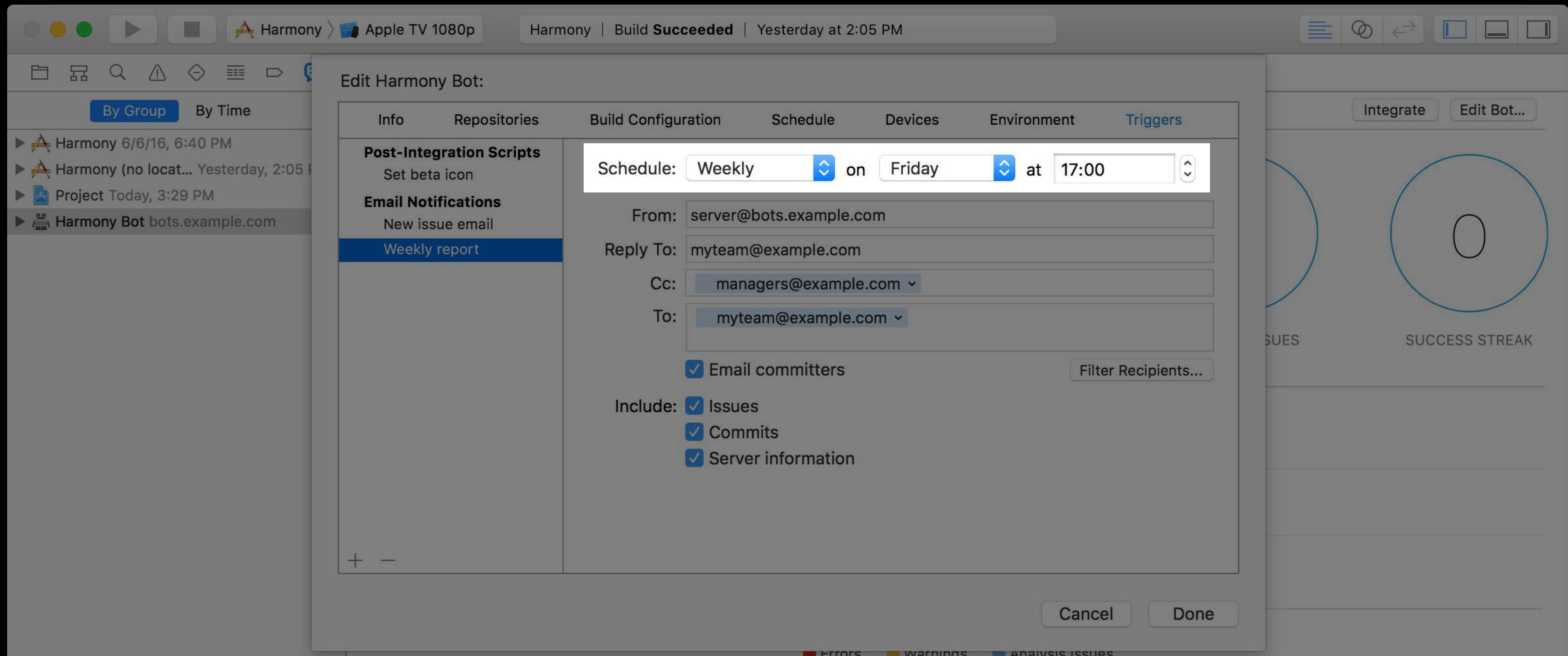
At the bottom of the dialog are "Cancel" and "Done" buttons. The status bar at the bottom of the window shows "Errors", "Warnings", and "Analysis issues".

Test History

# Advanced Triggers

NEW

## Email notifications

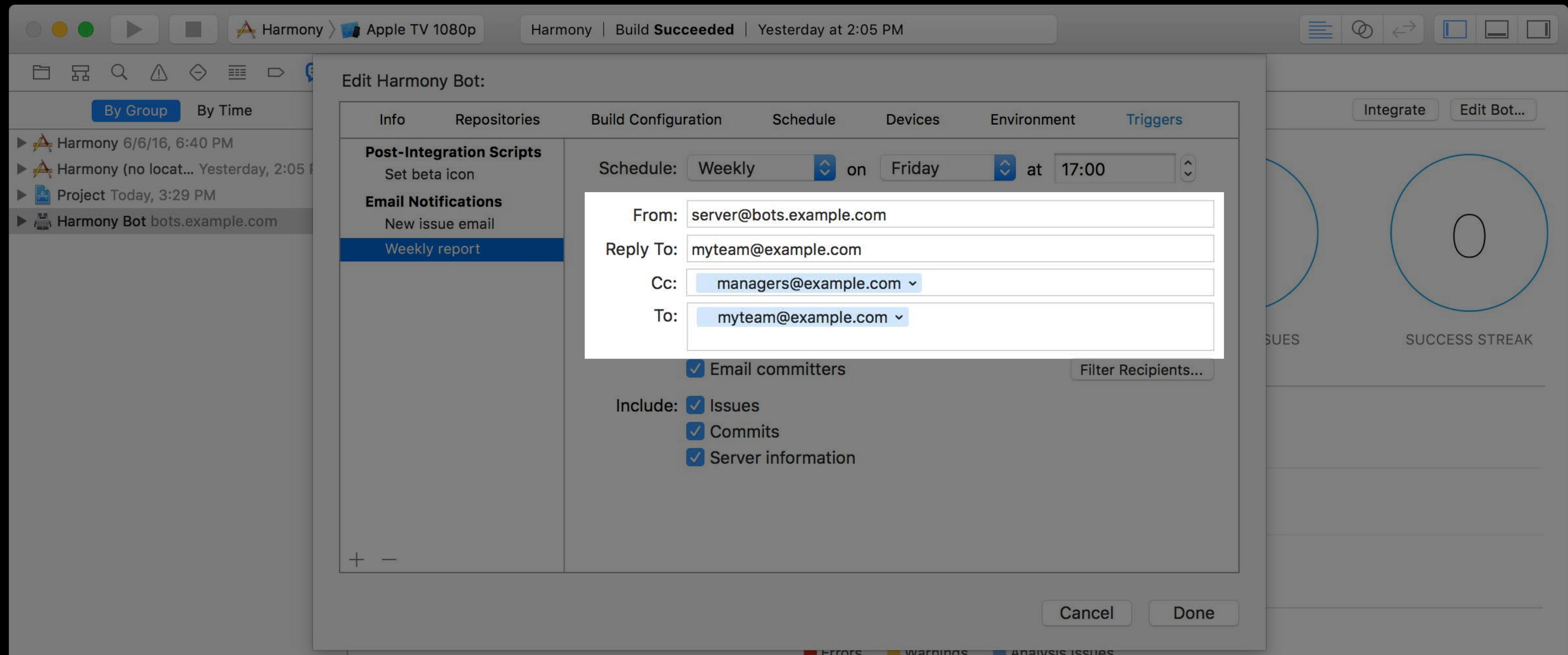


Test History

# Advanced Triggers

NEW

## Email notifications

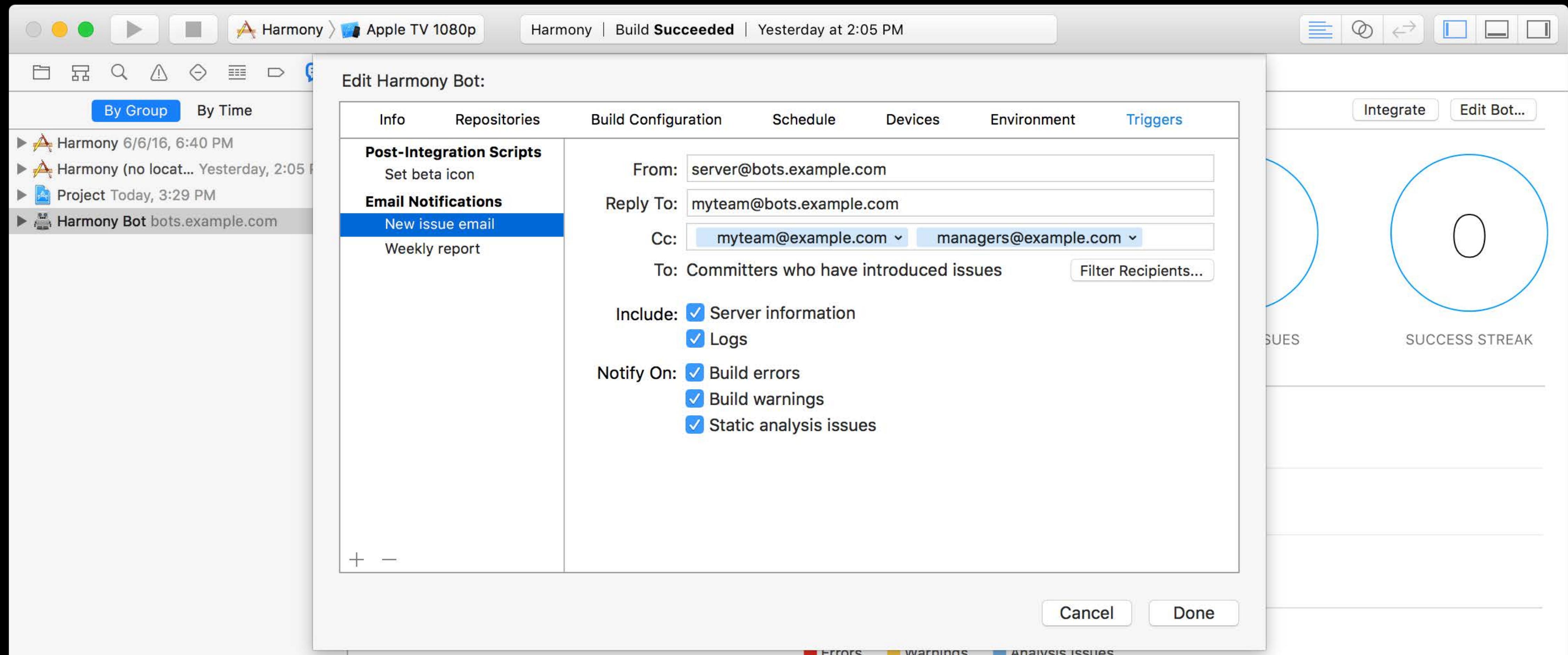


Test History

# Advanced Triggers

NEW

## Email notifications



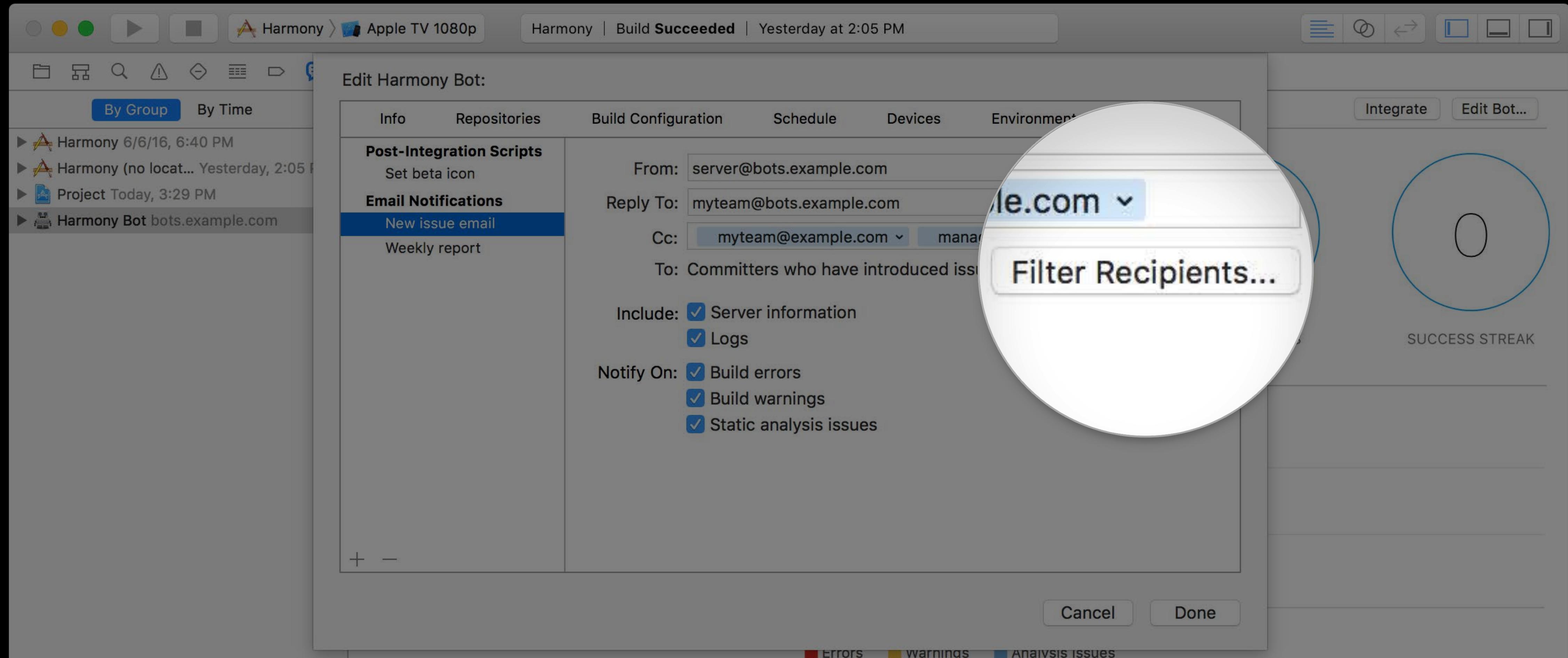
The screenshot shows the Harmony application interface. The title bar indicates "Harmony | Build Succeeded | Yesterday at 2:05 PM". The main window is titled "Edit Harmony Bot:" and contains a tab bar with "Info", "Repositories", "Build Configuration", "Schedule", "Devices", "Environment", and "Triggers". The "Triggers" tab is selected. On the left, a sidebar lists "Post-Integration Scripts" (Set beta icon) and "Email Notifications" (New issue email, Weekly report). The "Email Notifications" section is active, showing fields for "From" (server@bots.example.com), "Reply To" (myteam@bots.example.com), "Cc" (myteam@example.com, managers@example.com), and "To" (Committers who have introduced issues). Below these are checkboxes for "Include" (Server information, Logs) and "Notify On" (Build errors, Build warnings, Static analysis issues). At the bottom of the dialog are "Cancel" and "Done" buttons. The status bar at the bottom shows "Errors", "Warnings", and "Analysis issues".

