Mobile Application Development

Lecture 14
iOS SDK

Lecture Summary

- iOS operating system
- iOS SDK
- Tools of the trade
- Model-View-Controller
- MVC interaction patterns
- View Controllers
- DEMO

iOS

- iOS is Apple's mobile operating system, shipping with iPhone, iPod Touch, and iPad devices
- First released in 2007
- Current version is iOS7
  - released on September 2013
  - runs on iPhone 4/4s/5/5c/5s, iPad 2/new iPad, iPod Touch 5th gen, iPad Mini
- iOS apps run in a UNIX-based system and have full support for threads, sockets, etc...

Memory management in iOS

- iOS uses a virtual memory system: each program has its own virtual address space
- iOS runs on constrained devices, in terms of available memory: memory is limited to the amount physical memory available
- iOS does not support paging to disk when memory gets full, so the virtual memory system releases memory if it needs more space
- Notifications of low-memory are sent to apps, so they can free memory

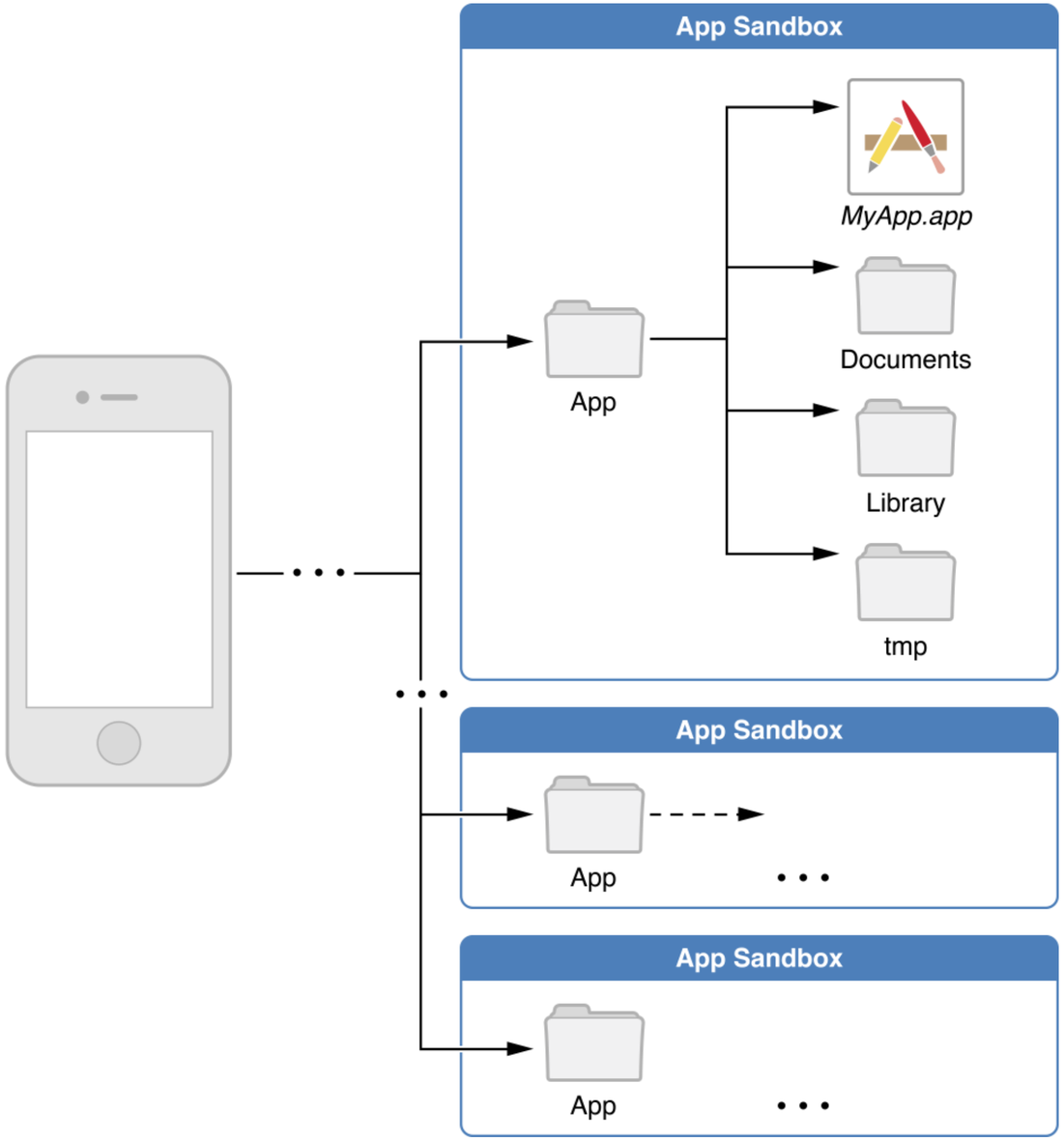
Multi-threading in iOS

- Since version 4, iOS allows applications to be run in the background even when they are not visible on the screen
- Most background apps reside in memory but do not actually execute any code
- Background apps are suspended by the system shortly after entering the background to preserve battery life

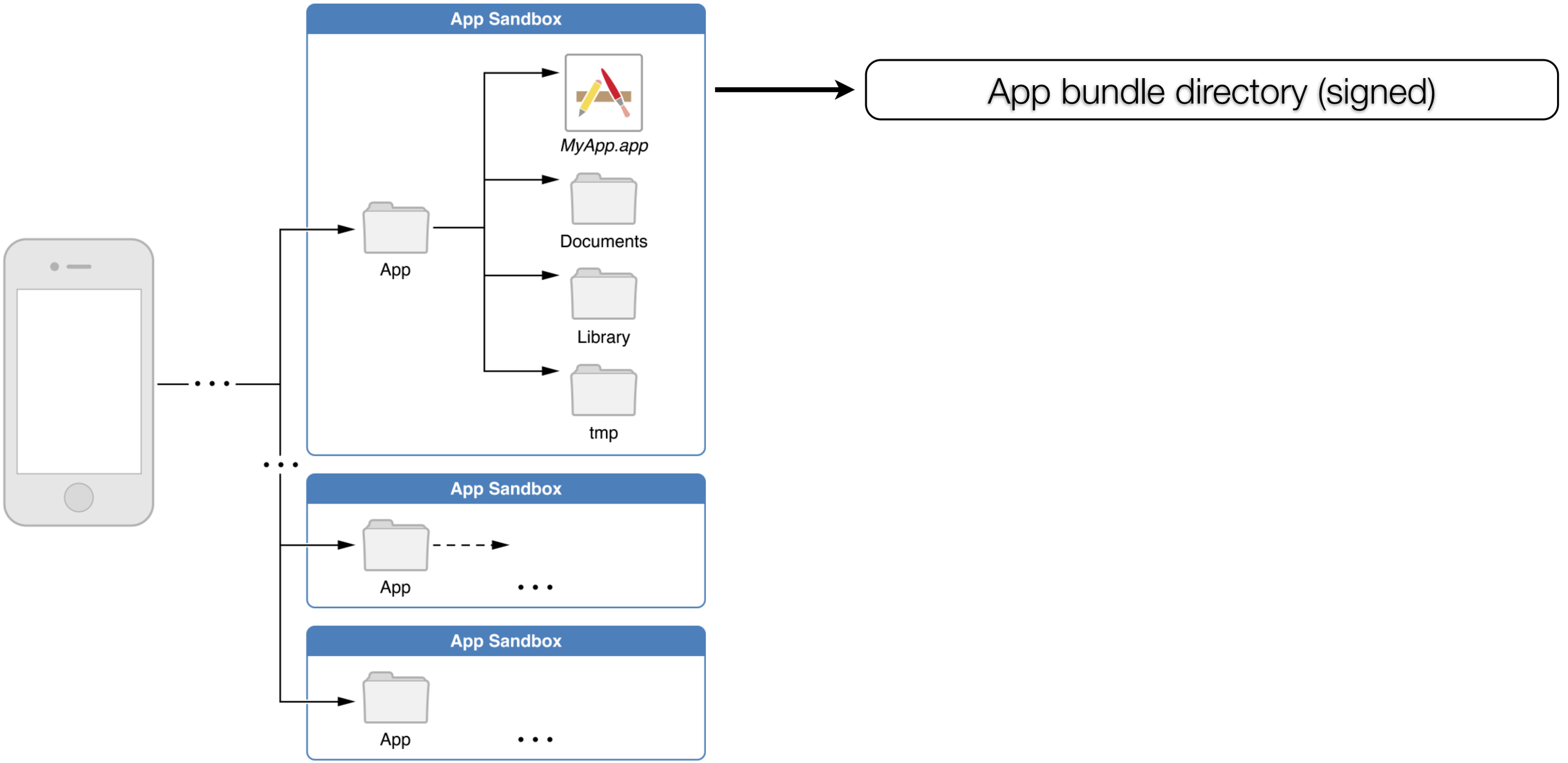
- In some cases, apps may ask the OS for background execution, but this requires a proper management of the app states

