Practical Approaches to Great App Performance

Session 407

Jon Hess, Xcode Engineer
Matthieu Lucas, Photos Engineer
Approaching Performance
A framework for getting started

Jon Hess, Xcode Engineer
Fixing Bugs

- Reproduce
- Debug
- Modify
- Repeat
Fixing Bugs Performance

Reproduce

Debug Profile

Modify

Repeat
Types of Performance Work
Types of Performance Work

Major Regression Off Target Poor Design
Types of Performance Work

- **Major Regression**
- **Off Target**
Types of Performance Work

- Major Regression
- Off Target
- Poor Design
Types of Performance Work

- Major Regression
- Off Target
- Poor Design
Test
Unit Integration
Unit Tests

Focused benchmarks
Isolate issues
Pinpoints regressions
Integration Tests

- Measures user experience
- Measures dependencies
- Measures side effects
Demo

Introduction to profiling
Common Solutions
Common Solutions

- Defer
- Batch
- Share results
- Fewer views
- Direct observation
- Prefer records to dictionaries
Designing for Performance
Practical examples from Photos

Matthieu Lucas, Photos Engineer
Nashville
May 6 – 11, 2017 · Tennessee

Marrakech Médina
Aug 6, 2017 · Marrakech-Tensift-El Haouz

Essaouira
Aug 7, 2017 · Marrakech-Tensift-El Haouz

Lisbon
Aug 19 – 21, 2017 · Lisbon
Years

2012
Iceland, Japan, South Africa & 2 more

2013
Autonomous City of Buenos Aires & 4 more

2014
Campania, Hawaii, Idaho, Utah & 2 more
Not a great user experience
Responsiveness
Smooth animations
Great user experience
Launching to Moments
Building Collections/Years
Launching to Moments

Building Collections/Years
Launching to Moments

What is launch?
Launching to Moments

What is launch?

Cold
Launching to Moments
What is launch?

Cold

Warm
Launching to Moments
What is launch?

Cold

Warm

Hot
Launching to Moments

What is launch?

Cold

Warm

Hot
Launching to Moments
Measuring launch

Time it takes from the moment you hit the application’s icon until you can start interacting with the application
Launching to Moments
Measuring launch

Time it takes from the moment you hit the application’s icon until you can start interacting with using the application
Launching to Moments

Goals
Launching to Moments

Goals

Instant
Launching to Moments

Goals

Instant

No spinner
Launching to Moments

Goals

Instant

No spinner

No placeholders
Launching to Moments

Goals
Launching to Moments
Goals

Instant?
Launching to Moments

Goals

Instant?

• Same time as the zoom animation from the home screen
Launching to Moments

Goals

Instant?
• Same time as the zoom animation from the home screen
• Between 500 and 600 milliseconds
Launching to Moments

Goals

Instant?

• Same time as the zoom animation from the home screen
• Between 500 and 600 milliseconds
• Seamless transition
Launching to Moments

Anatomy

- dyld
  - Load/Link dylibs
  - Run static initializers

- main/UIApplicationMain
  - willFinishLaunching
  - didFinishLaunching
  - First layout
Launching to Moments

Anatomy

dyld
• Load/Link dylibs
• Run static initializers

main/UIApplicationMain
• willFinishLaunching
• didFinishLaunching
• First layout

App Startup Time: Past, Present, and Future

WWDC 2017
Launching to Moments

Anatomy

- dyld
  - Load/Link dylibs
  - Run static initializers

- main/UIApplicationMain
  - willFinishLaunching
  - didFinishLaunching
  - First layout

0 ms - 100 ms

100 ms - 600 ms
Launching to Moments
Principles
Launching to Moments

Principles

Be lazy
Launching to Moments

Principles

Be lazy

Be proactive
Launching to Moments

Principles

Be lazy

Be proactive

Be constant
Launching to Moments

Breakdown:

- Initialize Database: 80 ms
- Configure Data Sources: 500 ms
- Prepare View Controllers: 600 ms
- Load Library Images: 2,000 ms
- Fetch Cloud Status: 400 ms