### Test History

# Advanced Triggers

NEW

## Email notifications

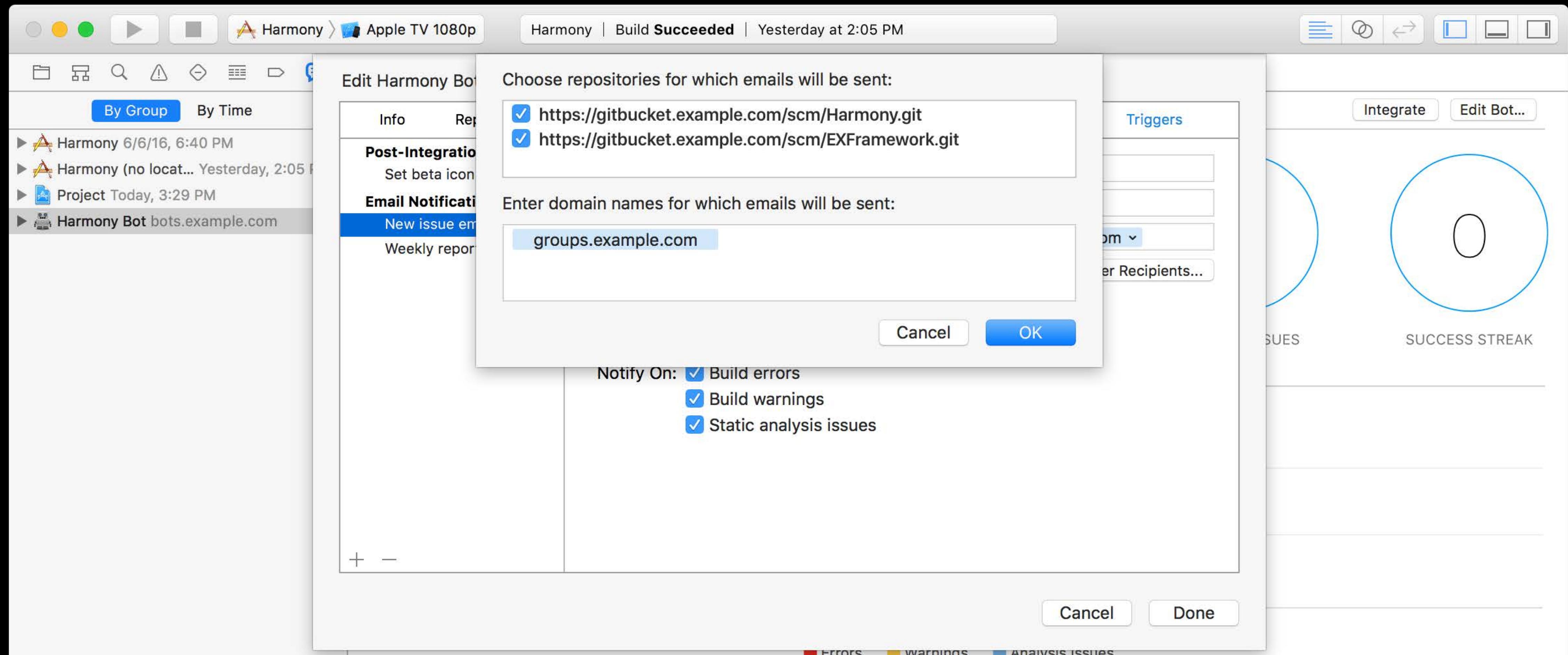


Test History

# Advanced Triggers

NEW

## Email notifications



### Test History

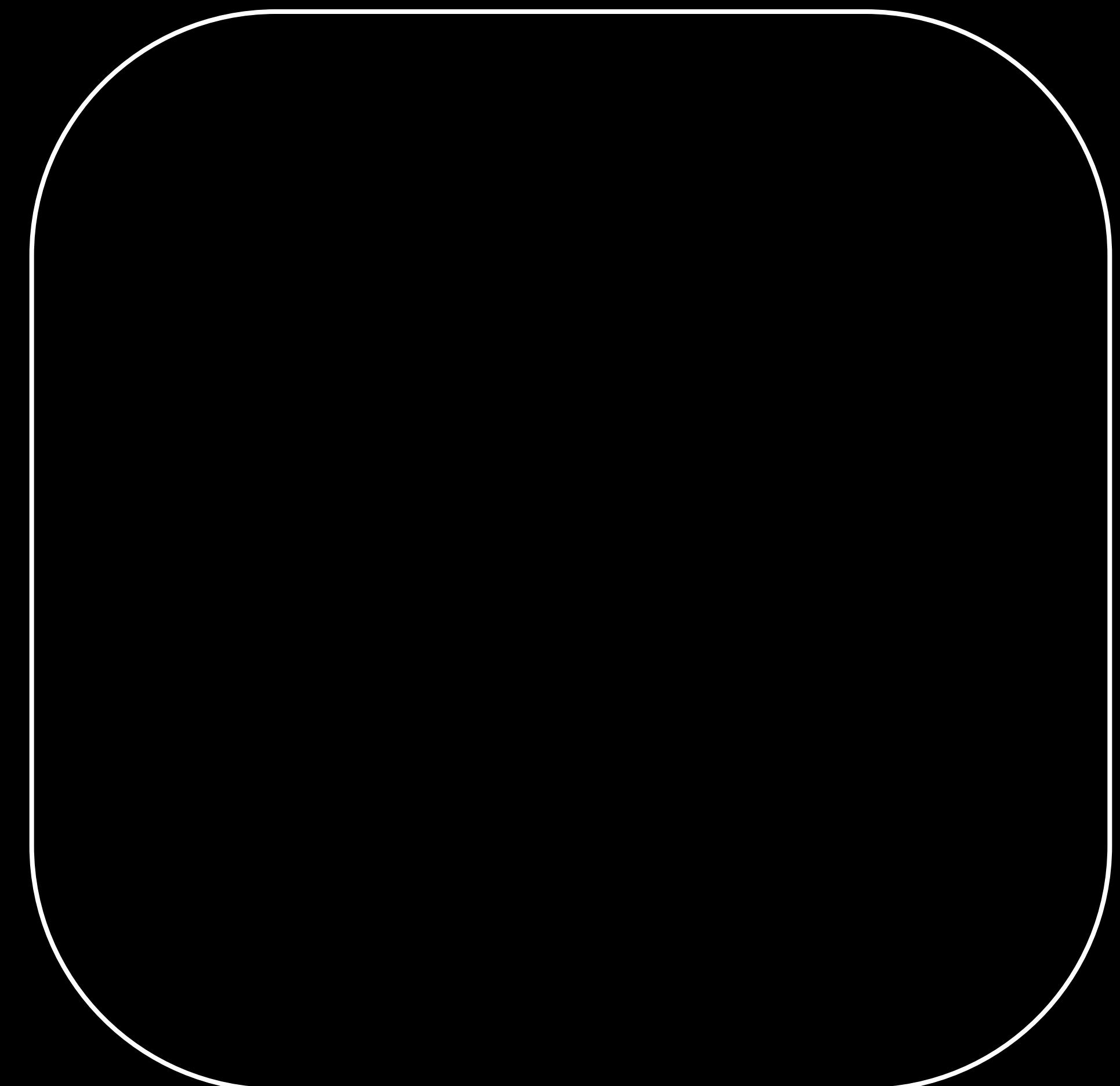
# Issue Tracking and Blame

We all have issues

# Issue Tracking and Blame

We all have issues

Nobody is perfect

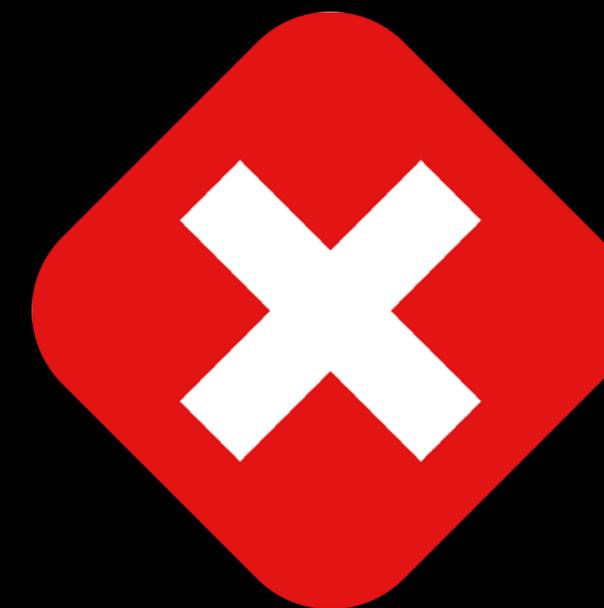


# Issue Tracking and Blame

We all have issues

Nobody is perfect

- Tests will fail



# Issue Tracking and Blame

We all have issues

Nobody is perfect

- Tests will fail
- Errors will come up



# Issue Tracking and Blame

We all have issues

Nobody is perfect

- Tests will fail
- Errors will come up
- Xcode will blame you



# Issue Tracking and Blame

We all have issues

Nobody is perfect

- Tests will fail
- Errors will come up
- Xcode will blame you

Even if you are perfect



# Issue Tracking and Blame

We all have issues

Nobody is perfect

- Tests will fail
- Errors will come up
- Xcode will blame you

Even if you are perfect

- SDKs change



# Issue Tracking and Blame

We all have issues

Nobody is perfect

- Tests will fail
- Errors will come up
- Xcode will blame you

Even if you are perfect

- SDKs change
- Language improvements



# Issue Tracking and Blame

We all have issues

Nobody is perfect

- Tests will fail
- Errors will come up
- Xcode will blame you

Even if you are perfect

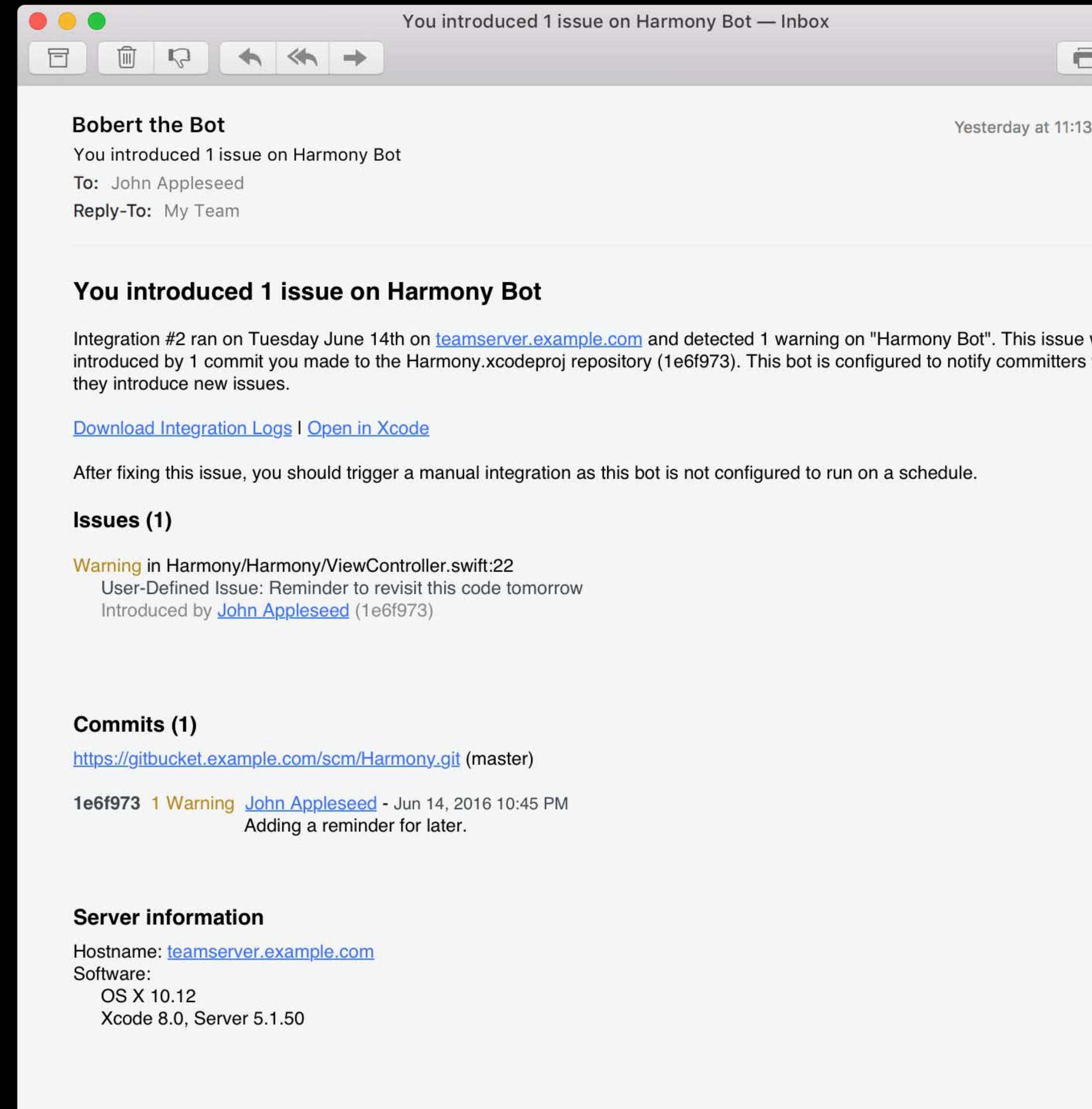
- SDKs change
- Language improvements
- Smarter tools



# Issue Tracking and Blame

## Identifying issue owners

NEW



You introduced 1 issue on Harmony Bot — Inbox

Yesterday at 11:13

**Bobert the Bot**

You introduced 1 issue on Harmony Bot

To: John Appleseed

Reply-To: My Team

**You introduced 1 issue on Harmony Bot**

Integration #2 ran on Tuesday June 14th on [teamserver.example.com](https://teamserver.example.com) and detected 1 warning on "Harmony Bot". This issue was introduced by 1 commit you made to the Harmony.xcodeproj repository (1e6f973). This bot is configured to notify committers when they introduce new issues.

[Download Integration Logs](#) | [Open in Xcode](#)

After fixing this issue, you should trigger a manual integration as this bot is not configured to run on a schedule.

**Issues (1)**

**Warning** in Harmony/Harmony/ViewController.swift:22

User-Defined Issue: Reminder to revisit this code tomorrow

Introduced by [John Appleseed](#) (1e6f973)

**Commits (1)**

<https://gitbucket.example.com/scm/Harmony.git> (master)

**1e6f973 1 Warning** [John Appleseed](#) - Jun 14, 2016 10:45 PM

Adding a reminder for later.

**Server information**

Hostname: [teamserver.example.com](https://teamserver.example.com)

Software:

OS X 10.12

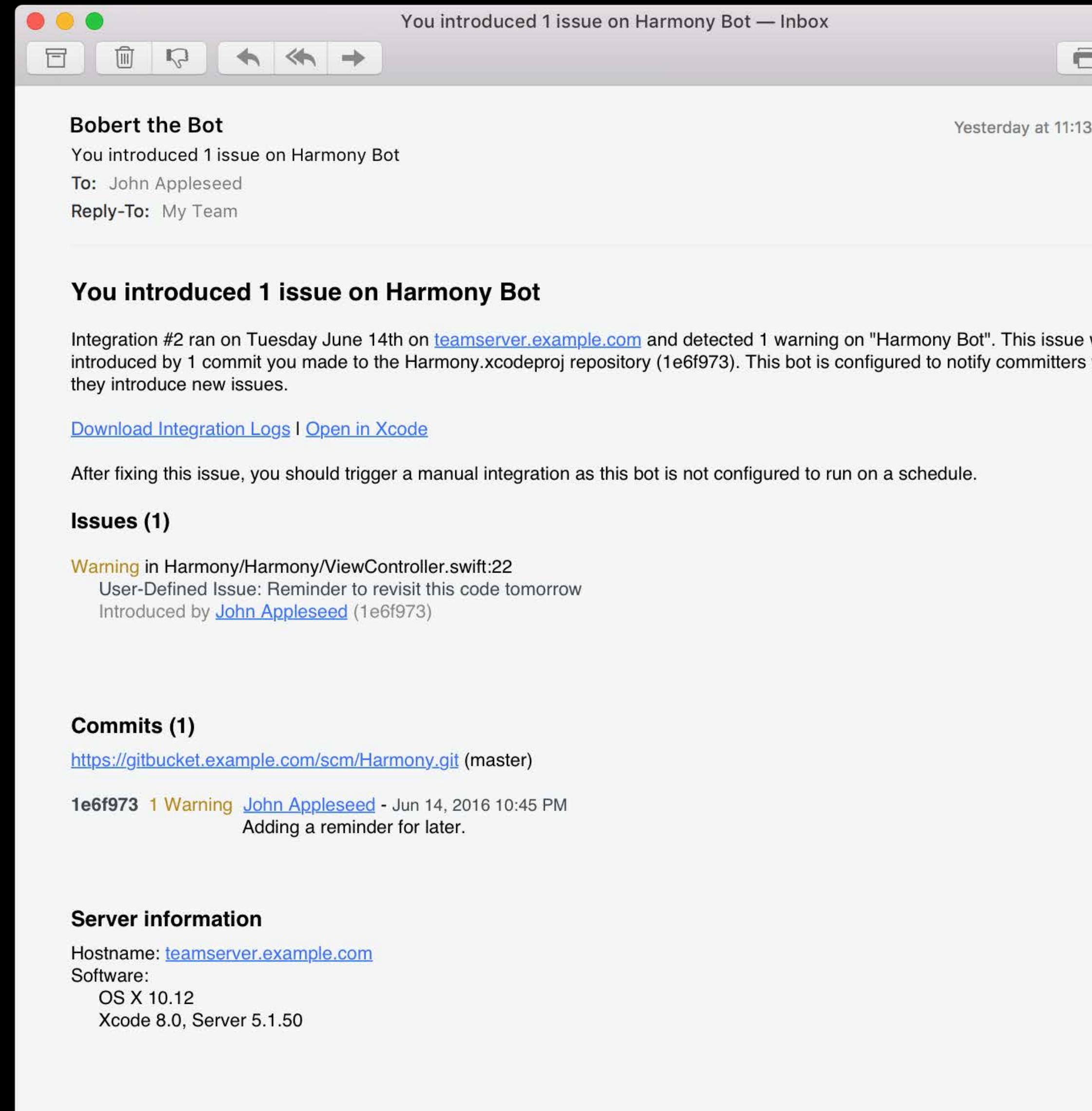
Xcode 8.0, Server 5.1.50

# Issue Tracking and Blame

## Identifying issue owners

Lets you know when it's time to act

NEW



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Software:

OS X 10.12

Xcode 8.0, Server 5.1.50

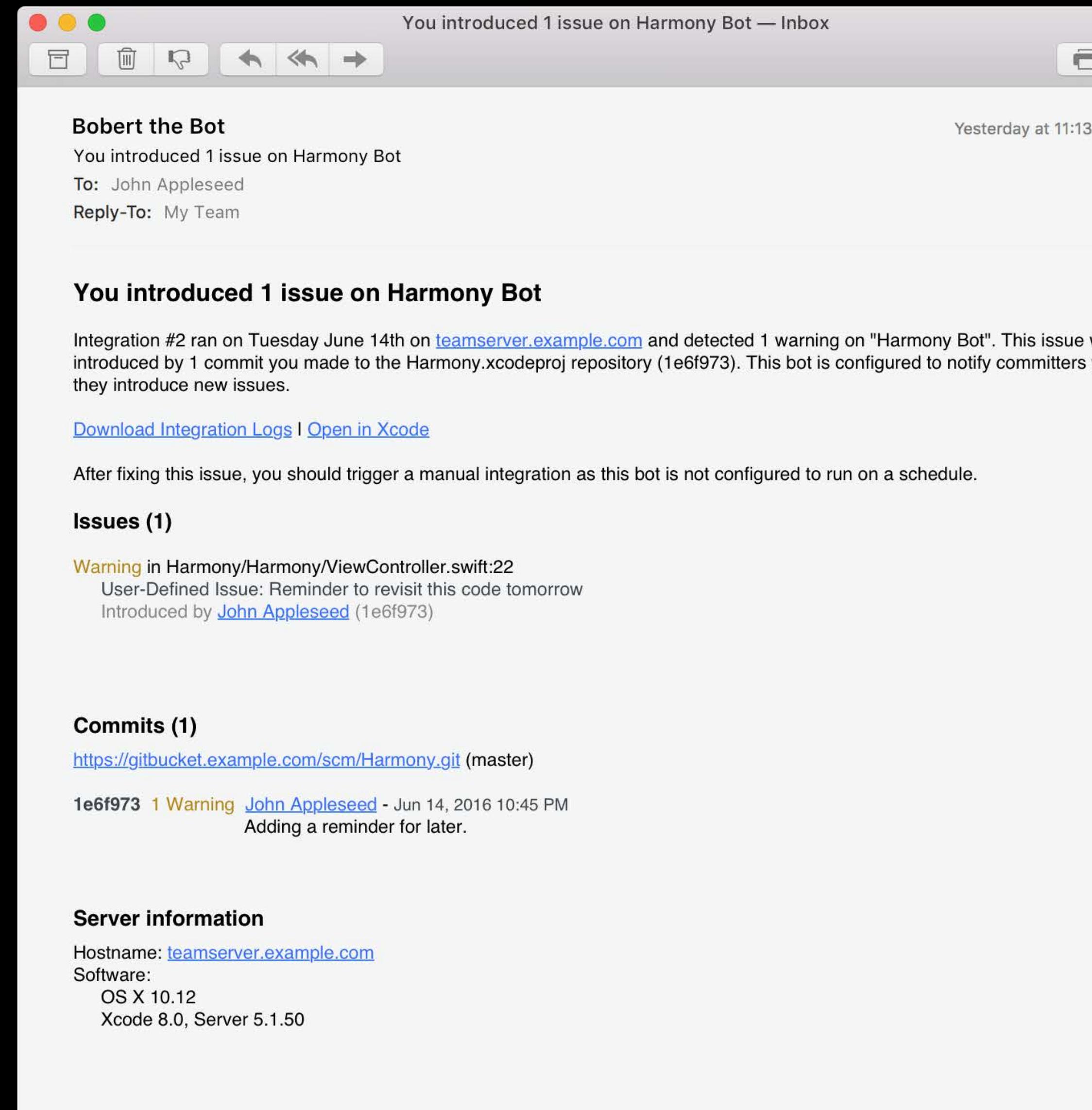
# Issue Tracking and Blame

## Identifying issue owners

Lets you know when it's time to act

You broke it

NEW



You introduced 1 issue on Harmony Bot — Inbox

Yesterday at 11:13

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To: John Appleseed  
Reply-To: My Team

**You introduced 1 issue on Harmony Bot**  
Integration #2 ran on Tuesday June 14th on [teamserver.example.com](https://teamserver.example.com) and detected 1 warning on "Harmony Bot". This issue was introduced by 1 commit you made to the Harmony.xcodeproj repository (1e6f973). This bot is configured to notify committers when they introduce new issues.