App sandbox

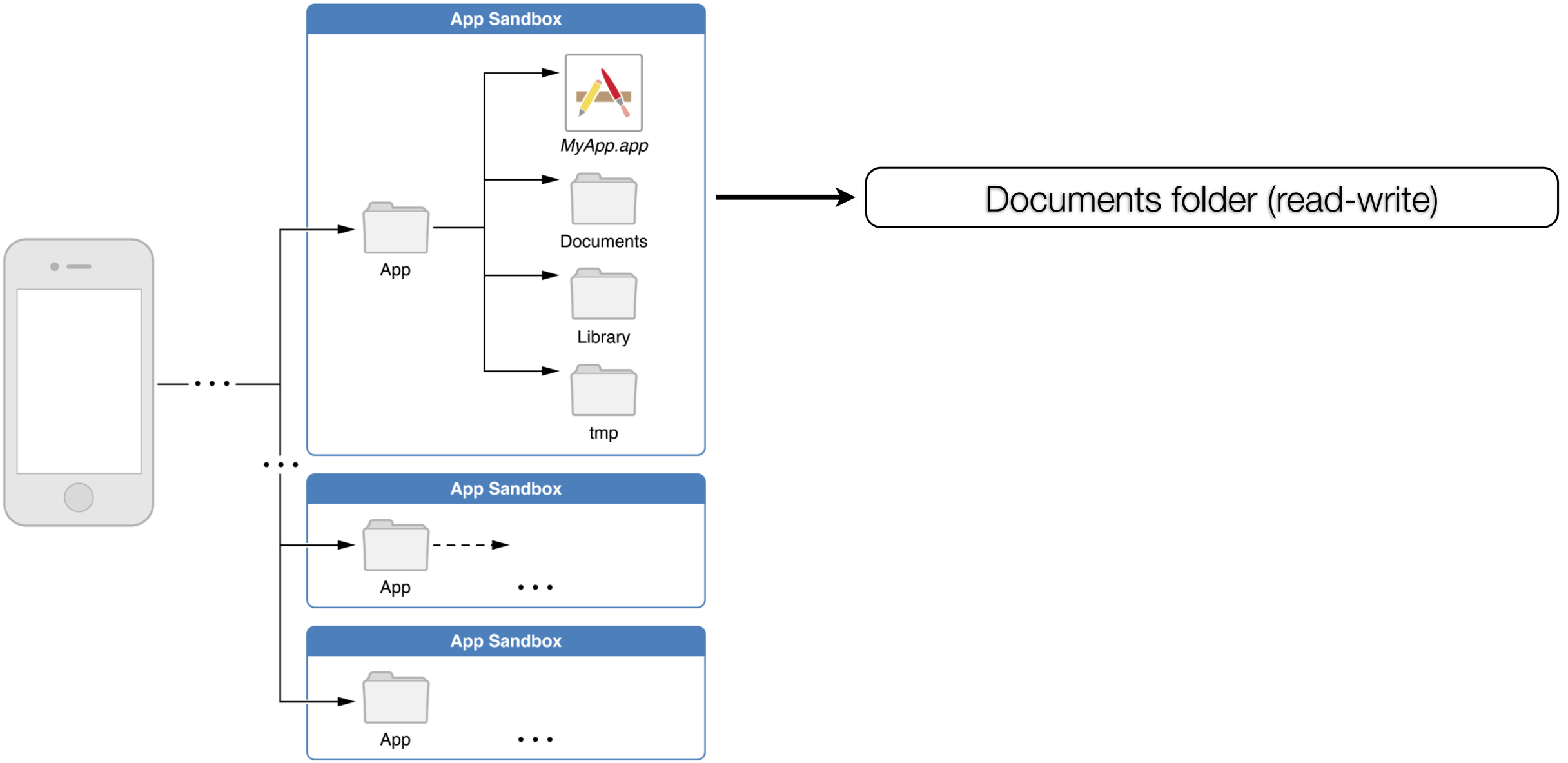
- For security reasons, iOS places each app (including its preferences and data) in a sandbox at install time
- A sandbox provides controls that limit the app's access to files, preferences, network resources, hardware, ...
- The system installs each app in its own sandbox directory, which can be seen as the home for the app and its data
- Each sandbox directory contains several well-known subdirectories for placing files
- **The sandbox only prevents the hijacked app from affecting other apps and other parts of the system, not the app itself**