Total: 3,580 ms
Launching to Moments

Breakdown

- Initialize Database: 80 ms
- Configure Data Sources: 500 ms
- Prepare View Controllers: 600 ms
- Load Library Images: 2,000 ms
- Fetch Cloud Status: 400 ms
Launching to Moments
Breakdown—Initialize Database
Launching to Moments
Breakdown—Initialize Database

Load database early
Launching to Moments
Breakdown—Initialize Database

Load database early

Review the queries done during launch
Launching to Moments
Breakdown—Initialize Database

Load database early

Review the queries done during launch

Ensure required queries are efficient as possible
Launching to Moments

Breakdown

- Prepare View Controllers: 600 ms
- Load Library Images: 2,000 ms
- Initialize Database: 80 ms
- Configure Data Sources: 500 ms
- Fetch Cloud Status: 400 ms
Launching to Moments

Breakdown

- Prepare View Controllers: 600 ms
- Configure Data Sources: 500 ms
- Load Library Images: 2,000 ms
- Initialize Database: 30 ms
- Fetch Cloud Status: 400 ms
Launching to Moments
Breakdown—Prepare View Controllers
Launching to Moments
Breakdown—Prepare View Controllers

Minimize the preparation cost of non-visible view controllers
Launching to Moments
Breakdown—Prepare View Controllers

Minimize the preparation cost of non-visible view controllers

Do as little work as possible in the initializers
Launching to Moments
Breakdown—Prepare View Controllers

Minimize the preparation cost of non-visible view controllers

Do as little work as possible in the initializers

Ensure only visible views are loaded
Launching to Moments

Breakdown

- Initialize Database: 30 ms
- Configure Data Sources: 500 ms
- Prepare View Controllers: 120 ms
- Load Library Images: 2,000 ms
- Fetch Cloud Status: 400 ms
Launching to Moments
Breakdown—Configure Data Sources
Launching to Moments

Breakdown—Configure Data Sources

Load only the needed data synchronously
Launching to Moments
Breakdown—Configure Data Sources

Load only the needed data synchronously

Schedule preheating of the remaining data asynchronously
Launching to Moments

Breakdown

- Prepare View Controllers: 120 ms
- Initialize Database: 30 ms
- Configure Data Sources: 100 ms
- Load Library Images: 2,000 ms
- Fetch Cloud Status: 400 ms
Launching to Moments
Breakdown—Load Library Images
Launching to Moments
Breakdown—Load Library Images

Evaluate number of images needed
Launching to Moments
Breakdown—Load Library Images

Evaluate number of images needed

Load low resolution thumbnails
Launching to Moments

Breakdown

- Prepare View Controllers: 120 ms
- Initialize Database: 30 ms
- Configure Data Sources: 100 ms
- Load Library Images: 2,000 ms
- Fetch Cloud Status: 400 ms
Launching to Moments

Breakdown

- Prepare View Controllers: 120 ms
- Load Library Images: 200 ms
- Initialize Database: 30 ms
- Fetch Cloud Status: 400 ms
- Configure Data Sources: 100 ms
Launching to Moments
Breakdown—Fetch Cloud Status
Launching to Moments
Breakdown—Fetch Cloud Status

Evaluate if information is needed during launch
Launching to Moments
Breakdown—Fetch Cloud Status

Evaluate if information is needed during launch

Cache information
Launching to Moments
Breakdown—Fetch Cloud Status

Evaluate if information is needed during launch
Cache information
Leverage Background App Refresh
Launching to Moments

Breakdown

- Prepare View Controllers: 120 ms
- Load Library Images: 200 ms
- Initialize Database: 30 ms
- Fetch Cloud Status: 400 ms
- Configure Data Sources: 100 ms
Launching to Moments

Breakdown

- Prepare View Controllers: 120 ms
- Load Library Images: 200 ms
- Initialize Database: 30 ms
- Configure Data Sources: 100 ms
Launching to Moments