[Download Integration Logs](#) | [Open in Xcode](#)

After fixing this issue, you should trigger a manual integration as this bot is not configured to run on a schedule.

**Issues (1)**  
**Warning** in Harmony/Harmony/ViewController.swift:22  
User-Defined Issue: Reminder to revisit this code tomorrow  
Introduced by [John Appleseed](#) (1e6f973)

**Commits (1)**  
<https://gitbucket.example.com/scm/Harmony.git> (master)  
**1e6f973 1 Warning** [John Appleseed](#) - Jun 14, 2016 10:45 PM  
Adding a reminder for later.

**Server information**  
Hostname: [teamserver.example.com](https://teamserver.example.com)  
Software:  
OS X 10.12  
Xcode 8.0, Server 5.1.50

# Issue Tracking and Blame

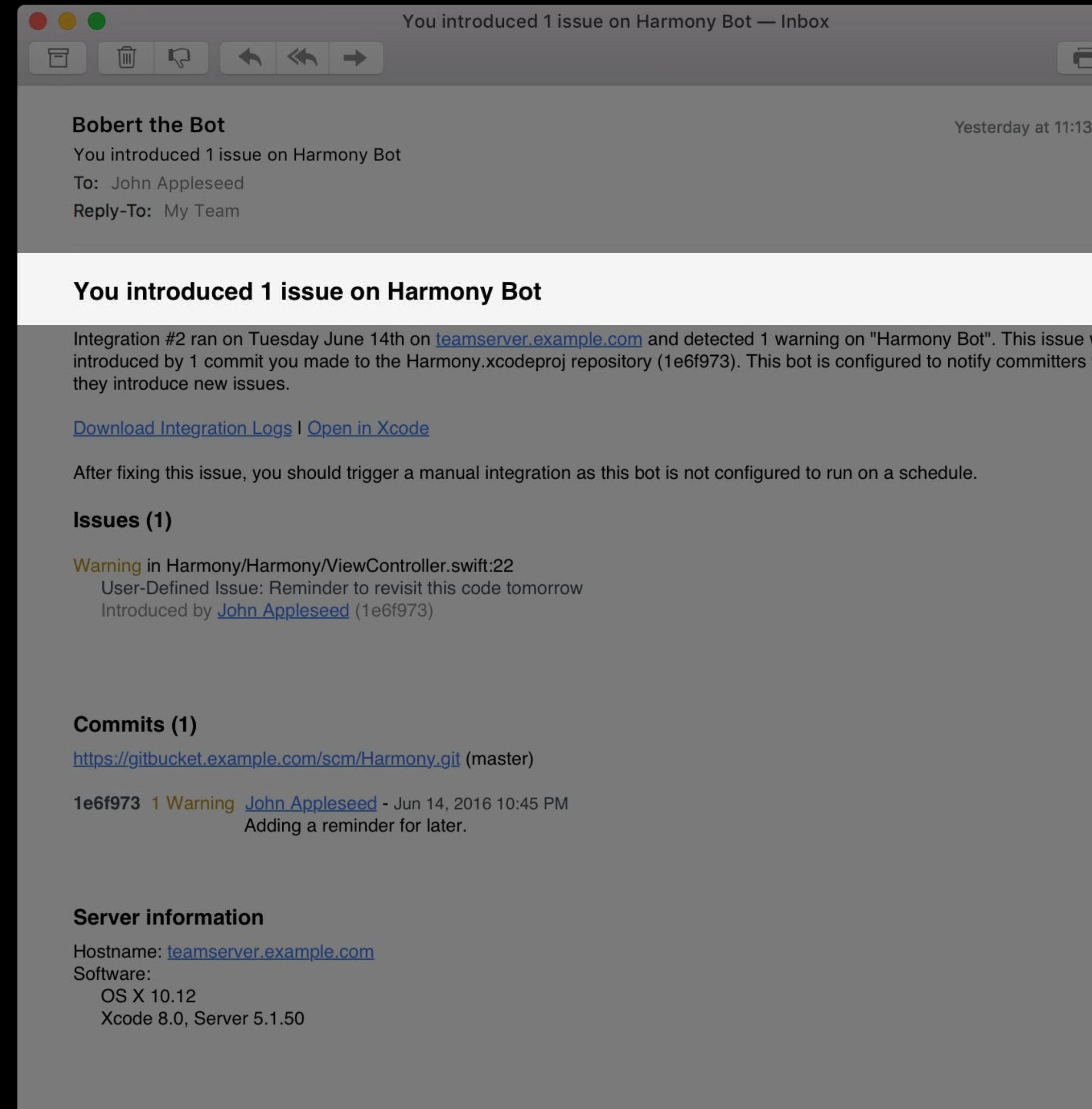
## Identifying issue owners

Lets you know when it's time to act

You broke it

- You introduced an issue

NEW



You introduced 1 issue on Harmony Bot — Inbox

Yesterday at 11:13

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To: John Appleseed  
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**You introduced 1 issue on Harmony Bot**

Integration #2 ran on Tuesday June 14th on [teamserver.example.com](https://teamserver.example.com) and detected 1 warning on "Harmony Bot". This issue introduced by 1 commit you made to the Harmony.xcodeproj repository (1e6f973). This bot is configured to notify committers they introduce new issues.

[Download Integration Logs](#) | [Open in Xcode](#)

After fixing this issue, you should trigger a manual integration as this bot is not configured to run on a schedule.

**Issues (1)**

**Warning** in Harmony/Harmony/ViewController.swift:22  
User-Defined Issue: Reminder to revisit this code tomorrow  
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**Commits (1)**

<https://gitbucket.example.com/scm/Harmony.git> (master)

1e6f973 1 Warning [John Appleseed](#) - Jun 14, 2016 10:45 PM  
Adding a reminder for later.

**Server information**

Hostname: [teamserver.example.com](https://teamserver.example.com)  
Software:  
OS X 10.12  
Xcode 8.0, Server 5.1.50

# Issue Tracking and Blame

## Identifying issue owners

Lets you know when it's time to act

You broke it

- You introduced an issue
- Issue is on or near line you modified

NEW

You introduced 1 issue on Harmony Bot — Inbox

Yesterday at 11:13

**Bobert the Bot**  
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To: John Appleseed  
Reply-To: My Team

**You introduced 1 issue on Harmony Bot**

Integration #2 ran on Tuesday June 14th on [teamserver.example.com](https://teamserver.example.com) and detected 1 warning on "Harmony Bot". This issue was introduced by 1 commit you made to the Harmony.xcodeproj repository (1e6f973). This bot is configured to notify committers when they introduce new issues.

[Download Integration Logs](#) | [Open in Xcode](#)

After fixing this issue, you should trigger a manual integration as this bot is not configured to run on a schedule.

**Issues (1)**

**Warning** in Harmony/Harmony/ViewController.swift:22  
User-Defined Issue: Reminder to revisit this code tomorrow  
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<https://gitbucket.example.com/scm/Harmony.git> (master)

1e6f973 1 Warning [John Appleseed](#) - Jun 14, 2016 10:45 PM  
Adding a reminder for later.

**Server information**

Hostname: [teamserver.example.com](https://teamserver.example.com)  
Software:  
OS X 10.12  
Xcode 8.0, Server 5.1.50

# Issue Tracking and Blame

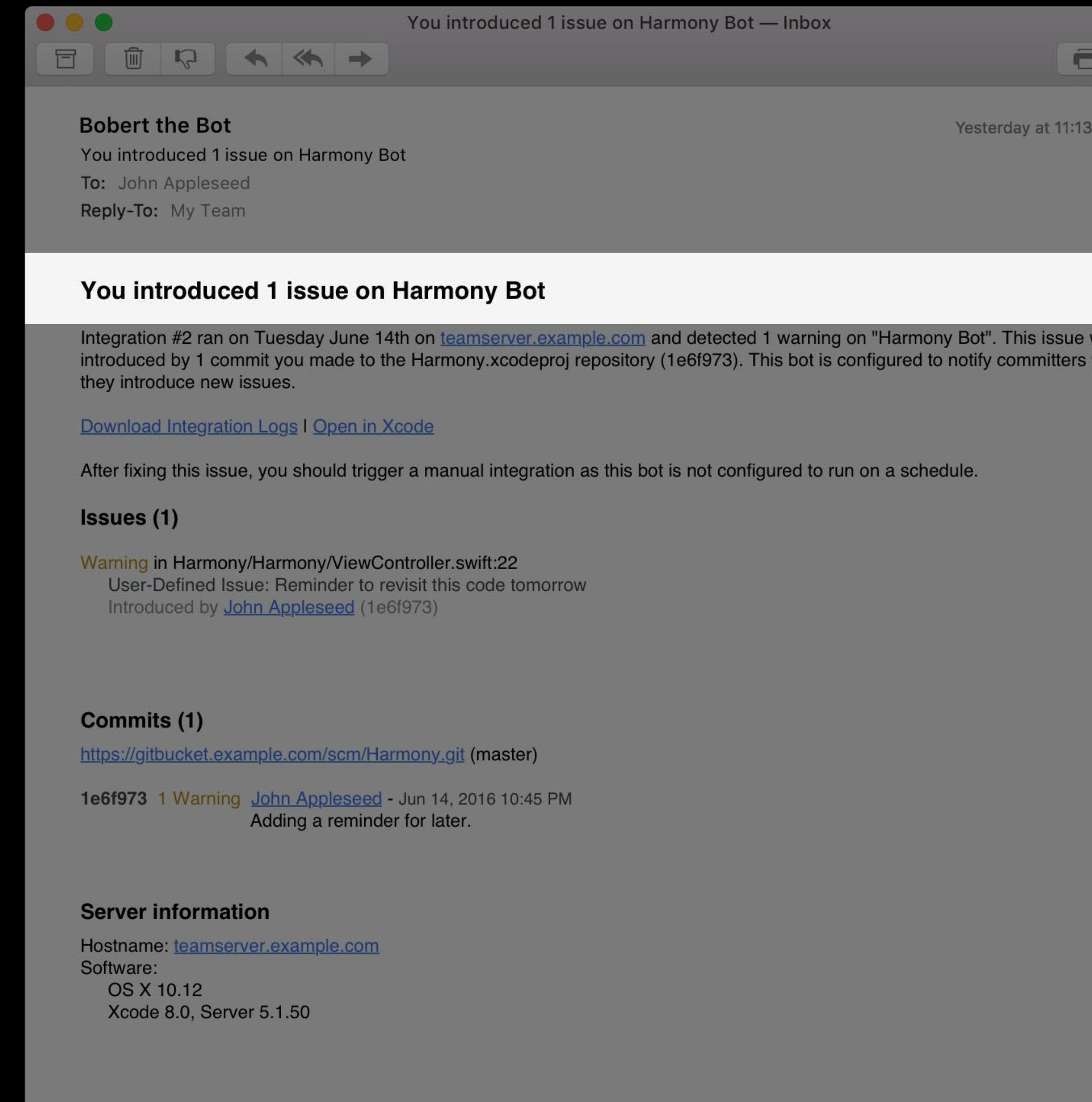
## Identifying issue owners

Lets you know when it's time to act

You broke it

- You introduced an issue
- Issue is on or near line you modified
- You are the only committer

NEW



# Issue Tracking and Blame

## Identifying issue owners

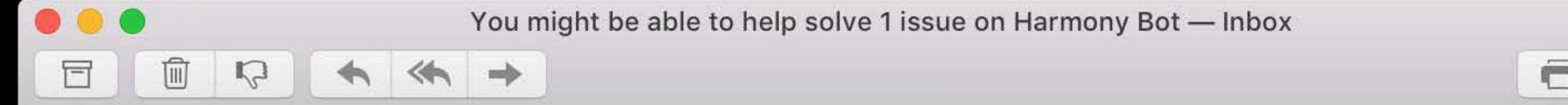
NEW

Lets you know when it's time to act

You broke it

- You introduced an issue
- Issue is on or near line you modified
- You are the only committer

You can help fix it



You might be able to help solve 1 issue on Harmony Bot — Inbox

Yesterday at 11:13

**Bobert the Bot**

You might be able to help solve 1 issue on Harmony Bot

To: John Appleseed

Reply-To: My Team

**You might be able to help solve 1 issue on Harmony Bot**

Integration #3 ran on Tuesday June 14th on [teamserver.example.com](https://teamserver.example.com) and detected 1 warning on "Harmony Bot". You might be able to help solve this issue which was introduced to the Harmony.xcodeproj repository as it has been identified close to the commit you made (5bd9f6b). This bot is configured to notify committers when they introduce new issues.

[Download Integration Logs](#) | [Open in Xcode](#)

After fixing this issue, you should trigger a manual integration as this bot is not configured to run on a schedule.

**Issues (1)**

**Warning** in Harmony/Harmony/ViewController.swift:19

Semantic Issue: Initialization of immutable value 'foo' was never used; consider replacing with assignment to '\_' or removing.  
Potentially introduced by [John Appleseed](#) (5bd9f6b)

**Commits (1)**

<https://gitbucket.example.com/scm/Harmony.git> (master)

**5bd9f6b 1 Warning** [John Appleseed](#) - Jun 14, 2016 11:15 PM  
Making some small adjustments in the view controller code.

**Server information**

Hostname: [teamserver.example.com](https://teamserver.example.com)  
Software:  
OS X 10.12  
Xcode 8.0, Server 5.1.50

# Issue Tracking and Blame

## Identifying issue owners

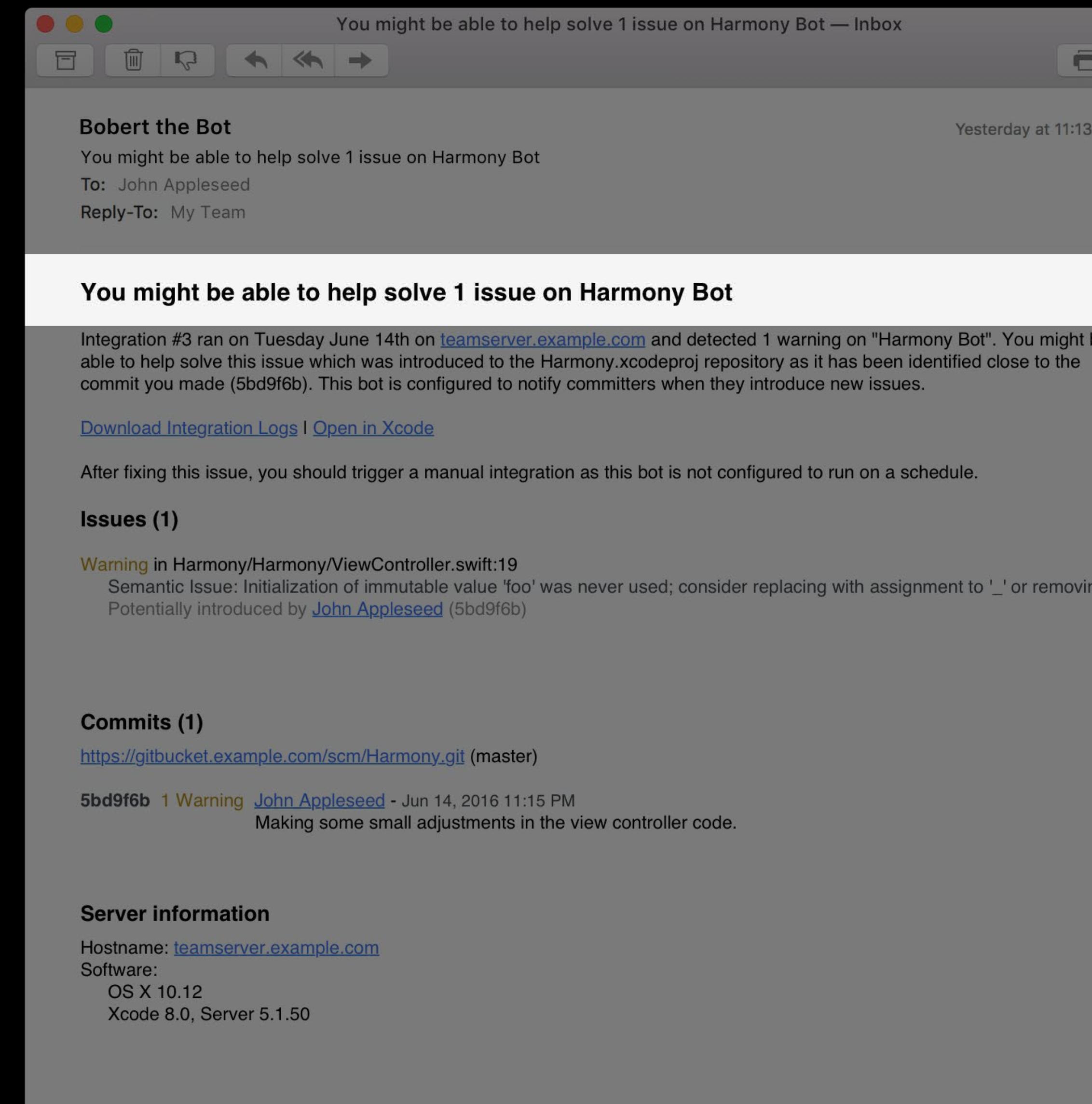
Lets you know when it's time to act

You broke it

- You introduced an issue
- Issue is on or near line you modified
- You are the only committer

You can help fix it

- You probably know how to fix an issue



The screenshot shows a Mac OS X Mail application window. The subject of the email is "You might be able to help solve 1 issue on Harmony Bot — Inbox". The email is from "Bob the Bot" and is dated "Yesterday at 11:13". The message body contains the following text:

You might be able to help solve 1 issue on Harmony Bot

To: John Appleseed

Reply-To: My Team

**You might be able to help solve 1 issue on Harmony Bot**

Integration #3 ran on Tuesday June 14th on [teamserver.example.com](https://teamserver.example.com) and detected 1 warning on "Harmony Bot". You might be able to help solve this issue which was introduced to the Harmony.xcodeproj repository as it has been identified close to the commit you made (5bd9f6b). This bot is configured to notify committers when they introduce new issues.

[Download Integration Logs](#) | [Open in Xcode](#)

After fixing this issue, you should trigger a manual integration as this bot is not configured to run on a schedule.