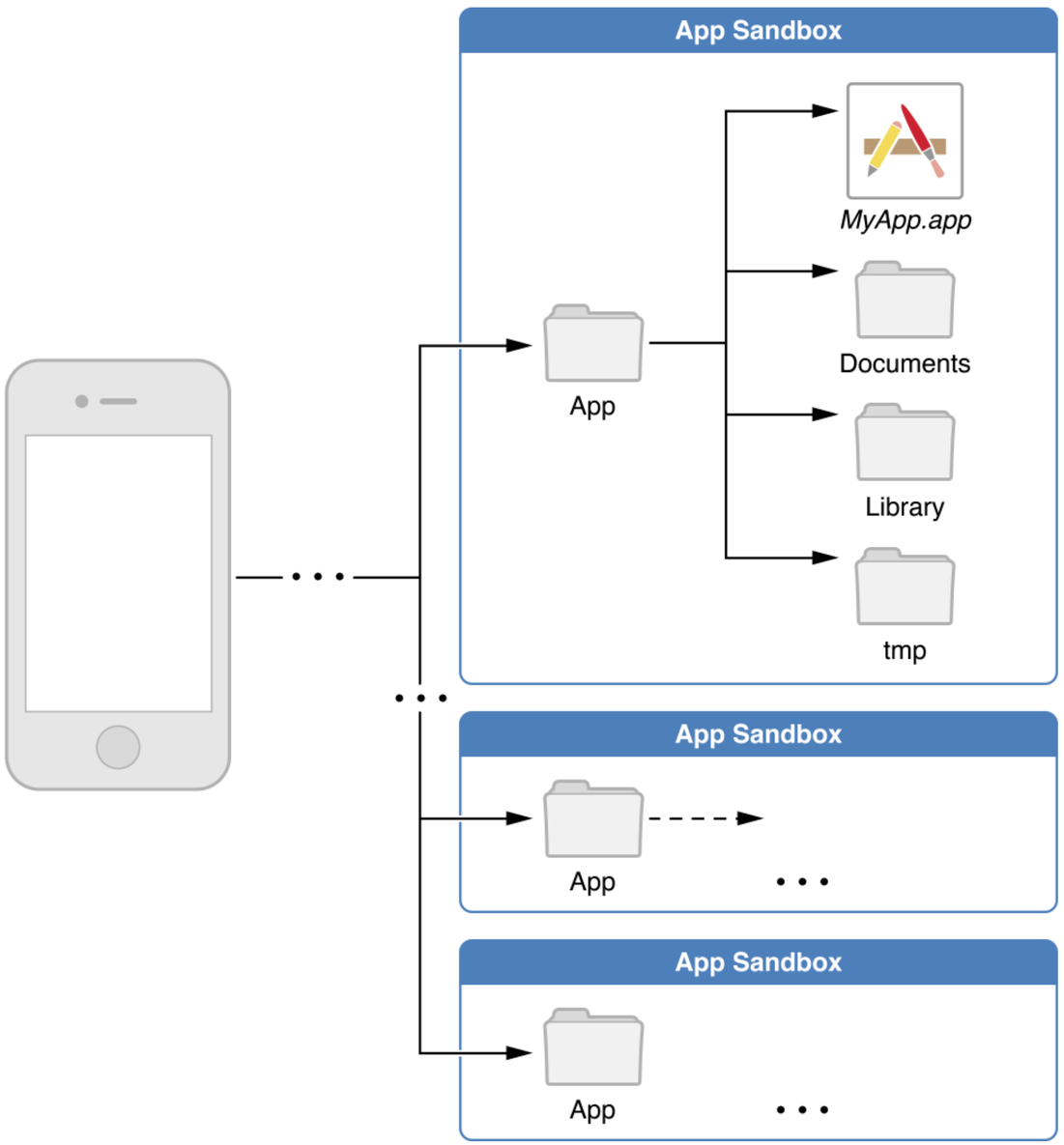
App sandbox


App Sandbox
MyApp.app
Documents
App
Library
tmp
App Sandbox
App
App Sandbox
App
App bundle directory (signed)

App sandbox

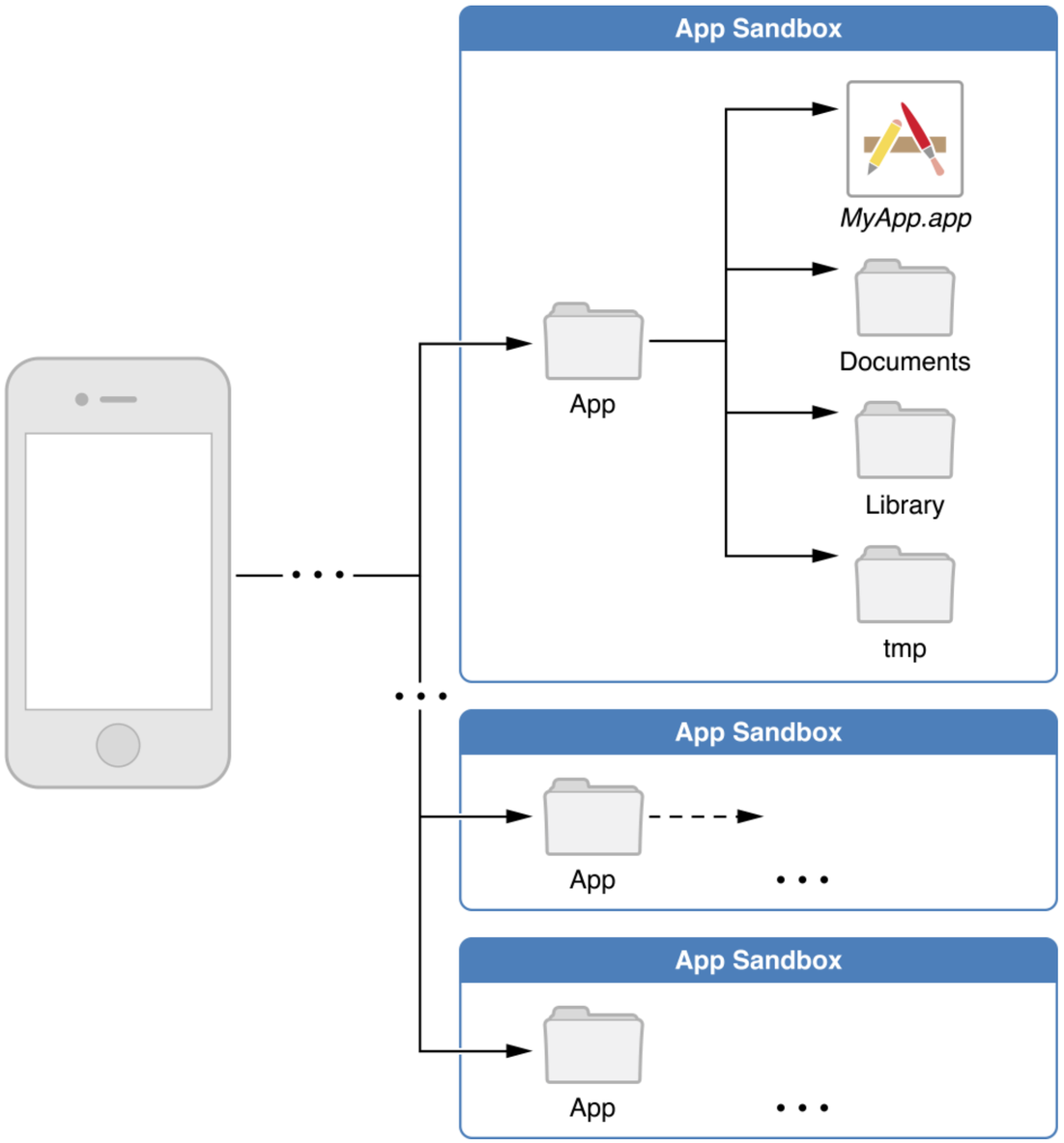

App Sandbox
MyApp.app
Documents
App
Library
tmp
App Sandbox
App
App Sandbox
App
Documents folder (read-write)

App sandbox



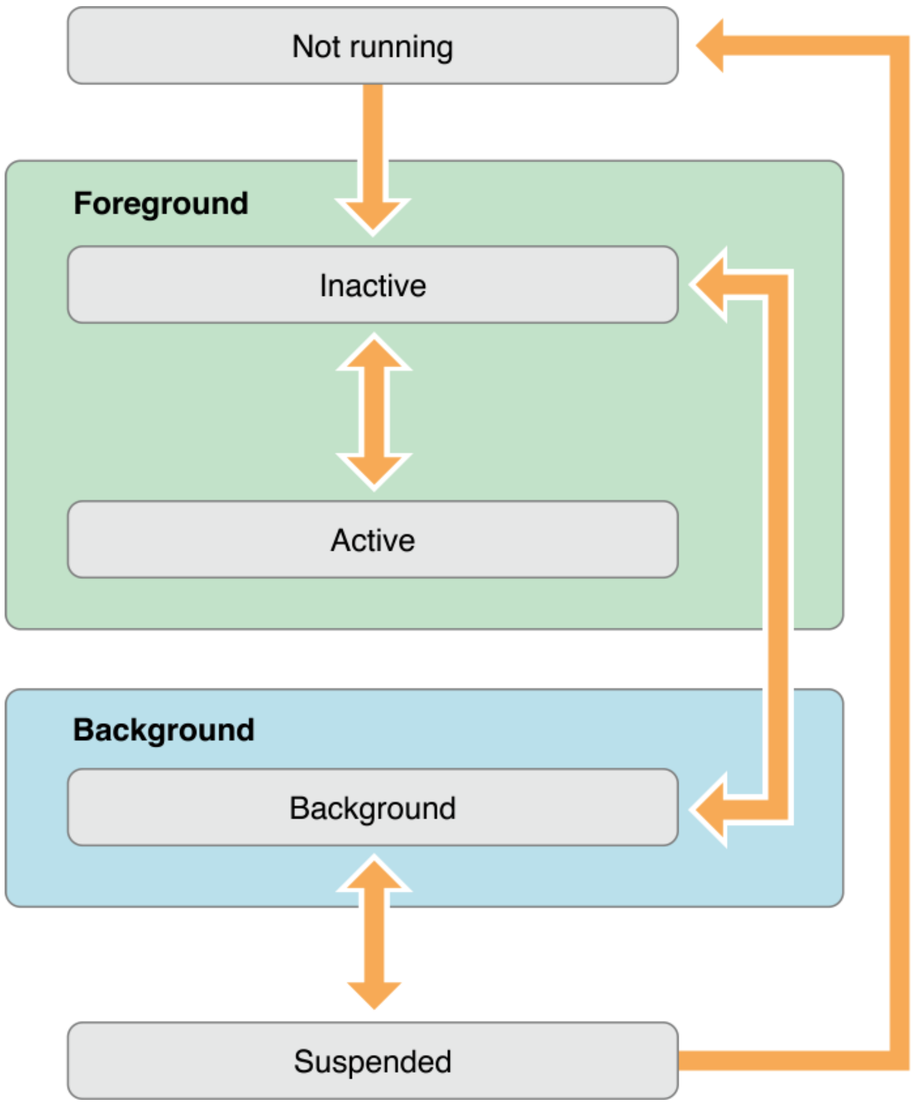
User-specific files, backed up by iTunes