Breakdown

- Initialize Database: 30 ms
- Configure Data Sources: 100 ms
- Load Library Images: 200 ms
- Prepare View Controllers: 120 ms

Total: 3,580 ms

Updated Total: 450 ms
Think about the cost of preparing content
Measure the cost of preparing content
Strive for constant time
Launching to Moments

Building Collections/Years
Building Collections/Years

Complex view hierarchy
Building Collections/Years

Complex view hierarchy

- Thousands of pictures displayed
Building Collections/Years

Complex view hierarchy
• Thousands of pictures displayed
• Live updates
Building Collections/Years

Complex view hierarchy

- Thousands of pictures displayed
- Live updates
- Animations
Building Collections/Years

Complex view hierarchy
- Thousands of pictures displayed
- Live updates
- Animations
- Gestures
Building Collections/Years

Goals
Building Collections/Years

Goals

No spinner
Building Collections/Years

Goals

No spinner

No placeholders
Building Collections/Years

Goals

No spinner
No placeholders
Smooth animations
Building Collections/Years

Principles
Building Collections/Years

Principles

Be lazy
Building Collections/Years

Principles

Be lazy

Be proactive
Building Collections/Years

Principles

Be lazy

Be proactive

Be constant
Building Collections/Years
Principles

Be lazy
Be proactive
Be constant
Be timely
Building Collections/Years

Basic Approach

UICollectionView with a cell for each item
Building Collections/Years

Basic Approach

UICollectionView with a cell for each item
- Too many views/layers
Building Collections/Years

Basic Approach

UICollectionView with a cell for each items

- Too many views/layers
- Layout complexity
Building Collections/Years

Basic Approach

UICollectionView with a cell for each item

- Too many views/layers
- Layout complexity
- Memory cost
Building Collections/Years

Atlasing Approach
Building Collections/Years

Atlasing Approach

Rendered strips
Building Collections/Years

Atlasing Approach

Rendered strips

Displayed as a single image
Building Collections/Years
Atlasing Approach

Rendered strips
Displayed as a single image
Generated/Cached on the fly
Building Collections/Years

Atlasing Approach

Rendered strips
Displayed as a single image
Generated/Cached on the fly
Building Collections/Years

Atlasing Approach
Building Collections/Years

Atlasing Approach

Render multiple images into in a single one
Building Collections/Years

Atlasing Approach

Render multiple images into a single one

Fewer

• Cells
• Layers
• Objects
Building Collections/Years
Atlasing Approach Trade-off

Long Press/3D Touch Preview
Building Collections/Years
Atlasing Approach Trade-off

Long Press/3D Touch Preview
• Gesture handlers
Building Collections/Years
Atlassing Approach Trade-off

Long Press/3D Touch Preview
• Gesture handlers
• Mapping with individual items and rendered strips
Why generating them on the fly?
Live updates
View sizes
2013
Autonomous City of Buenos Aires, Hawaii, Magallanes and Antartica Chilena, Arizona & 1 more

2014
Campania, Hawaii, Idaho, Utah, California & Alberta
Years

2012
Iceland, Japan, South Africa & 2 more

2013
Autonomous City of Buenos Aires & 4 more

2014
Campania, Hawaii, Idaho, Utah & 2 more
Why not generating the whole section?
Think about the layout cost of your view hierarchy
Measure the layout cost of your view hierarchy
Always think about performance
More Information


<table>
<thead>
<tr>
<th>Lab</th>
<th>Lab Name</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhotoKit &amp; Photos Extensions Lab</td>
<td>Technology Lab 3</td>
<td>Thursday 3:00PM</td>
</tr>
<tr>
<td>Power and Performance Lab</td>
<td>Technology Lab 9</td>
<td>Friday 9:00AM</td>
</tr>
<tr>
<td>Profiling and Debugging Lab</td>
<td>Technology Lab 10</td>
<td>Friday 9:00AM</td>
</tr>
</tbody>
</table>