**Issues (1)**

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# Issue Tracking and Blame

## Identifying issue owners

Lets you know when it's time to act

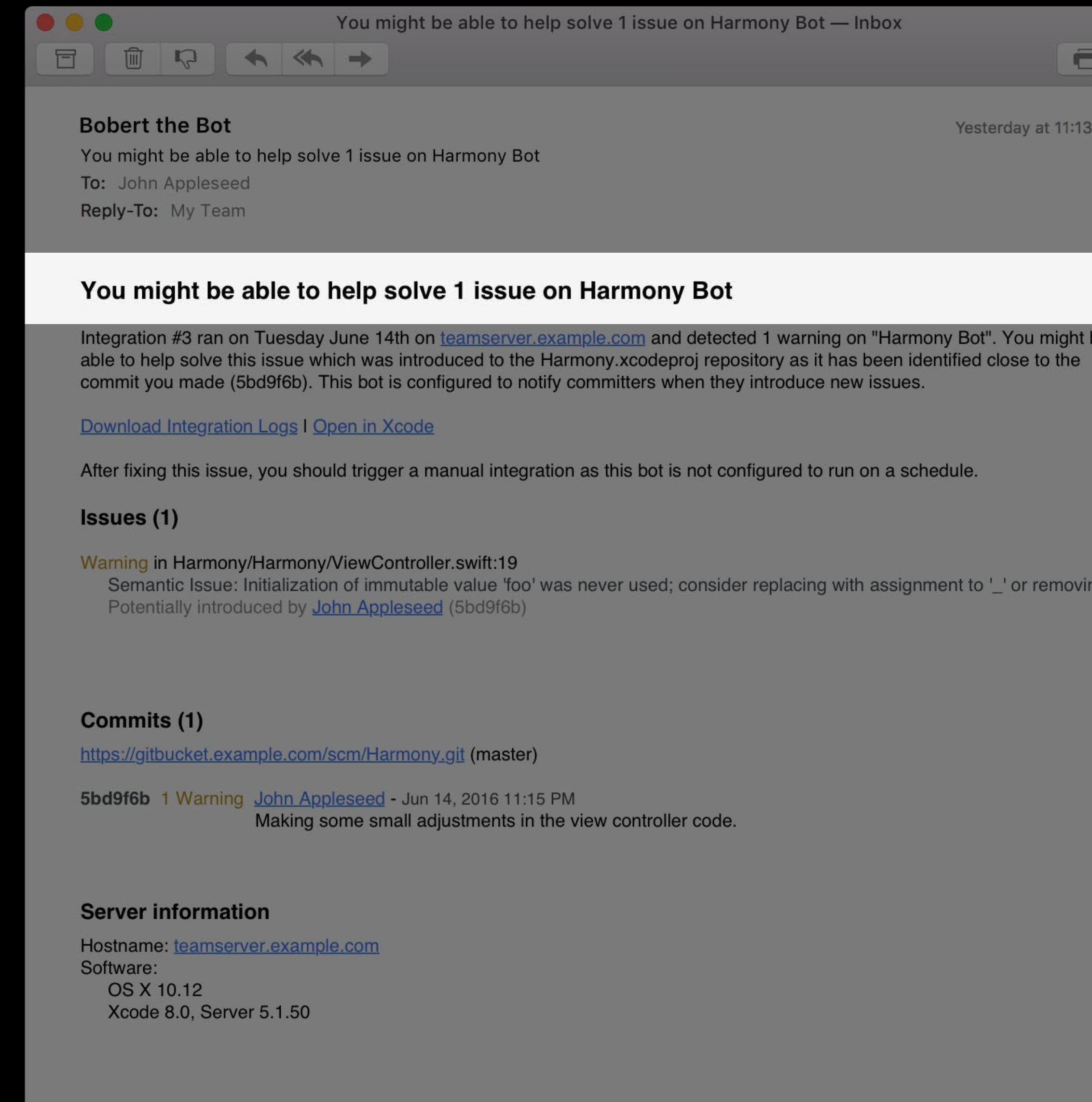
You broke it

- You introduced an issue
- Issue is on or near line you modified
- You are the only committer

You can help fix it

- You probably know how to fix an issue
- You seem to know about the area involved

NEW



You might be able to help solve 1 issue on Harmony Bot — Inbox

Yesterday at 11:13

**Bob the Bot**

You might be able to help solve 1 issue on Harmony Bot

To: John Appleseed

Reply-To: My Team

**You might be able to help solve 1 issue on Harmony Bot**

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**Server information**

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Software:

OS X 10.12

Xcode 8.0, Server 5.1.50

# Issue Tracking and Blame

## Identifying issue owners

Lets you know when it's time to act

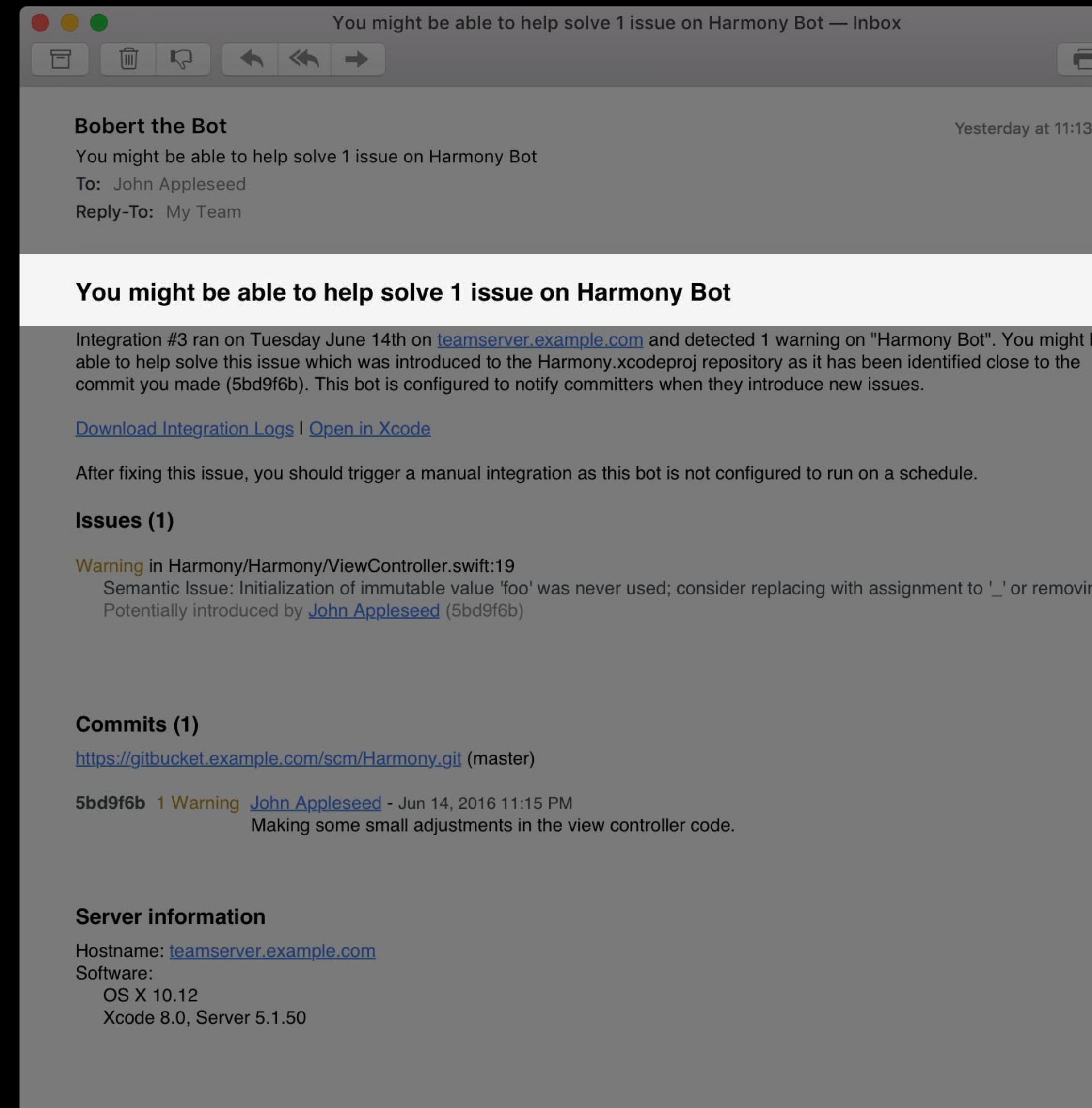
You broke it

- You introduced an issue
- Issue is on or near line you modified
- You are the only committer

You can help fix it

- You probably know how to fix an issue
- You seem to know about the area involved
- Fuzzy matching

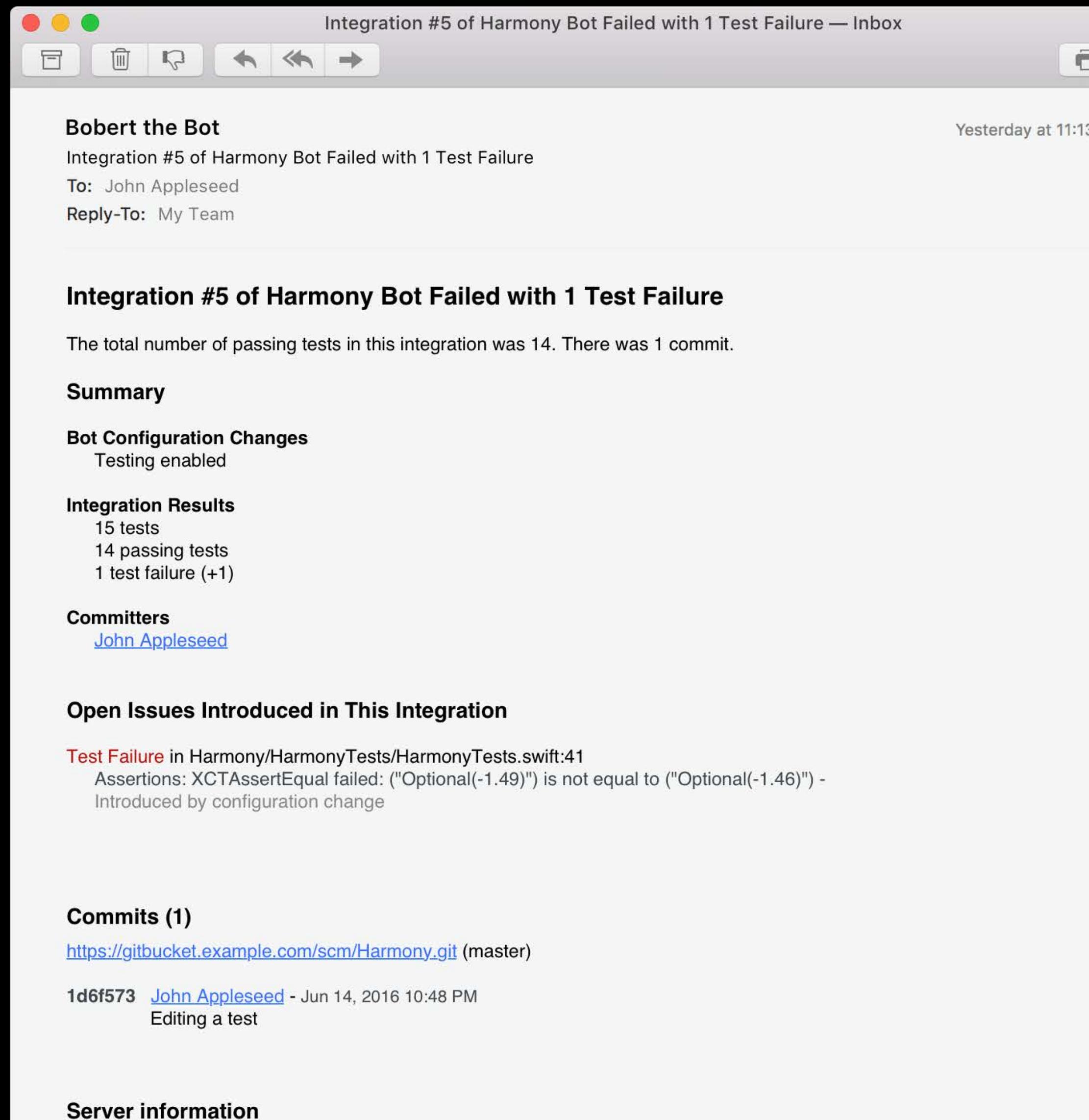
NEW



# Issue Tracking and Blame

## Bot configuration changes

NEW



Integration #5 of Harmony Bot Failed with 1 Test Failure — Inbox

Yesterday at 11:13

**Bob the Bot**

Integration #5 of Harmony Bot Failed with 1 Test Failure

To: John Appleseed

Reply-To: My Team

**Integration #5 of Harmony Bot Failed with 1 Test Failure**

The total number of passing tests in this integration was 14. There was 1 commit.

**Summary**

**Bot Configuration Changes**  
Testing enabled

**Integration Results**  
15 tests  
14 passing tests  
1 test failure (+1)

**Committers**  
[John Appleseed](#)

**Open Issues Introduced in This Integration**

**Test Failure** in Harmony/HarmonyTests/HarmonyTests.swift:41  
Assertions: XCTAssertEqual failed: ("Optional(-1.49)") is not equal to ("Optional(-1.46)") -  
Introduced by configuration change

**Commits (1)**  
<https://gitbucket.example.com/scm/Harmony.git> (master)

1d6f573 [John Appleseed](#) - Jun 14, 2016 10:48 PM  
Editing a test

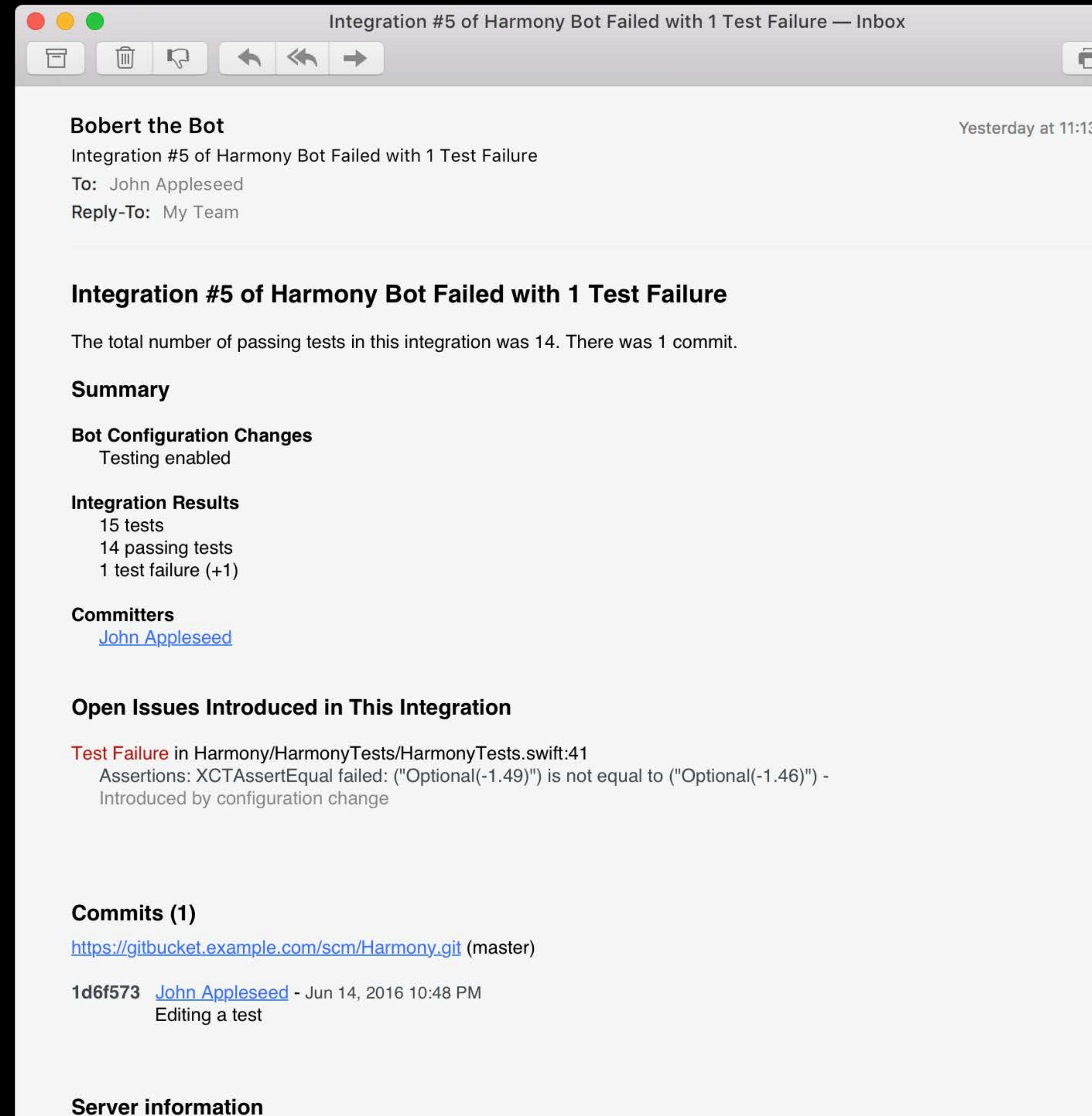
**Server information**

# Issue Tracking and Blame

## Bot configuration changes

Tracks changes to your bot configuration

NEW



Integration #5 of Harmony Bot Failed with 1 Test Failure — Inbox

Yesterday at 11:13

**Bob the Bot**

Integration #5 of Harmony Bot Failed with 1 Test Failure

To: John Appleseed

Reply-To: My Team

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Editing a test

**Server information**

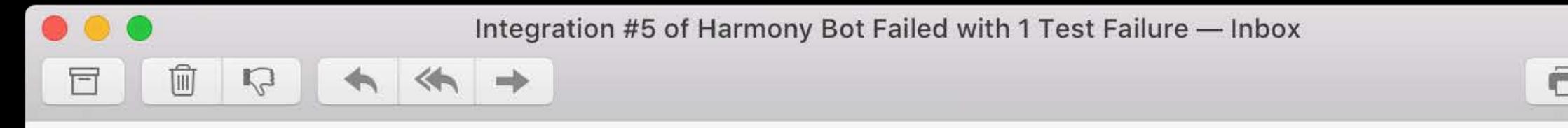
# Issue Tracking and Blame

## Bot configuration changes

Tracks changes to your bot configuration

Attributes issues to changes where possible

NEW



Integration #5 of Harmony Bot Failed with 1 Test Failure — Inbox

Yesterday at 11:13

**Bob the Bot**  
Integration #5 of Harmony Bot Failed with 1 Test Failure  
To: John Appleseed  
Reply-To: My Team

**Integration #5 of Harmony Bot Failed with 1 Test Failure**  
The total number of passing tests in this integration was 14. There was 1 commit.