App sandbox



Temporary files folder (read-write); contents are erased when the app exits

App Launch Cycle



- When the app is launched it moves from the *not-running* state to the *active* or *background* state
- iOS creates a process and main thread for the app and calls the app's main function on that main thread (**main event loop**)
- The main event loop receives events from the operating system that are generated by user actions (e.g. UI-related events)
- Each application has a *delegate* (conforming to the `UIApplicationDelegate` protocol) which receives messages when the app changes its state
- State transitions are accompanied by a corresponding call to the methods of the app delegate object
- These methods are a chance to respond to state changes in an appropriate way

App Life Cycle

1. App launched
2. App initialized
3. Load root view controller
4. Wait for event
5. Handle event
6. App terminates

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Event loop - objects are destroyed (`dealloc` gets called) when the event loop completes its execution

UIApplicationDelegate methods

`application:willFinishLaunchingWithOptions:` This method is the app's first chance to execute code at launch time

`application:didFinishLaunchingWithOptions:` This method allows you to perform any final initialization before your app is displayed to the user

`applicationDidBecomeActive:` Lets your app know that it is about to become the foreground app; use this method for any last minute preparation

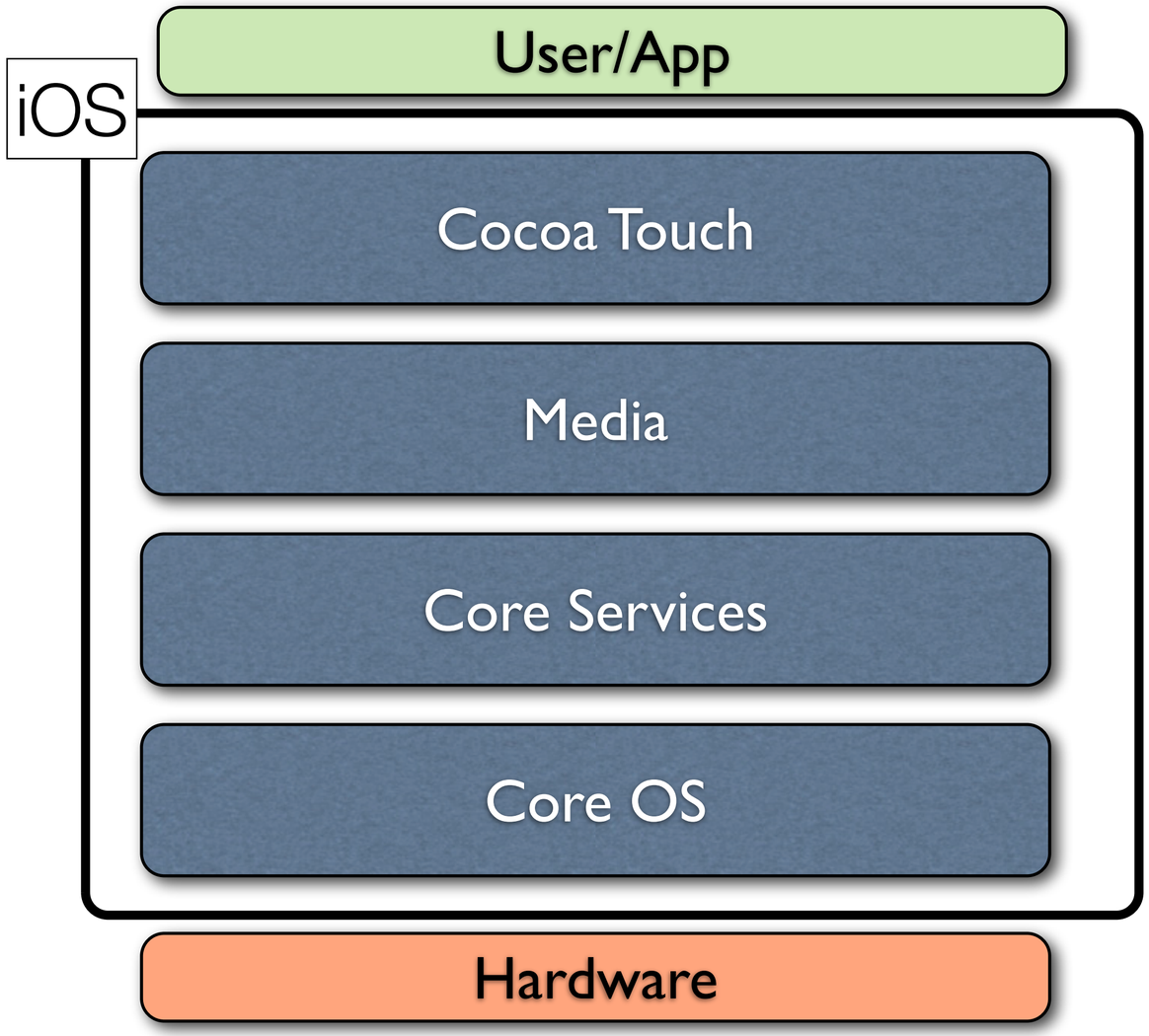
`applicationWillResignActive:` Lets you know that your app is transitioning away from being the foreground app; use this method to put your app into a dormant state

`applicationDidEnterBackground:` Lets you know that your app is now running in the background and may be suspended at any time

`applicationWillEnterForeground:` Lets you know that your app is moving out of the background and back into the foreground, but that it is not yet active

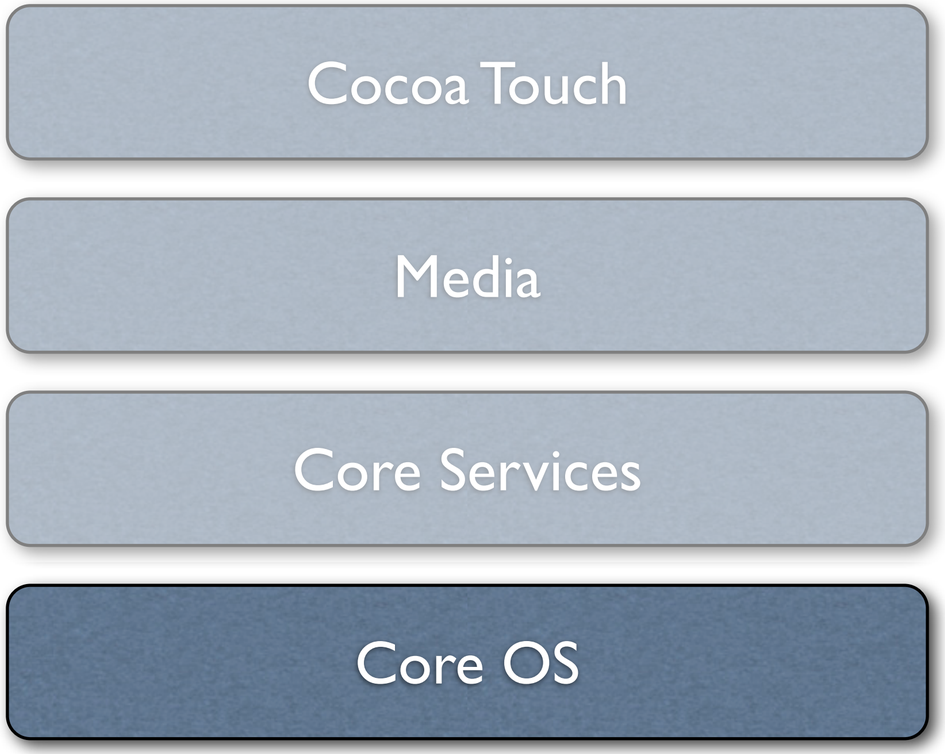
`applicationWillTerminate:` Lets you know that your app is being terminated; this method is not called if app is suspended