**Summary**

**Bot Configuration Changes**  
Testing enabled

**Integration Results**  
15 tests  
14 passing tests  
1 test failure (+1)

**Committers**  
[John Appleseed](#)

**Open Issues Introduced in This Integration**

**Test Failure** in Harmony/HarmonyTests/HarmonyTests.swift:41  
Assertions: XCTAssertEqual failed: ("Optional(-1.49)") is not equal to ("Optional(-1.46)") -  
Introduced by configuration change

**Commits (1)**  
<https://gitbucket.example.com/scm/Harmony.git> (master)

1d6f573 [John Appleseed](#) - Jun 14, 2016 10:48 PM  
Editing a test

**Server information**

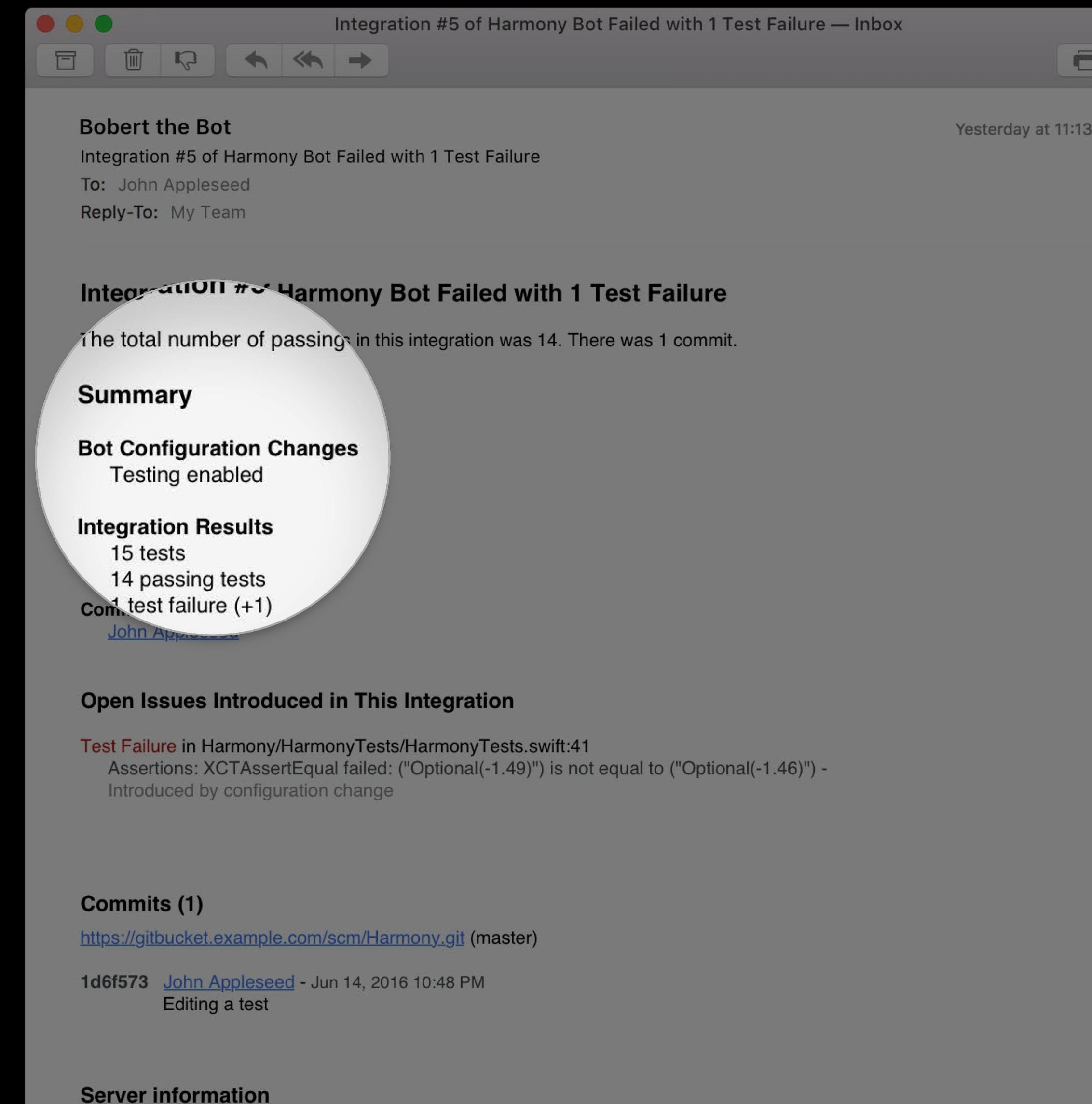
# Issue Tracking and Blame

## Bot configuration changes

Tracks changes to your bot configuration

Attributes issues to changes where possible

Included in email reports



NEW

# Upgrade Integrations

When it's not your fault

NEW

Harmony | Build **Succeeded** | Yesterday at 2:30 PM

Harmony Bot > **Upgrade (11)**

Summary Test

Integrate (11)

Status: Failed tests

Scheme: Harmony

Branch: master

Start Time: Today, 3:13 PM

Duration: 2 minutes, 52 seconds

0 ERRORS

No Change

Bot Configuration Changes

- Xcode upgraded from 7.3.1 to 8.0 beta
- Xcode SDKs upgraded

New Issues (2 warnings)

Test Failure UI Testing Failure - Exceeded timeout of 30 seconds, w...

Test case: -[HarmonyUITests testExample()] in Harmony/HarmonyUITests.swift:29

Introduced by Xcode upgrade

Warning 'asynchronously(group:qos:flags:execute:)' is deprecated...

In Harmony/Harmony/ViewController.swift:29

Introduced by Xcode upgrade

Warning 'asynchronously(group:qos:flags:execute:)' is deprecated...

In Harmony/Harmony/ViewController.swift:43

Introduced by Xcode upgrade

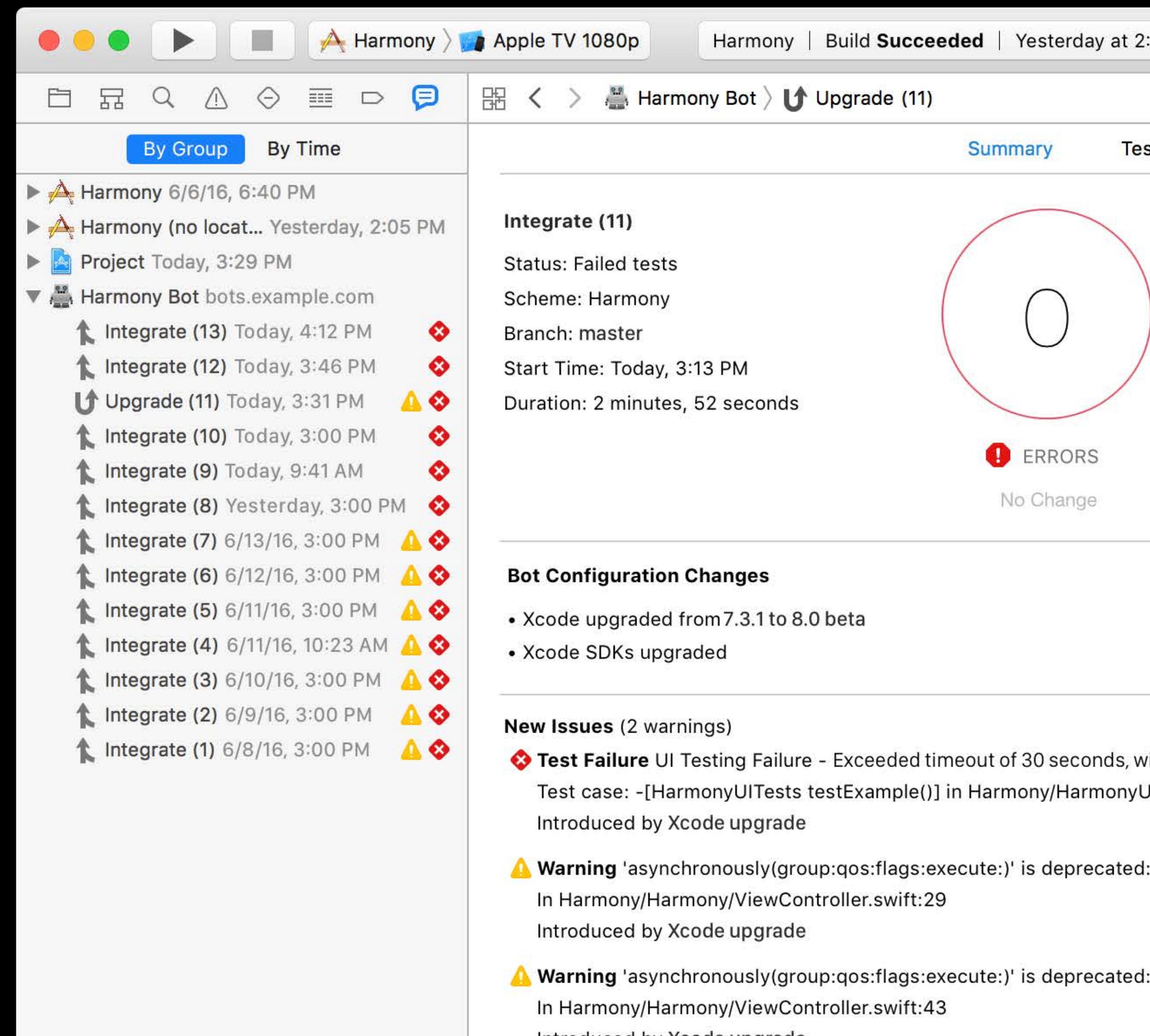
By Group	By Time
▶ Harmony 6/6/16, 6:40 PM	
▶ Harmony (no locat... Yesterday, 2:05 PM	
▶ Project Today, 3:29 PM	
▼ Harmony Bot bots.example.com	
↑ Integrate (13) Today, 4:12 PM	✗
↑ Integrate (12) Today, 3:46 PM	✗
↑ Upgrade (11) Today, 3:31 PM	⚠✗
↑ Integrate (10) Today, 3:00 PM	✗
↑ Integrate (9) Today, 9:41 AM	✗
↑ Integrate (8) Yesterday, 3:00 PM	✗
↑ Integrate (7) 6/13/16, 3:00 PM	⚠✗
↑ Integrate (6) 6/12/16, 3:00 PM	⚠✗
↑ Integrate (5) 6/11/16, 3:00 PM	⚠✗
↑ Integrate (4) 6/11/16, 10:23 AM	⚠✗
↑ Integrate (3) 6/10/16, 3:00 PM	⚠✗
↑ Integrate (2) 6/9/16, 3:00 PM	⚠✗
↑ Integrate (1) 6/8/16, 3:00 PM	⚠✗

# Upgrade Integrations

When it's not your fault

NEW

Re-integrates your project



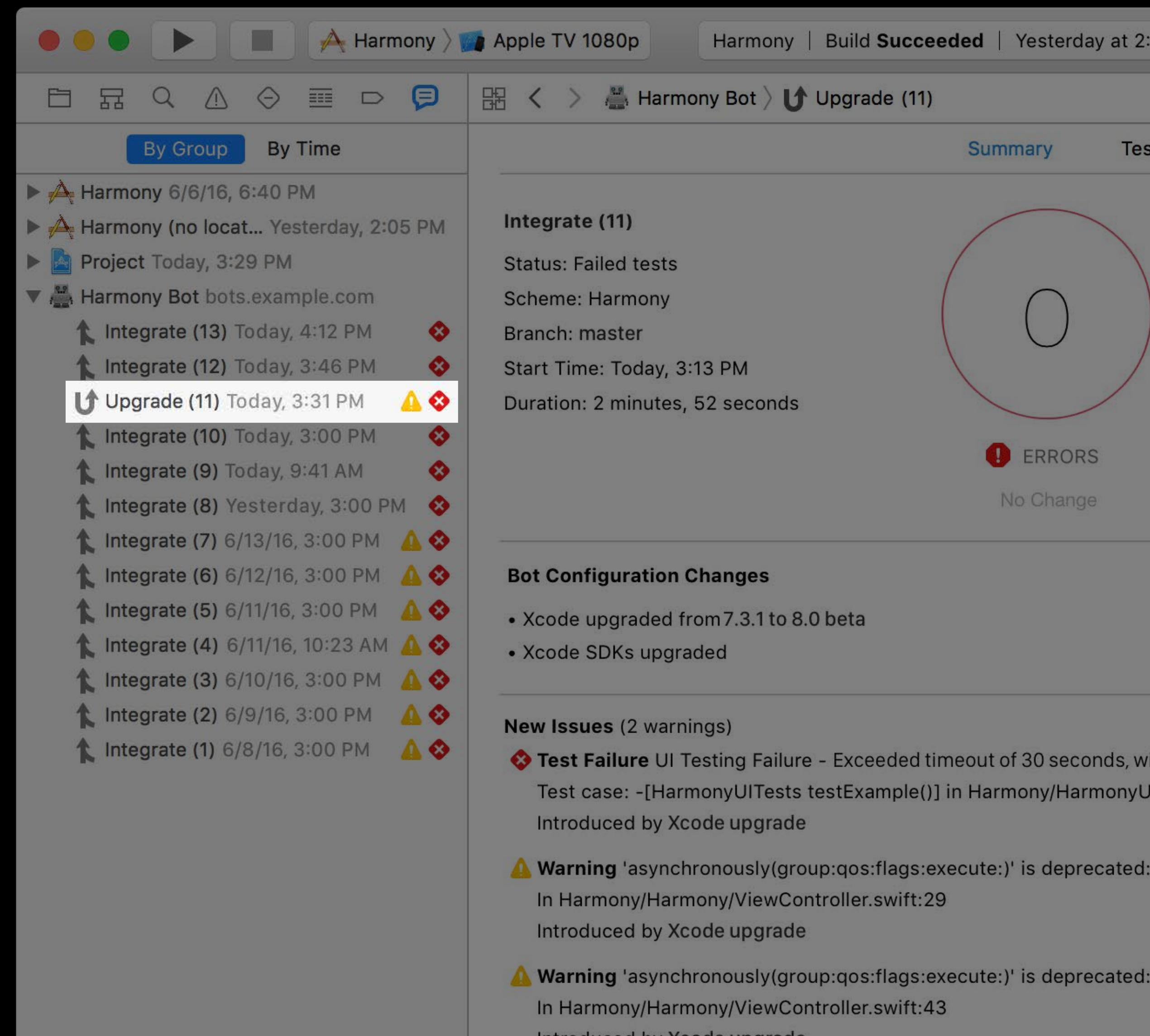
# Upgrade Integrations

When it's not your fault

NEW

Re-integrates your project

Same revision as the last integration



# Upgrade Integrations

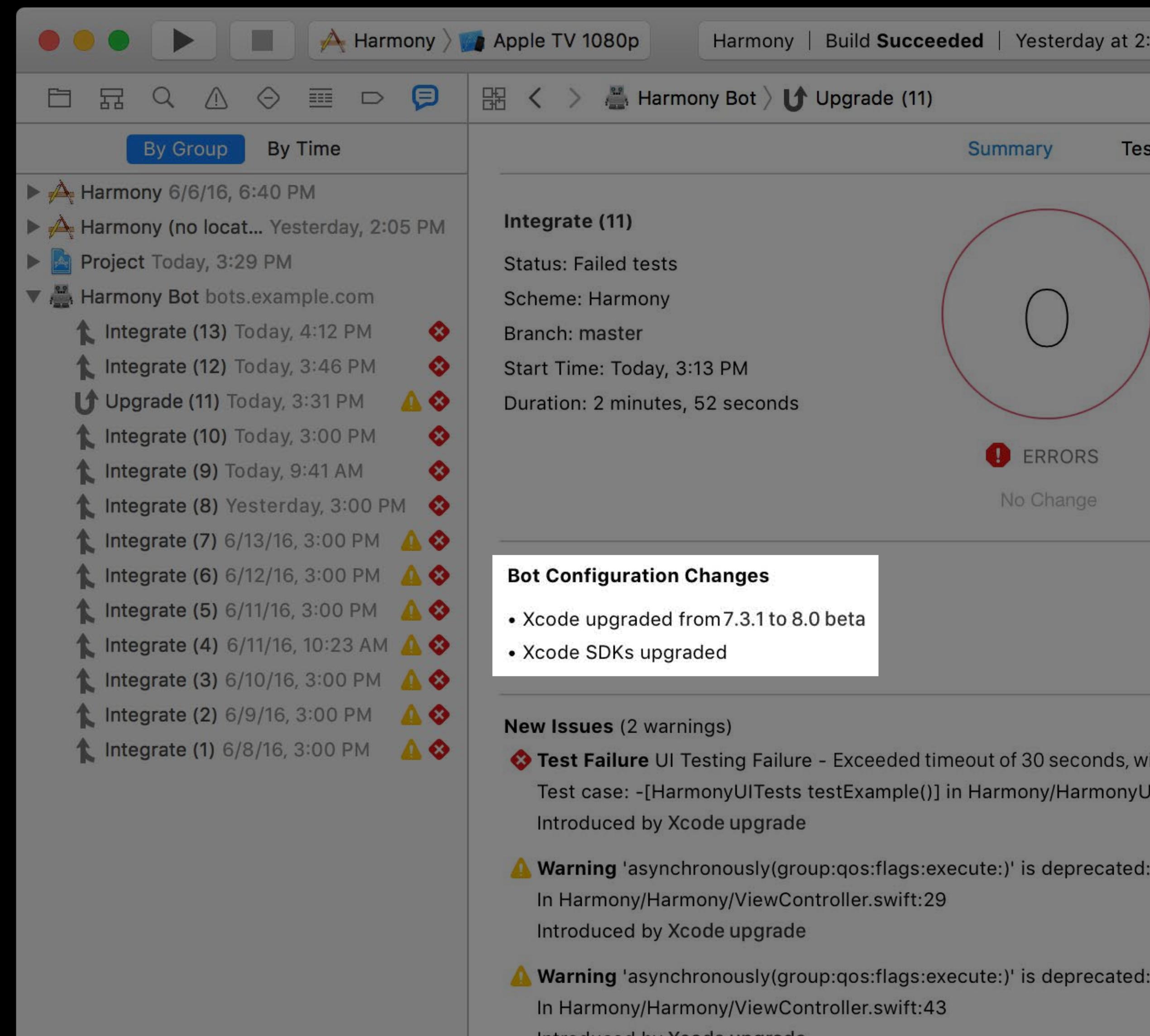
When it's not your fault

NEW

Re-integrates your project

Same revision as the last integration

Any new issues are due to the upgrade



# Upgrade Integrations

When it's not your fault

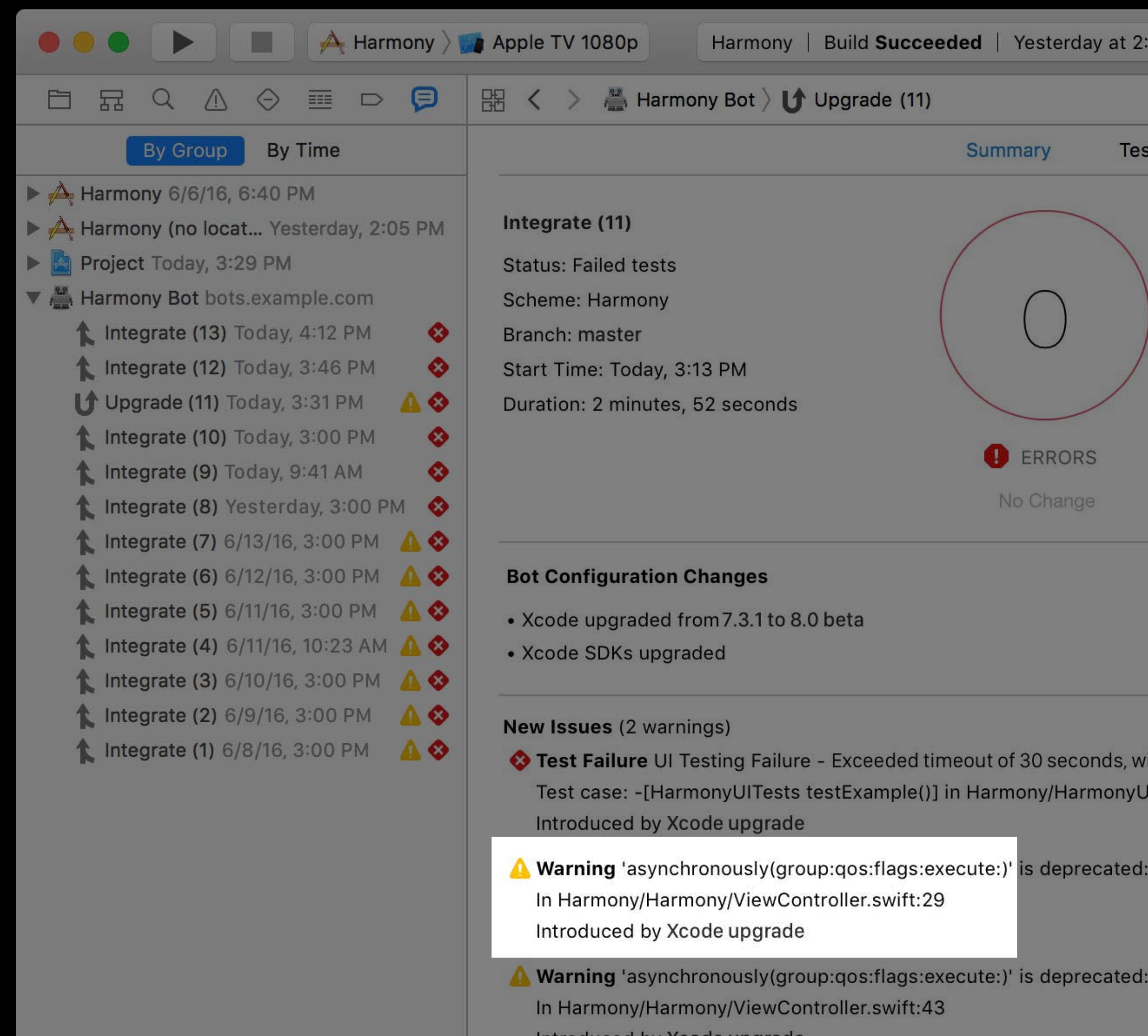
NEW

Re-integrates your project

Same revision as the last integration

Any new issues are due to the upgrade

Prevents blaming you for broken builds



# Configurable Integration User



# Configurable Integration User

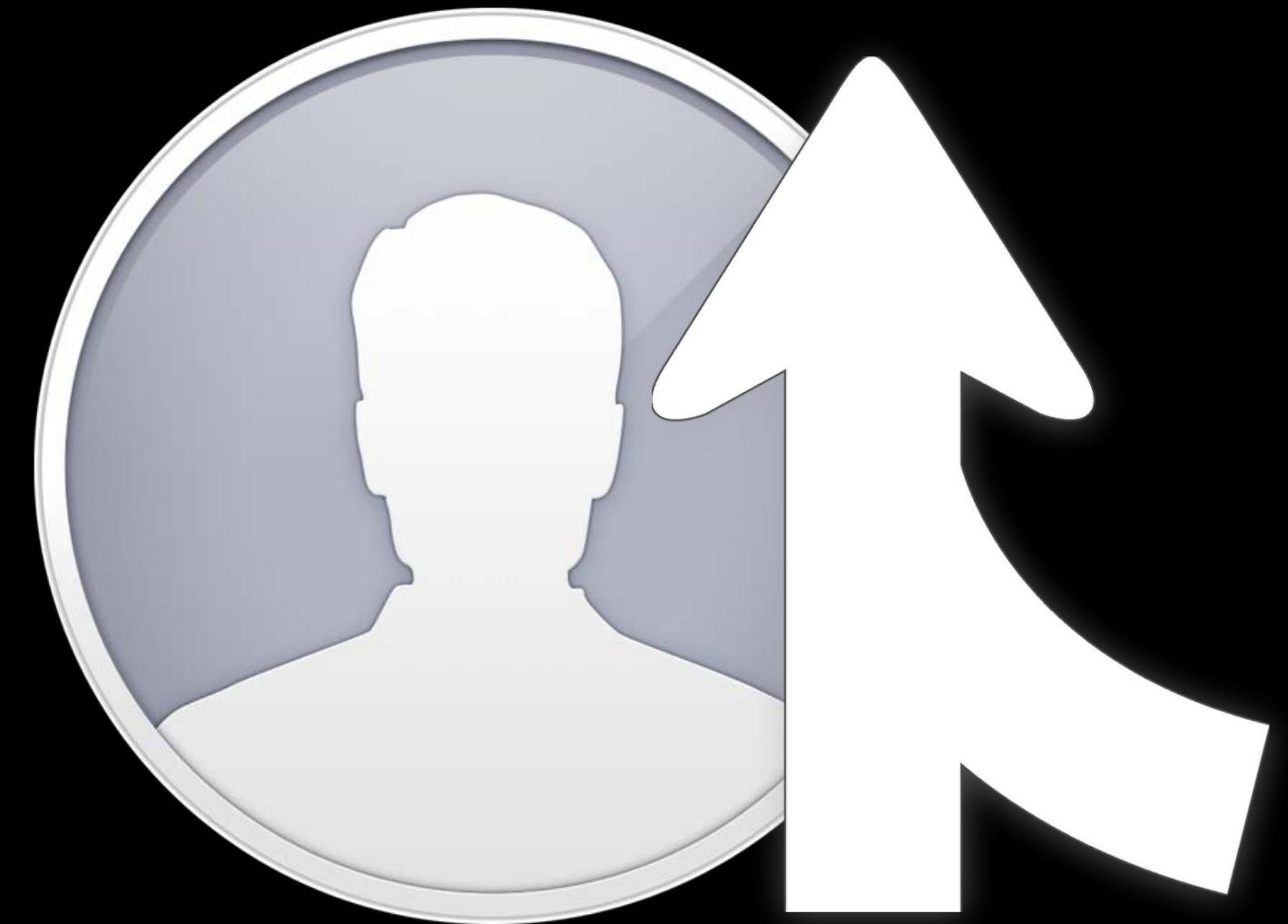
Improved visibility into your integrations



# Configurable Integration User

Improved visibility into your integrations

Allows customization



# Configurable Integration User

Improved visibility into your integrations

Allows customization

You own and manage how your  
integrations run



# Configurable Integration User

Improved visibility into your integrations

Allows customization

You own and manage how your integrations run

Can be any user on the system



# Configurable Integration User

Improved visibility into your integrations

Allows customization

You own and manage how your integrations run

Can be any user on the system

Runs as a menu extra



Server

- Example Server
- Alerts
- Certificates
- Logs
- Stats

Accounts

- Users
- Groups

Services

- Caching
- Calendar
- Contacts
- File Sharing
- Mail
- Messages
- Profile Manager
- Time Machine
- VPN
- Websites
- Wiki
- Xcode

Advanced

 Xcode

OFF



Choose Xcode to begin

Use Xcode Server to continually build and test your team's apps.

Download the latest version of Xcode 

[Choose Xcode...](#)

Server

- Example Server
- Alerts
- Certificates
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- Stats

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- Calendar
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- File Sharing
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- Profile Manager
- Time Machine
- VPN
- Websites
- Wiki
- Xcode

Advanced

**Testing User**

Xcode Server requires a logged-in user to integrate your projects. It is recommended that you use a dedicated, non-administrative user.

OFF

User Account:

Full Name:

Account Name:

Password:  

Verify:

Allow user to administer this server

**Choose Xcode to begin**

Use Xcode Server to continually build and test your team's apps.

[Download the latest version of Xcode](#) 

Server

- Example Server
- Alerts
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- Messages
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- VPN
- Websites
- Wiki
- Xcode

Advanced

 Xcod

Preparing to configure Xcode Server...

OFF



Choose Xcode to begin

Use Xcode Server to continually build and test your team's apps.

[Download the latest version of Xcode](#)

[Choose Xcode...](#)

Server

- Example Server
- Alerts
- Certificates
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Services

- Caching
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- File Sharing
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- Messages
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- VPN
- Websites
- Wiki
- Xcode

Advanced

 Xcod

Configuring Xcode Server...

OFF



Choose Xcode to begin

Use Xcode Server to continually build and test your team's apps.

[Download the latest version of Xcode](#)

[Choose Xcode...](#)

Server

- Example Server
- Alerts
- Certificates
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- Mail
- Messages
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- Time Machine
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- Websites
- Wiki
- Xcode

Advanced

 Xcod

Upgrading Xcode Server data...

OFF



Choose Xcode to begin

Use Xcode Server to continually build and test your team's apps.

Download the latest version of Xcode 

[Choose Xcode...](#)

Server

- Example Server
- Alerts
- Certificates
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- Contacts
- File Sharing
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- VPN
- Websites
- Wiki
- Xcode

Advanced

 Xcod

Configuring access...

OFF



Choose Xcode to begin

Use Xcode Server to continually build and test your team's apps.

Download the latest version of Xcode 

[Choose Xcode...](#)

Server

- Example Server
- Alerts
- Certificates
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- File Sharing
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- Wiki
- Xcode

Advanced

 Xcod

Finishing Xcode Server setup...

OFF



Choose Xcode to begin

Use Xcode Server to continually build and test your team's apps.

[Download the latest version of Xcode](#)

[Choose Xcode...](#)

Server

- Example Server
- Alerts
- Certificates
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**Xcode**

Advanced

**You must log in as Customized Integration User to run integrations.**

Integrations will not start until you log in. If you use fast user switching to return to this user, integrations will continue to run in the background.

[.local](#)

Learn about configuring devices for this service 

Permissions: Logged in users can create bots, anyone can view bots

Build using: Xcode 8.0 (8A147)

Run tests as:  Customized Integration User (Logged Out)

Developer Teams: No Teams

Development Devices:

Name	Type	Status

Add a developer team to test on iOS devices





Xcode Server is ready  
Waiting for integrations to run.



Server

- Example Server
- Alerts
- Certificates
- Logs
- Stats

Accounts

- Users
- Groups

Services

- Caching
- Calendar
- Contacts
- File Sharing
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- Profile Manager
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- Wiki

**Xcode**

ON

Status: Available on your local network at Example-Server.local  
[Learn about configuring devices for this service](#)

Permissions: Logged in users can create bots, anyone can view bots  
[Edit Permissions...](#)

Build using: Xcode 8.0 (8A147)  
[Choose Xcode...](#)

Run tests as: Customized Integration User (Logged In)  
[Switch User...](#)

Developer Teams: No Teams  
[Add Team...](#)

Development Devices:

Name	Type	Status
Add a developer team to test on iOS devices		

[View bots](#)  [Search](#)