iOS Layers



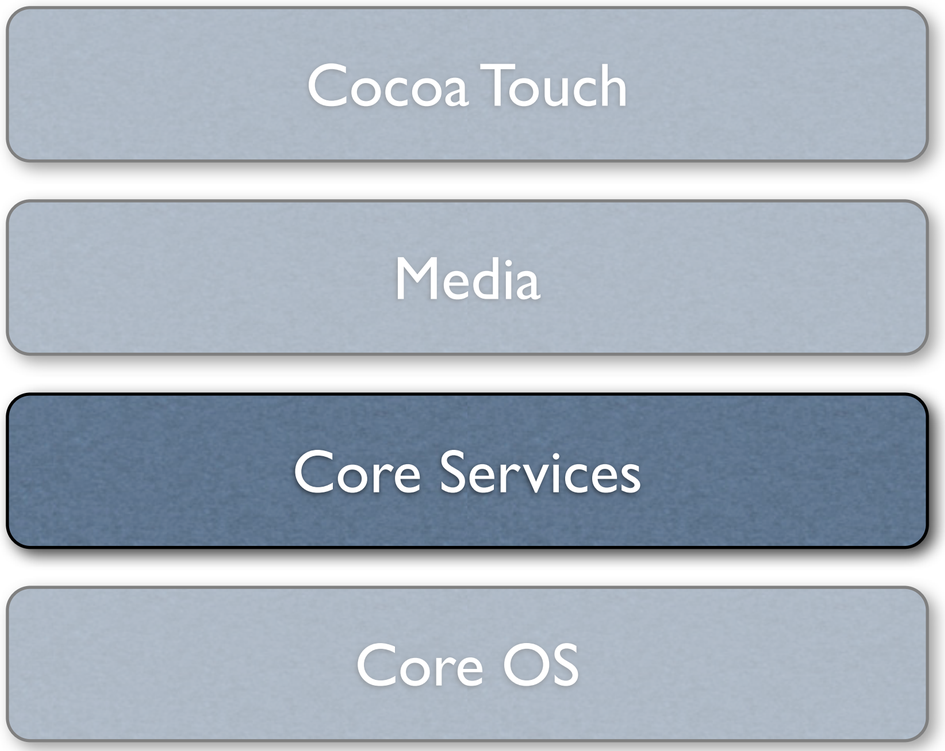
- The iOS architecture is layered
- iOS acts as an intermediary between the underlying hardware and the apps
- Apps communicate with the hardware through a set of well-defined system interfaces
- Lower layers contain fundamental services and technologies
- Higher-level layers build upon the lower layers and provide more sophisticated services and technologies
- iOS technologies are packaged as frameworks (especially **Foundation and UIKit frameworks**)
- A framework is a directory that contains a dynamic shared library and the resources (such as header files, images, and helper apps) needed to support that library

iOS Layers



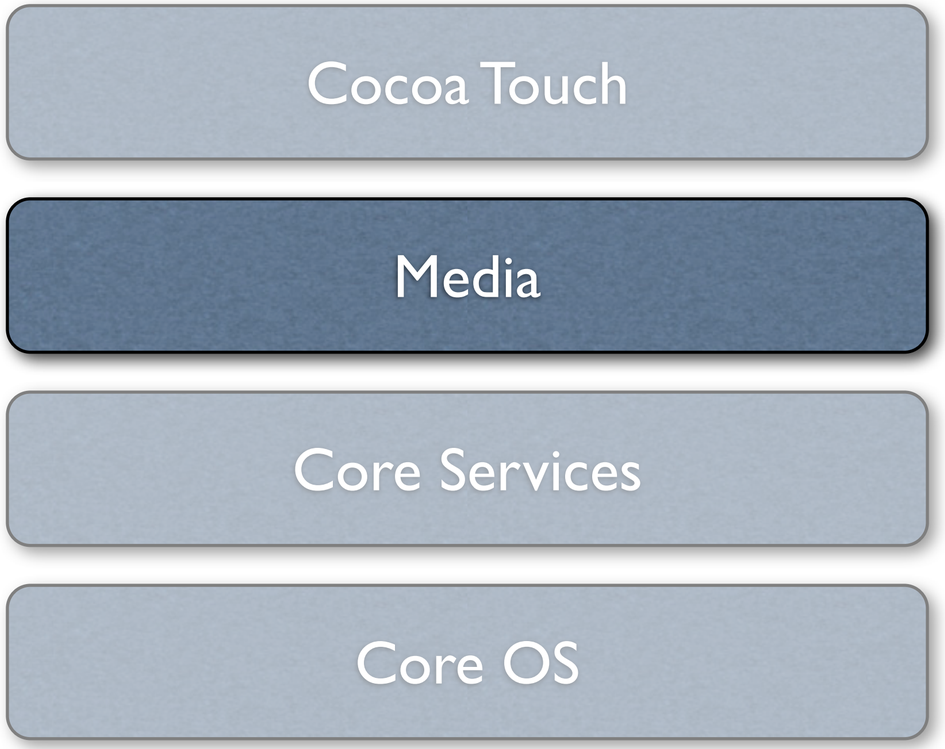
- Low-level features
- Main frameworks:
  - **Accelerate Framework**: vector and matrix math, digital signal processing, large number handling, and image processing
  - **Core Bluetooth Framework**
  - **Security Framework**: support for symmetric encryption, hash-based message authentication codes (HMACs), and digests
  - **System**: kernel environment, drivers, and low-level UNIX interfaces of the OS; Support for *Concurrency* (POSIX threads and Grand Central Dispatch), *Networking* (BSD sockets), *File-system* access, Standard I/O, Bonjour and DNS services, Locale information, *Memory allocation*, Math computations

iOS Layers



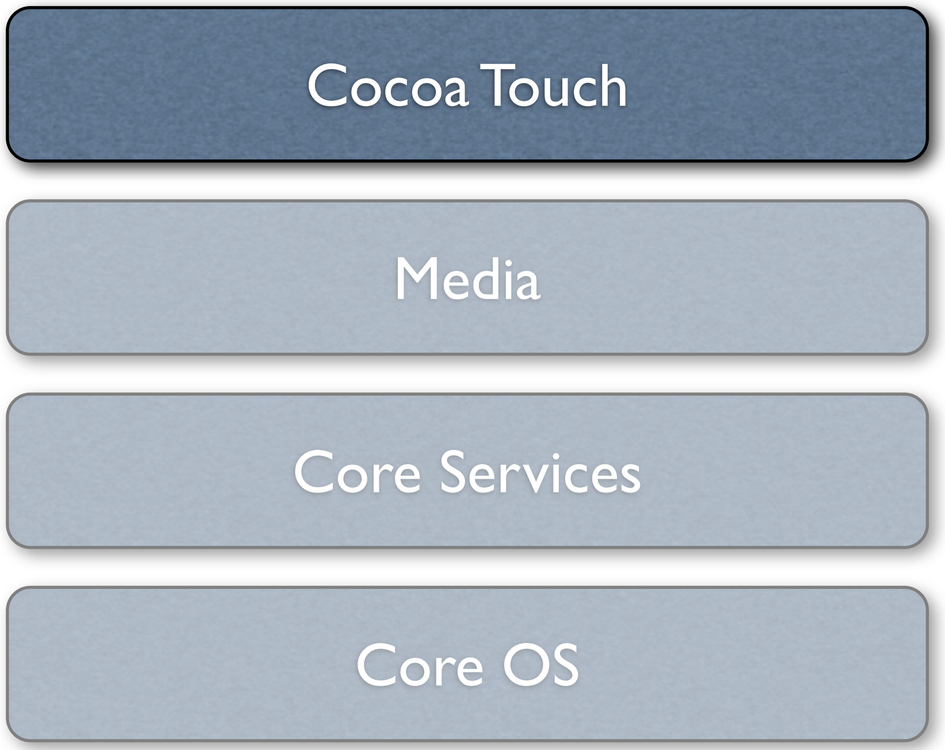
- Fundamental system services for apps
- Main frameworks:
  - **CFNetwork Framework**: BSD sockets, TLS/SSL connections, DNS resolution, HTTP/HTTPS connections
  - **Core Data Framework**
  - **Core Foundation Framework**: (C library) collections, strings, date and time, threads
  - **Core Location Framework**: provides location and heading information to apps
  - **Foundation Framework**: wraps Core Foundation in Objective-C types
  - **System Configuration Framework**: connectivity and reachability

iOS Layers



- Graphics, audio, and video technologies
- Main frameworks:
  - **AV Foundation Framework**: playing, recording, and managing audio and video content
  - **Media Player Framework**: high-level support for playing audio and video content
  - **Core Audio Frameworks**: native (low-level) support for handling audio
  - **Core Graphics Framework**: support for path-based drawing, antialiased rendering, gradients, images, colors
  - **Quartz Core Framework**: efficient view animations through Core Animation interfaces
  - **OpenGL ES Framework**: tools for drawing 2D and 3D content

iOS Layers



- Frameworks for building iOS apps
- Multitasking, touch-based input, push notifications, and many high-level system services
- Main frameworks:
  - **UIKit Framework**: construction and management of an application's user interface for iOS
  - **Map Kit Framework**: scrollable map to be incorporated into application user interfaces
  - **Game Kit Framework**: support for Game Center
  - **Address Book Framework**: standard system interfaces for managing contacts
  - **MessageUI Framework**: interfaces for composing email or SMS messages
  - **Event Kit Framework**: standard system interfaces for managing calendar events

UIKit Framework

- The UIKit framework provides the classes needed to construct and manage an application's user interface for iOS
- It provides an application object, event handling, drawing model, windows, views, and controls specifically designed for a touch screen interface
- UIKit provides:
  - Basic app management and infrastructure, including the app's main run loop
  - User interface management, including support for storyboards and nib files
  - A view controller model to encapsulate the contents of your user interface
  - Objects representing the standard system views and controls
  - Support for handling touch- and motion-based events

iOS SDK

- The iOS Software Development Kit (SDK) contains the tools and interfaces needed to develop, install, run, and test native apps
- Tools: **Xcode**
- Language: **Objective-C** (plus some C/C++)
- Libraries: **iOS frameworks**
- Documentations: **iOS Developer Library** (API reference, programming guides, release notes, tech notes, sample code...)

Xcode

- Xcode is the development environment used to create, test, debug, and tune apps
- The Xcode app contains all the other tools needed to build apps:
  - **Interface Builder**
  - **Debugger**
  - **Instruments**
  - **iOS Simulator**
- Xcode is used to write code which can be run on the simulator or a connected iDevice
- Instruments is used to analyze the app's behavior, such as monitoring memory allocation

Model-View-Controller

- All iOS applications are built using the **MVC pattern**
- MVC is used to organize parts of code into clean and separate fields, according to the responsibilities and features of each of them
- This organization is extremely important because it provides a way to create applications that are easy to write, maintain, and debug
- Basically, the way that the iOS SDK is built, drives developers to build applications using MVC
- Understanding and enforcing MVC is 90% of the job when developing in iOS

Model-View-Controller

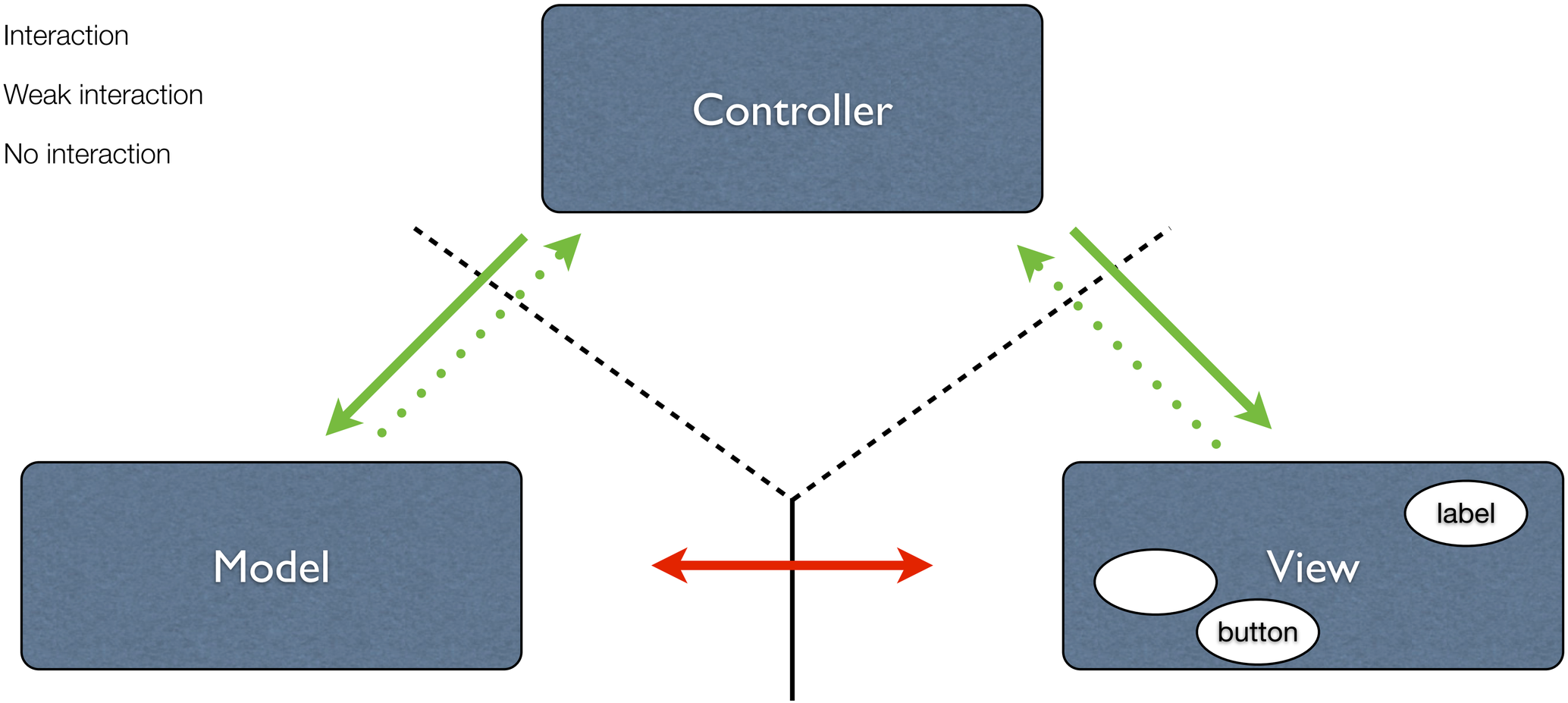
- MVC stands for Model-View-Controller
- An application's code can belong either to the model, to the view, or to the controller
- The **Model** is the representation of the data that will be used in the application; the model is independent from the View, since it does not know how data will be displayed (e.g. iPod library)
- The **View** is the user interface that will display the application's contents; the view is independent from the Model since it contains a bunch of graphical elements that can be used in any application (e.g. buttons, labels, sliders, ...)
- The **Controller** is the brain of the application: it manages how the data in the Model should be displayed in the View; it is highly dependent from the Model and the View since it needs to know which data it will handle and which graphical elements it will need to interact with
- The Controller coordinates and manages the application's UI logic