*Demo*

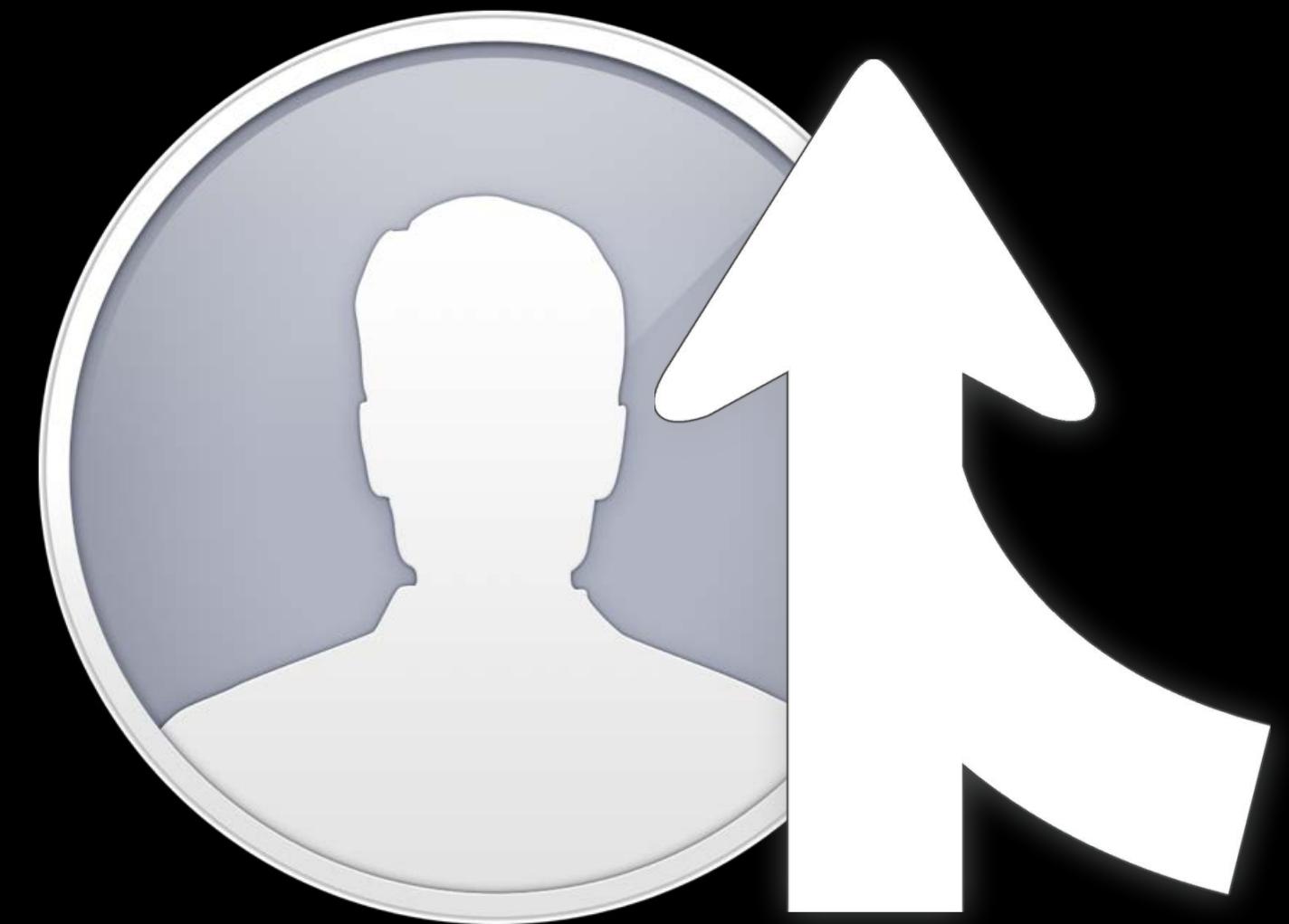
Xcode Server

# Configurable Integration User



# Configurable Integration User

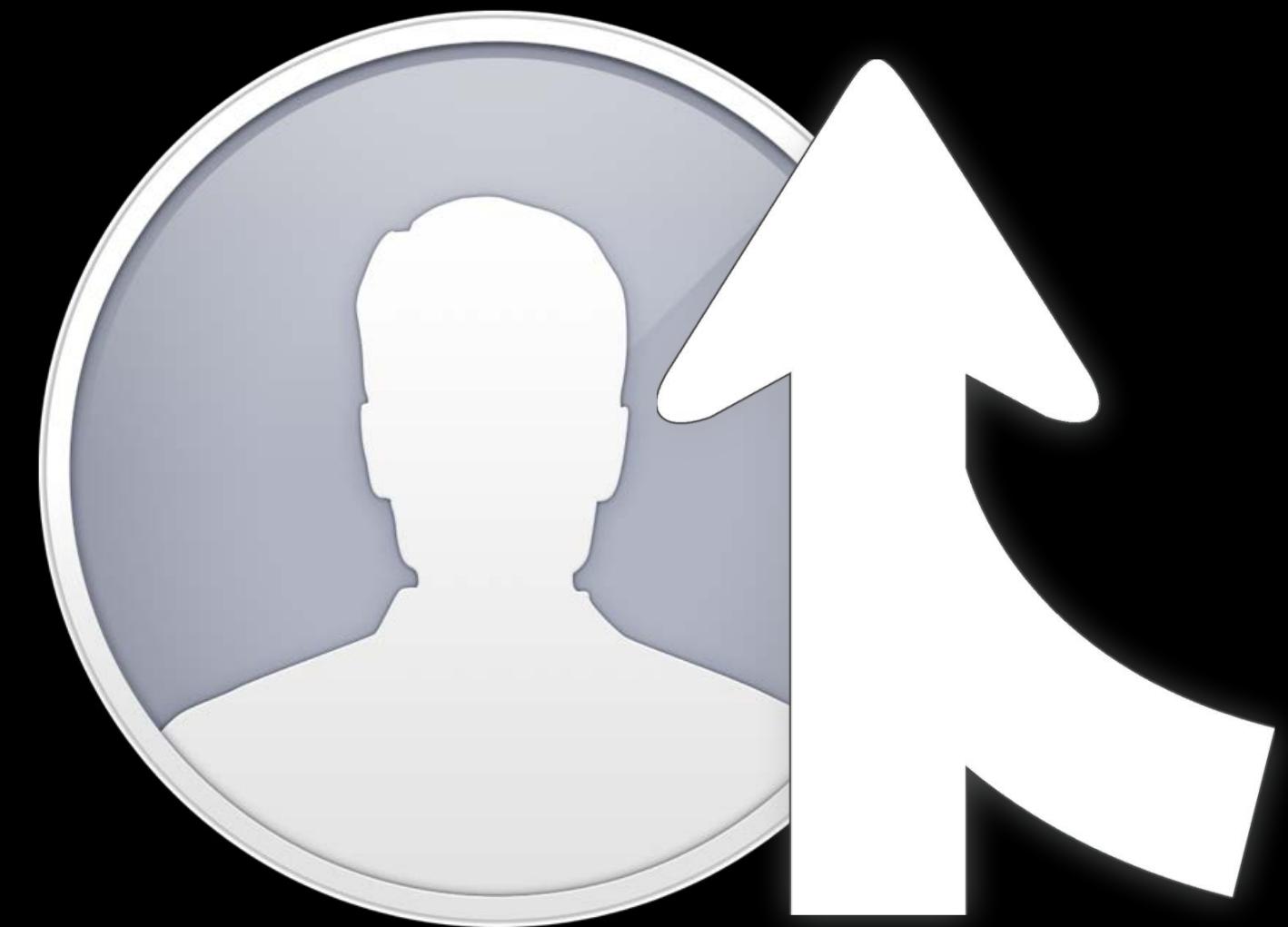
Improved visibility



# Configurable Integration User

Improved visibility

Customized simulators



# Configurable Integration User

Improved visibility

Customized simulators

Normal macOS user



# Configurable Integration User

Improved visibility

Customized simulators

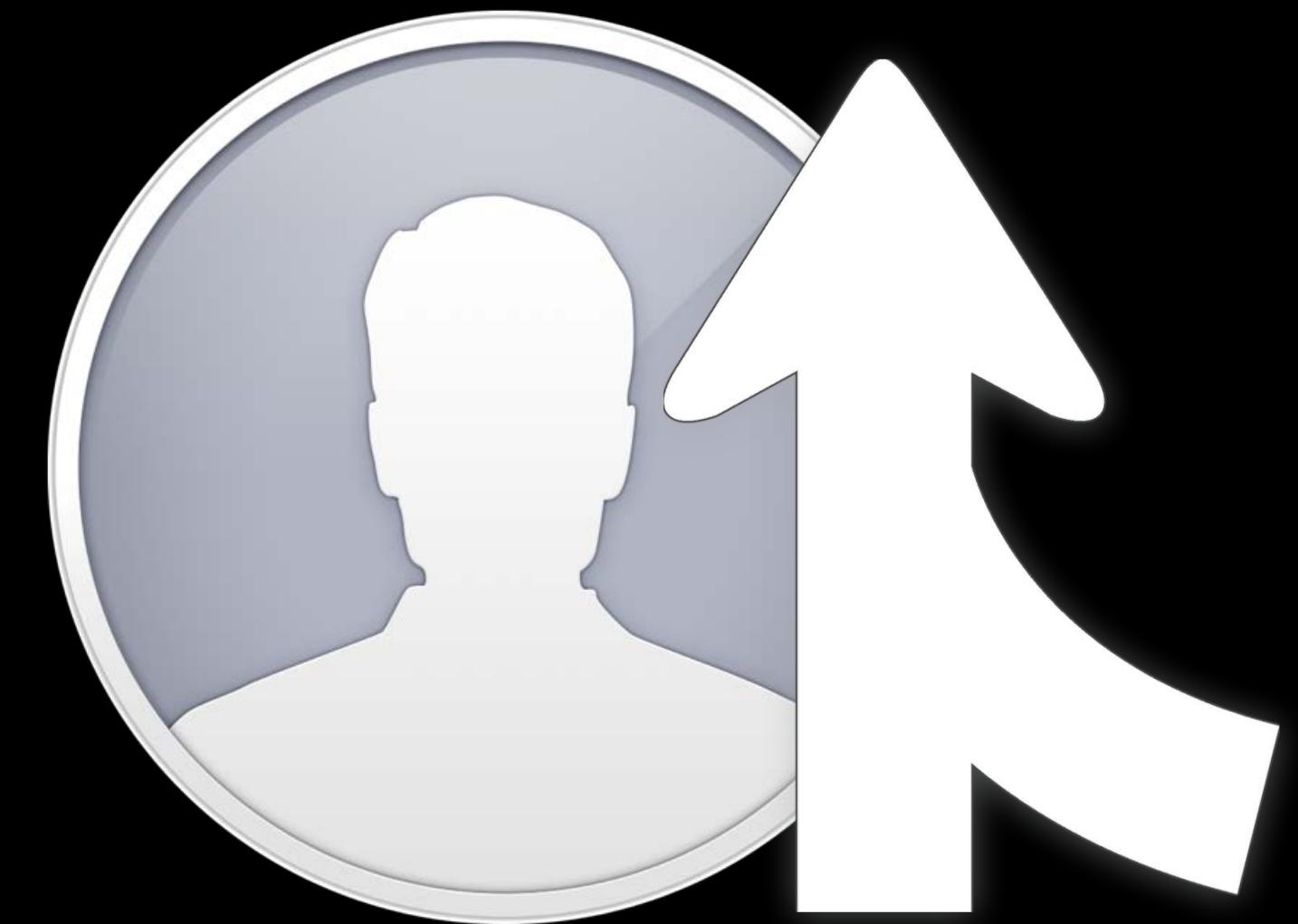
Normal macOS user

Runs as a menu extra



# Configurable Integration User

## Best practices



# Configurable Integration User

## Best practices

Dedicate a new user



# Configurable Integration User

## Best practices

Dedicate a new user

Avoid using administrator accounts



# Configurable Integration User

## Best practices

Dedicate a new user

Avoid using administrator accounts

Stay logged in with Fast User Switching



# Configurable Integration User

## Best practices

Dedicate a new user

Avoid using administrator accounts

Stay logged in with Fast User Switching

Disable screen lock



# Configurable Integration User

## Best practices

Dedicate a new user

Avoid using administrator accounts

Stay logged in with Fast User Switching

Disable screen lock

Customize for your needs



# Configurable Integration User

## Best practices

Dedicate a new user

Avoid using administrator accounts

Stay logged in with Fast User Switching

Disable screen lock

Customize for your needs

- Simulators



# Configurable Integration User

## Best practices

Dedicate a new user

Avoid using administrator accounts

Stay logged in with Fast User Switching

Disable screen lock

Customize for your needs

- Simulators
- Networking (VPN and proxies)



# Configurable Integration User

## Best practices

Dedicate a new user

Avoid using administrator accounts

Stay logged in with Fast User Switching

Disable screen lock

Customize for your needs

- Simulators
- Networking (VPN and proxies)
- User data and settings



# Configurable Integration User

## Best practices

Dedicate a new user

Avoid using administrator accounts

Stay logged in with Fast User Switching

Disable screen lock

Customize for your needs

- Simulators
- Networking (VPN and proxies)
- User data and settings
- Advanced provisioning



# xcodebuild

Building block for Continuous Integration Systems

# xcodebuild

## Test action

```
xcodebuild test -workspace <path>  
      -scheme <name>  
      -destination <specifier>
```

# xcodebuild

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xcodebuild test -workspace <path>  
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```

Builds sources

# xcodebuild

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Builds sources

Installs app on destination if needed

# xcodebuild

## Test action

```
xcodebuild test -workspace <path>  
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          -destination <specifier>
```

Builds sources

Installs app on destination if needed

Runs tests

# xcodebuild

## Test action

```
xcodebuild test -workspace <path>  
          -scheme <name>  
          -destination <specifier>
```

Builds sources

Installs app on destination if needed

Runs tests

Reports results in console

# Test Options

## Customizing tests

NEW

```
xcodebuild test -workspace <path>
  -scheme <name>
  -destination <specifier>
  -only-testing:TestBundleA/TestSuiteA/TestCaseA
  -only-testing:TestBundleB/TestSuiteB
  -only-testing:TestBundleC
```

# Test Options

## Customizing tests

NEW

```
xcodebuild test -workspace <path>
  -scheme <name>
  -destination <specifier>
  -only-testing:TestBundleA/TestSuiteA/TestCaseA
  -only-testing:TestBundleB/TestSuiteB
  -only-testing:TestBundleC
```

```
xcodebuild test -scheme <name>
  -skip-testing:TestBundleD/TestSuiteD/TestCaseD
```

# Additional Test Actions

Separating building from testing

NEW



Test

# Additional Test Actions

Separating building from testing

NEW

Build for Testing

Test without Building

# Building for Testing

Only building

NEW

```
xcodebuild build-for-testing -workspace <path>  
          -scheme <name>  
          -destination <specifier>
```

# Building for Testing

Only building

NEW

```
xcodebuild build-for-testing -workspace <path>  
          -scheme <name>  
          -destination <specifier>
```

Builds sources for testing

# Building for Testing

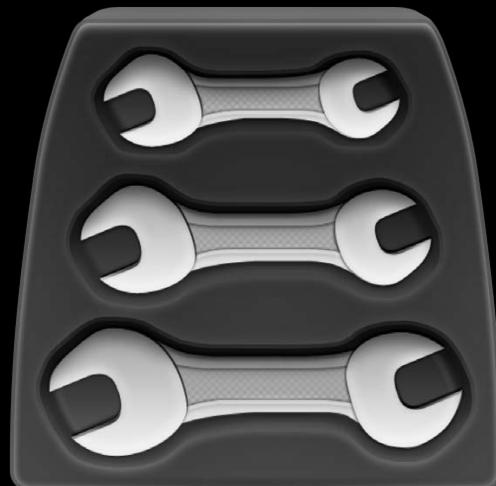
Only building

NEW

```
xcodebuild build-for-testing -workspace <path>  
-scheme <name>  
-destination <specifier>
```

Builds sources for testing

Outputs products in Derived Data



# Building for Testing

Only building

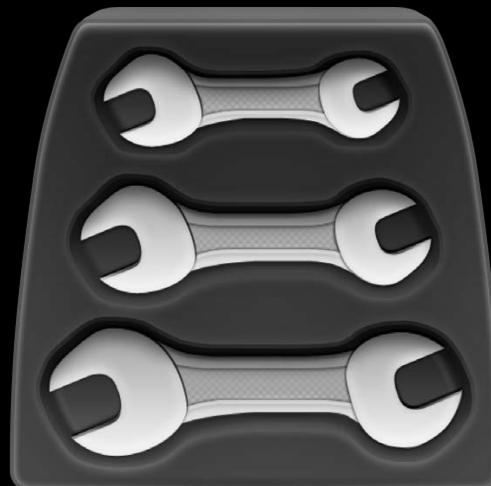
NEW

```
xcodebuild build-for-testing -workspace <path>  
-scheme <name>  
-destination <specifier>
```

Builds sources for testing

Outputs products in Derived Data

Generates an xctestrun file



# Test Without Building

Only testing

NEW

```
xcodetool test-without-building -workspace <path>  
-scheme <name>  
-destination <specifier>
```

# Test Without Building

Only testing

NEW

```
xcodebuild test-without-building -workspace <path>  
          -scheme <name>  
          -destination <specifier>
```

Finds binary products in Derived Data

# Test Without Building

Only testing

NEW

```
xcodebuild test-without-building -workspace <path>  
          -scheme <name>  
          -destination <specifier>
```

Finds binary products in Derived Data

Installs if necessary

# Test Without Building

Only testing

NEW

```
xcodebuild test-without-building -workspace <path>  
          -scheme <name>  
          -destination <specifier>
```

Finds binary products in Derived Data

Installs if necessary

Runs tests and report results as before

# Test Without Building

Only testing

NEW

```
xcodetool test-without-building -xctestrun <path>  
-destination <specifier>
```

# Test Without Building

Only testing

```
xcodetool test-without-building -xctestrun <path>  
-destination <specifier>
```

Ingests the xctestrun file



NEW

# Test Without Building

Only testing

```
xcodetool test-without-building -xctestrun <path>  
-destination <specifier>
```

Ingests the xctestrun file

Finds binary products relative to xctestrun file



NEW

# Test Without Building

Only testing

```
xcodetool test-without-building -xctestrun <path>  
-destination <specifier>
```