MVC interactions

Interaction

Weak interaction

No interaction

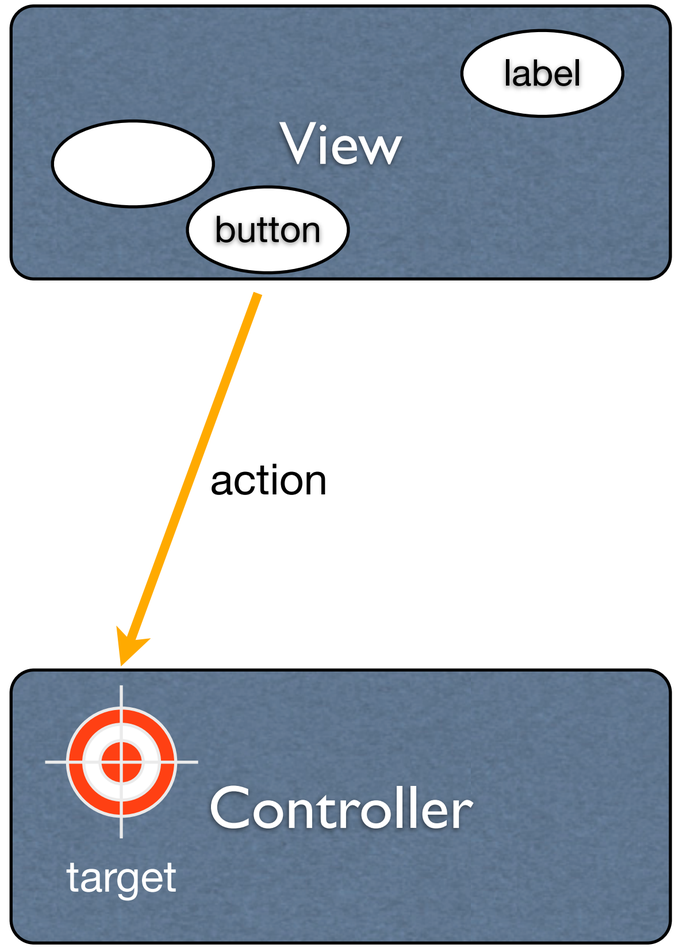


Model-View-Controller interactions

- The Model has direct interaction with neither the View (obviously) nor the Controller, since it responsibility is just to keep the data (e.g. a database)
- The Controller has direct interaction with the Model since it needs to retrieve and store the data
- The Controller has direct interaction with the View since it needs to update UI elements
- The Controller keeps a reference to UI elements it will use, called **outlets** (**IBOutlet**)
- The View has no direct interaction with neither the Model (obviously) nor the Controller, since its job is just to display UI elements on the screen

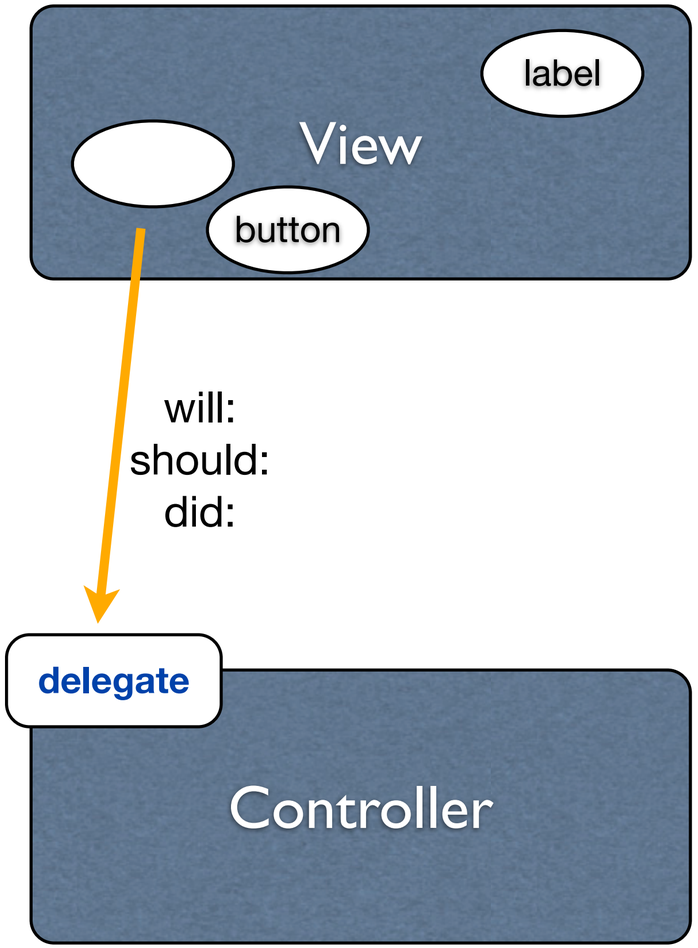
View-to-Controller interactions

- The View does not interact directly with the Controller, since View classes do not even know about the existence of the Controller
- However, the View should inform the Controller that certain events have occurred (e.g. a button has been clicked)
- The interaction between a View and its Controller occurs in a blind way, through **actions** (**IBAction**)
- The Controller can register to the View to be the **target** for an action; when the action is performed, the View will send it to the target
- This interaction model lets the View be totally independent from the Controller, yet allows the View to interact with the Controller



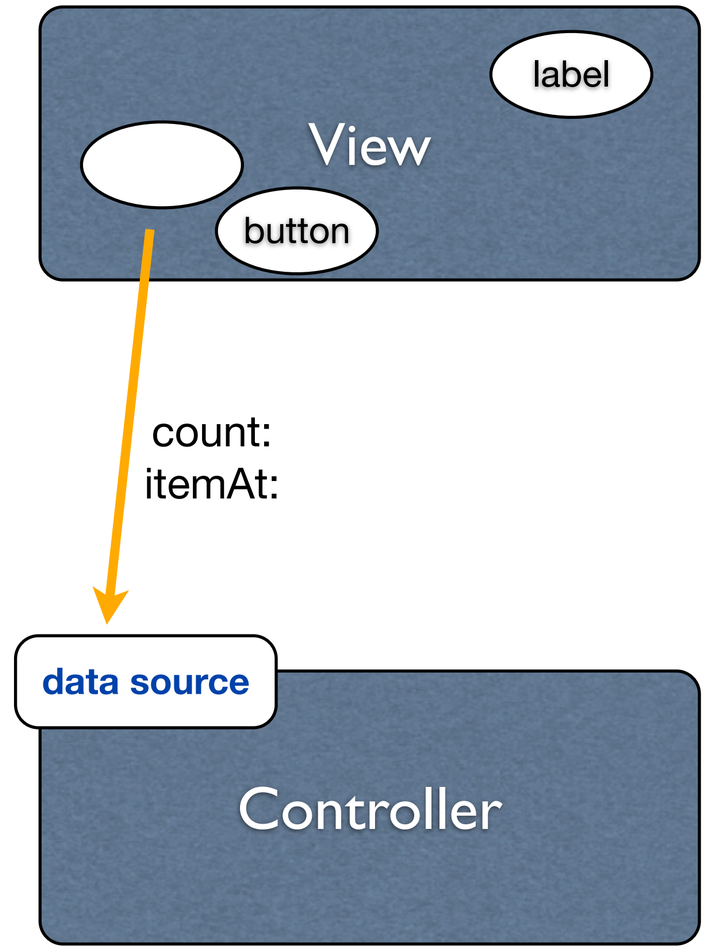
View-to-Controller interactions

- Some Views interact with the Controller, in order to coordinate (synchronize)
- When certain events **should**, **will**, or **did** occur (e.g. a list item was selected), the View must inform the Controller so that it can perform some operations
- This is called **delegation**: the Controller is the delegate, which means that the view passes the responsibility to the Controller to accomplish certain tasks
- There is a loose coupling between the View and the Controller
- Delegation is accomplished by using protocols