Ingests the xctestrun file

Finds binary products relative to xctestrun file

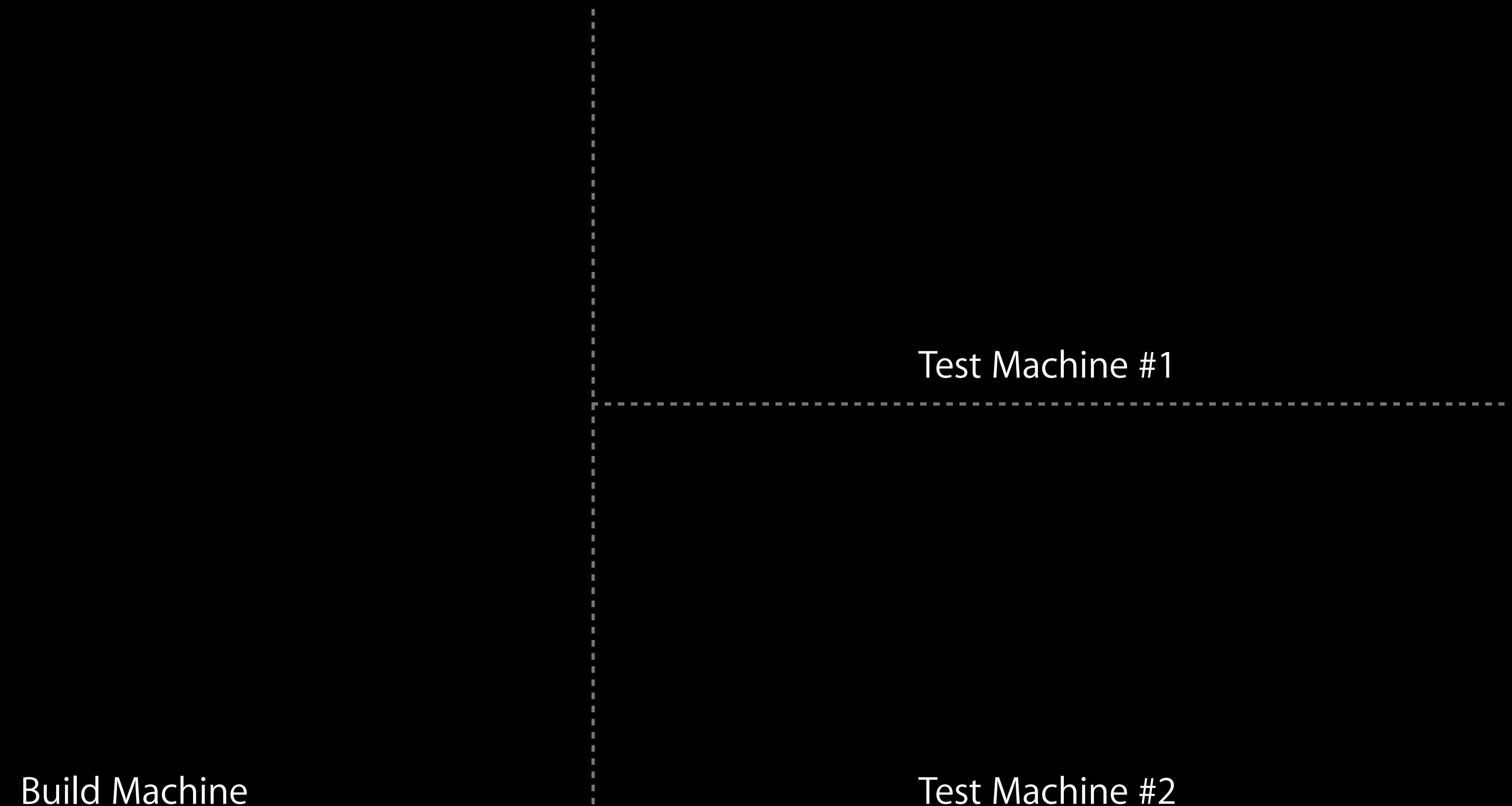
Runs tests, reports results as before



NEW

# xcodebuild

## Distributed testing

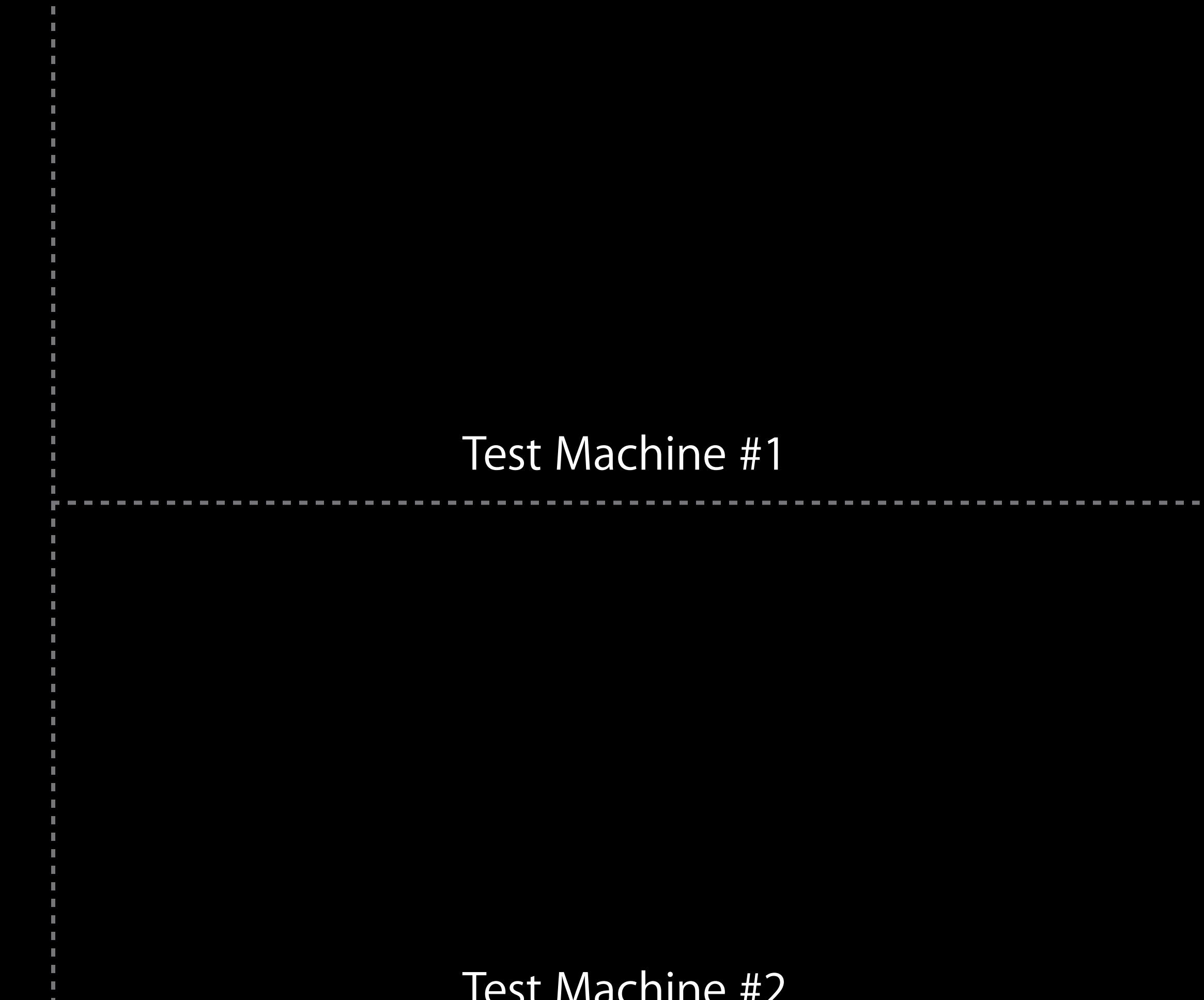


# xcodebuild

## Distributed testing



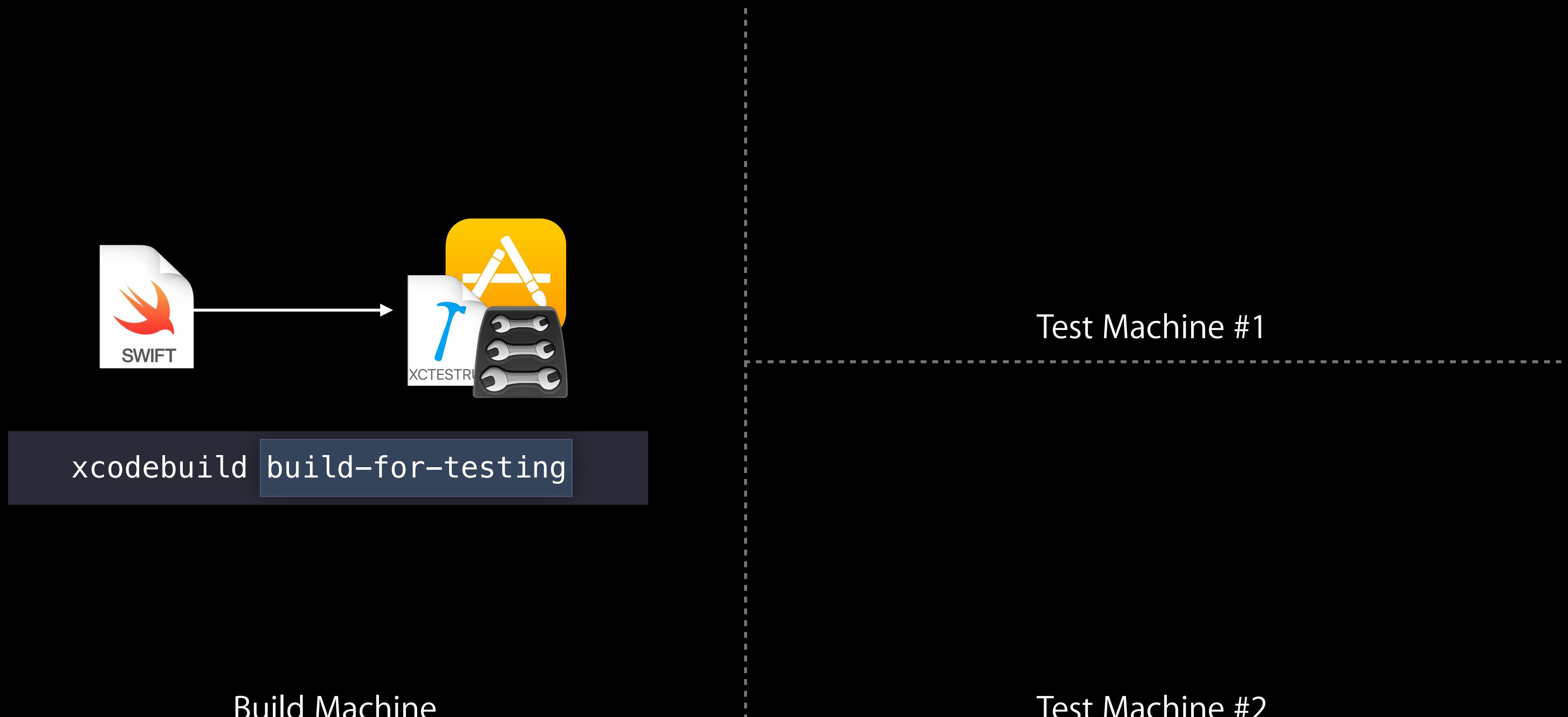
Build Machine



Test Machine #2

# xcodebuild

## Distributed testing



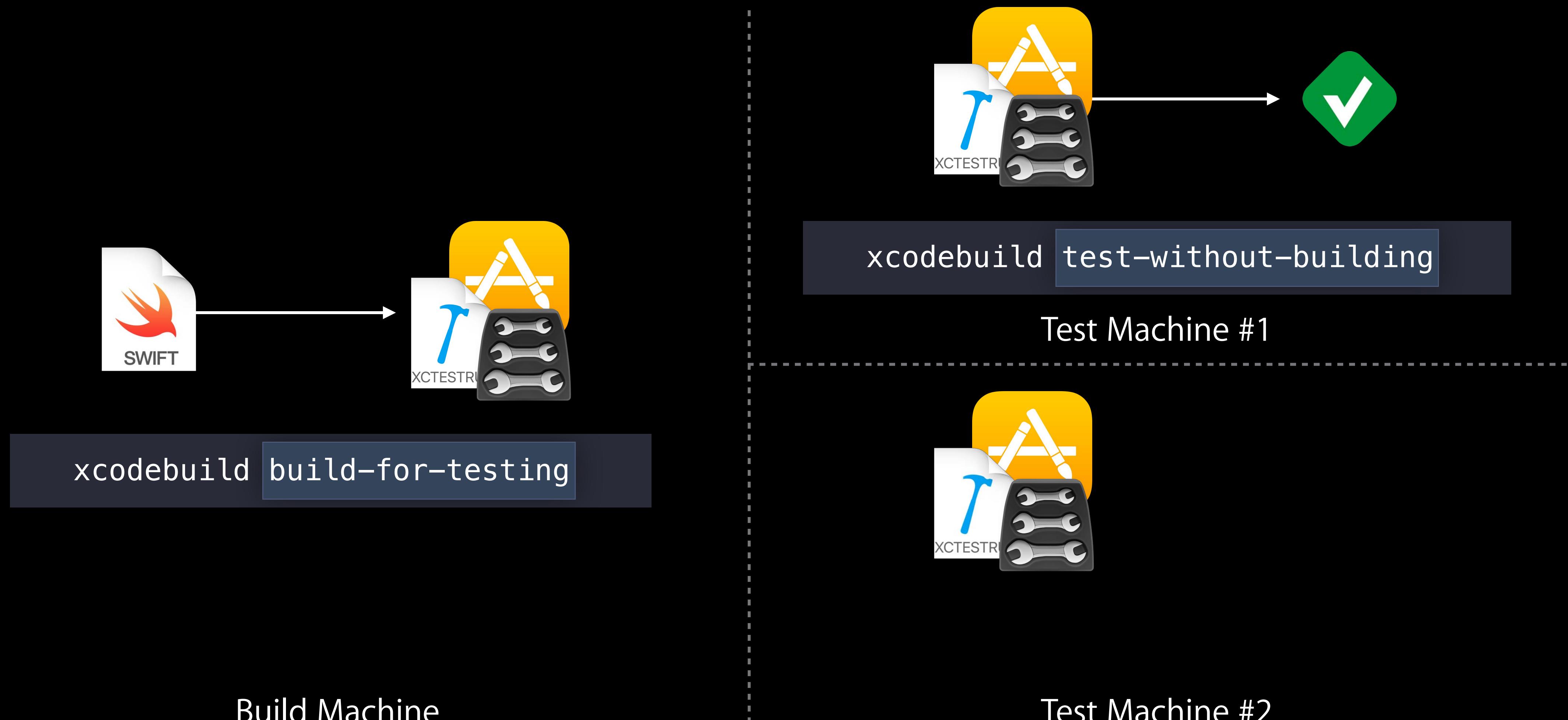
# xcodebuild

## Distributed testing



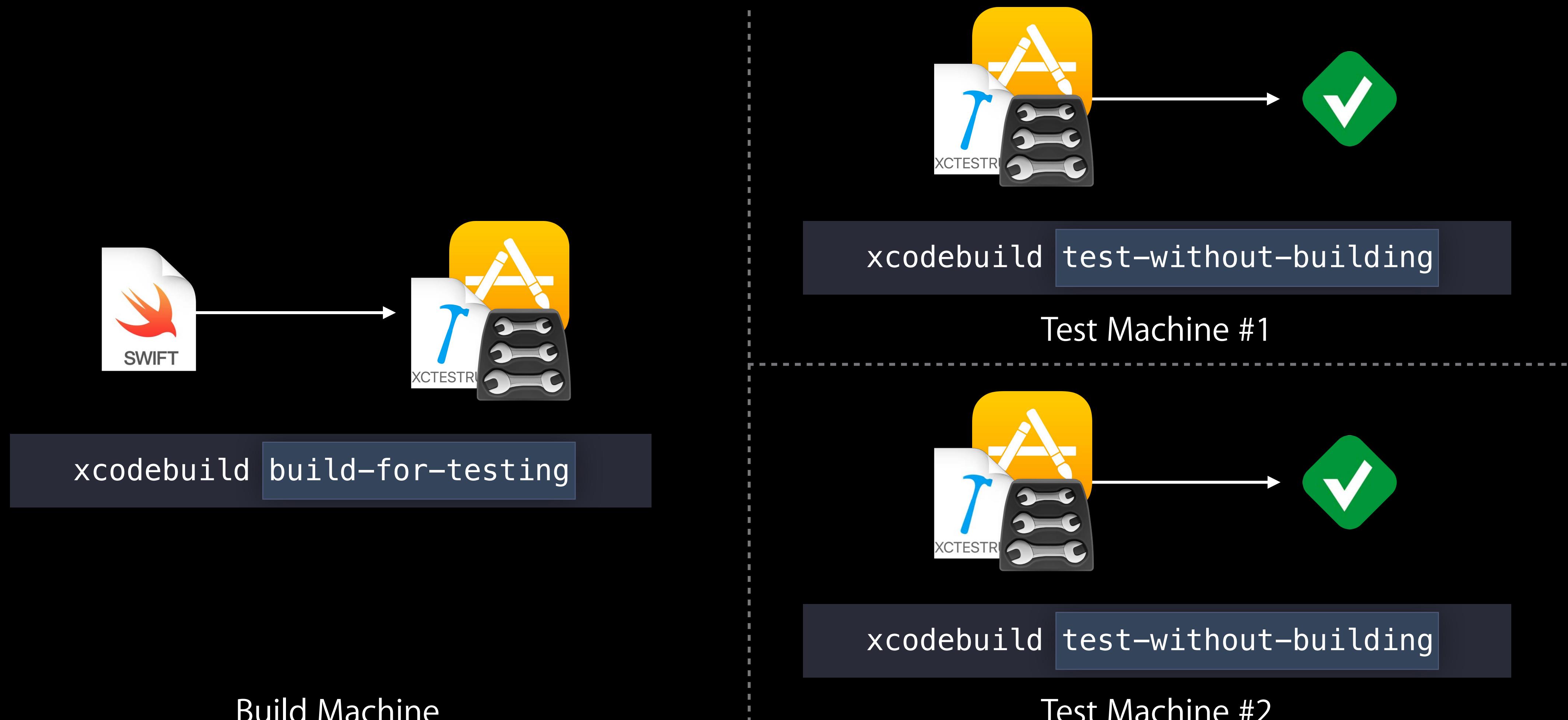
# xcodebuild

## Distributed testing



# xcodebuild

## Distributed testing



# xctestrun

## Test manifest

NEW

xctestrunk

Test manifest

NEW



xctestrunk

Test manifest

Tests to run or skip

NEW



# xctestrunk

## Test manifest

Tests to run or skip

Environment variables

NEW



# xctestrunk

## Test manifest

Tests to run or skip

Environment variables

Command-line arguments

NEW



# xctestrunk

## Test manifest

Tests to run or skip

Environment variables

Command-line arguments

Documentation in man pages

NEW



# xctestrun

## Test manifest

NEW

Tests to run or skip

Environment variables

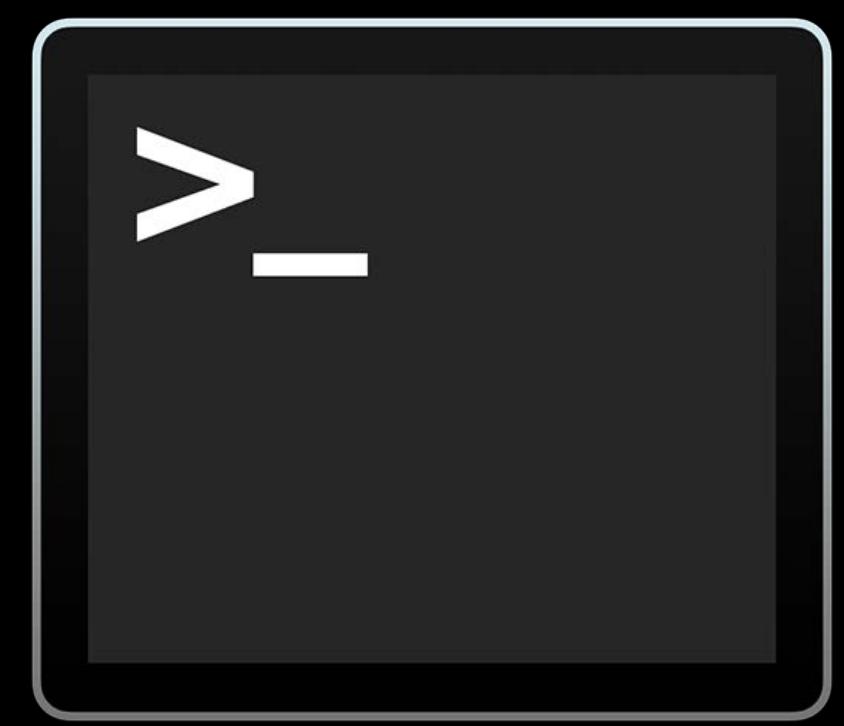
Command-line arguments

Documentation in man pages

```
man xcodebuild.xctestrun
```



# Summary



# Summary

## Testing Concepts

### Xcode

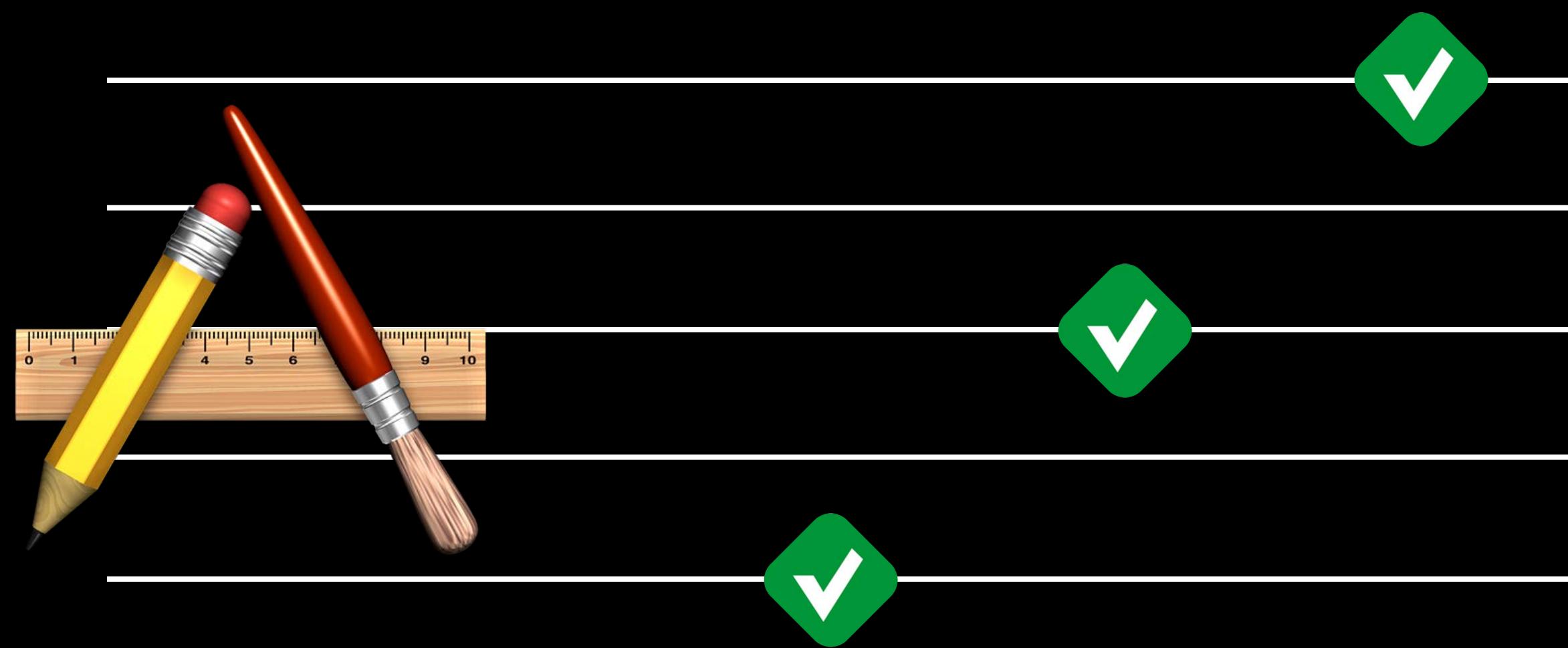
- Crash Log Gathering

### Xcode Server

- Advanced Triggers
- Issue Tracking and Blame
- Configurable Integration User

### xcodebuild





More Information

<https://developer.apple.com/wwdc16/409>

# Labs

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Xcode Open Hours

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Developer Tools  
Lab C      Thursday 9:00AM

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Xcode Open Hours

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Developer Tools  
Lab B      Friday 9:00AM

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W W D C 16