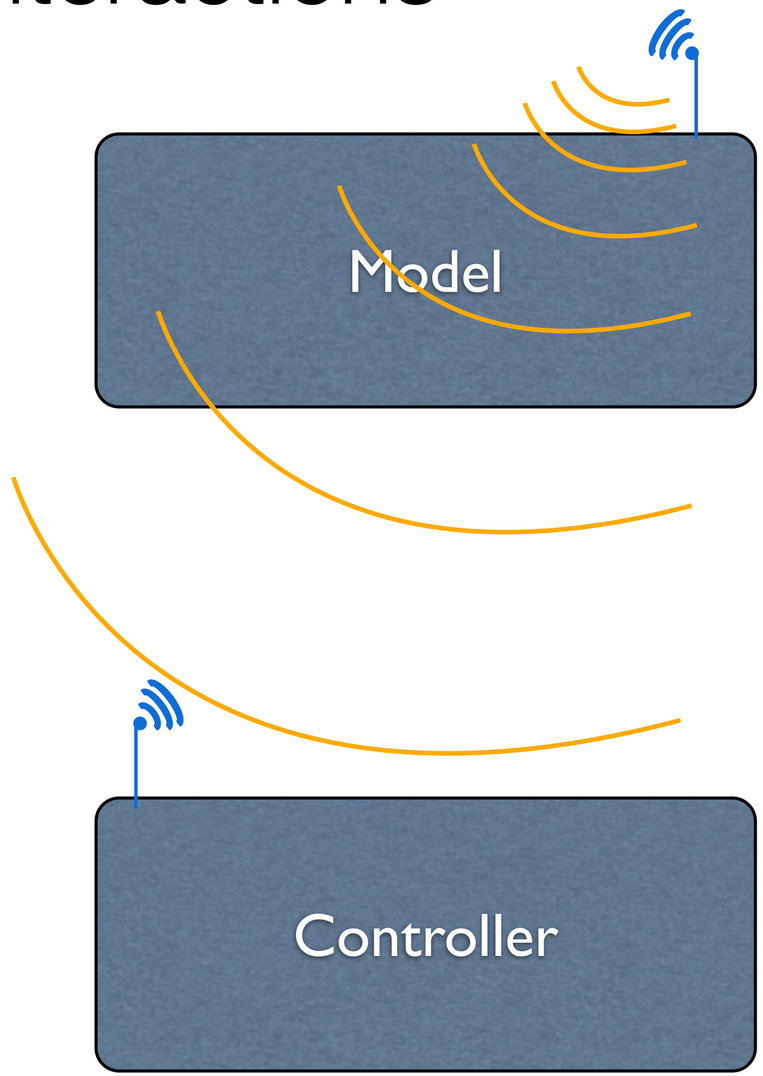
View-to-Controller interactions

- Some Views do not have enough information to be displayed directly (e.g. a list of elements)
- In general, Views do not own the data that they display, data belong to the Model
- The View needs the Controller to provide those data so that it can display them
- The Controller is a **data source** for the View
- Again, this is accomplished by using protocols
- Data source is indeed delegation, since the View is delegating the Controller to be the provider for the data to be displayed
- Data source is a protocol for providing data, delegate is a protocol for handling view-related events



Model-to-Controller interactions

- The Model cannot interact with the View, because it is UI-independent
- When data change, the Model should inform the Controller so that it can instruct the View to change what is being displayed
- The Model “broadcasts” the change event
- If the Controller is interested in the event, it will be notified
- This interaction occurs through **notifications** or **KVO (key-value observing)**



Model-View-Controller

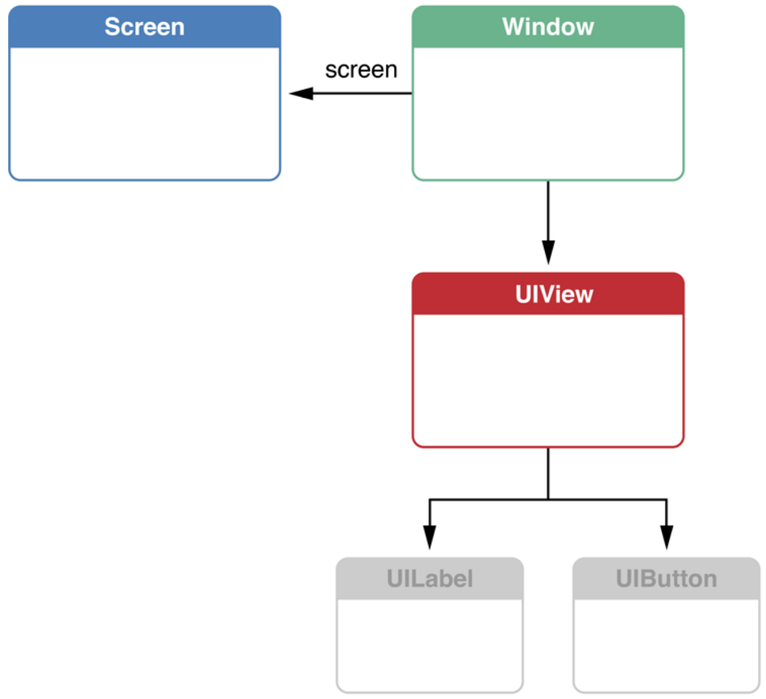
- The Controller's job is to retrieve and format data from the Model so that it can be displayed in the View
- Most of the work when developing apps is done within the Controller(s)
- Complex applications require several MVC to come into play, for instance when an event on a view causes another view to be displayed (typically, this is done by a Controller interacting with other Controllers)
- Some parts of a MVC are other MVCs (e.g. the tabs of a tabbed view are separate MVCs)

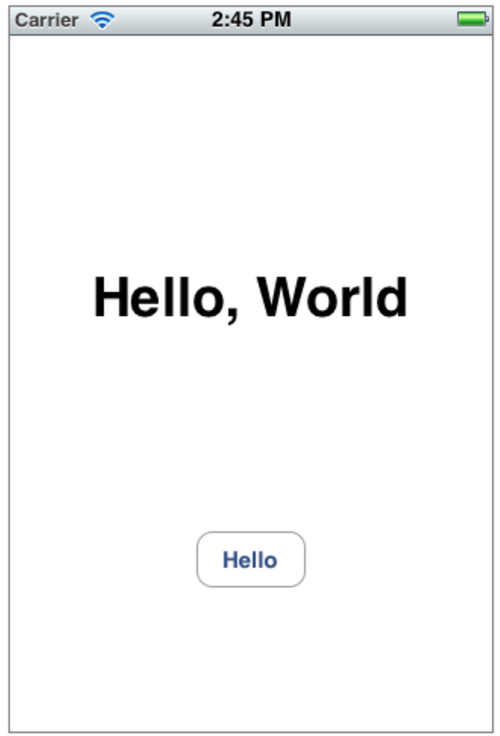
View Controllers

- View controller objects provide the infrastructure for managing content and for coordinating the showing and hiding of it
- By having different view controller classes control separate portions of user interface, the implementation of the user interface is broken up into smaller and more manageable units
- View controller objects represent the Controller part of the application's MVC

User interface: Screen, Window, and View

- `UIScreen` identifies a physical screen connected to the device
- `UIWindow` provides drawing support for the screen
- `UIView` objects perform the drawing; these objects are attached to the window and draw their contents when the window asks them to





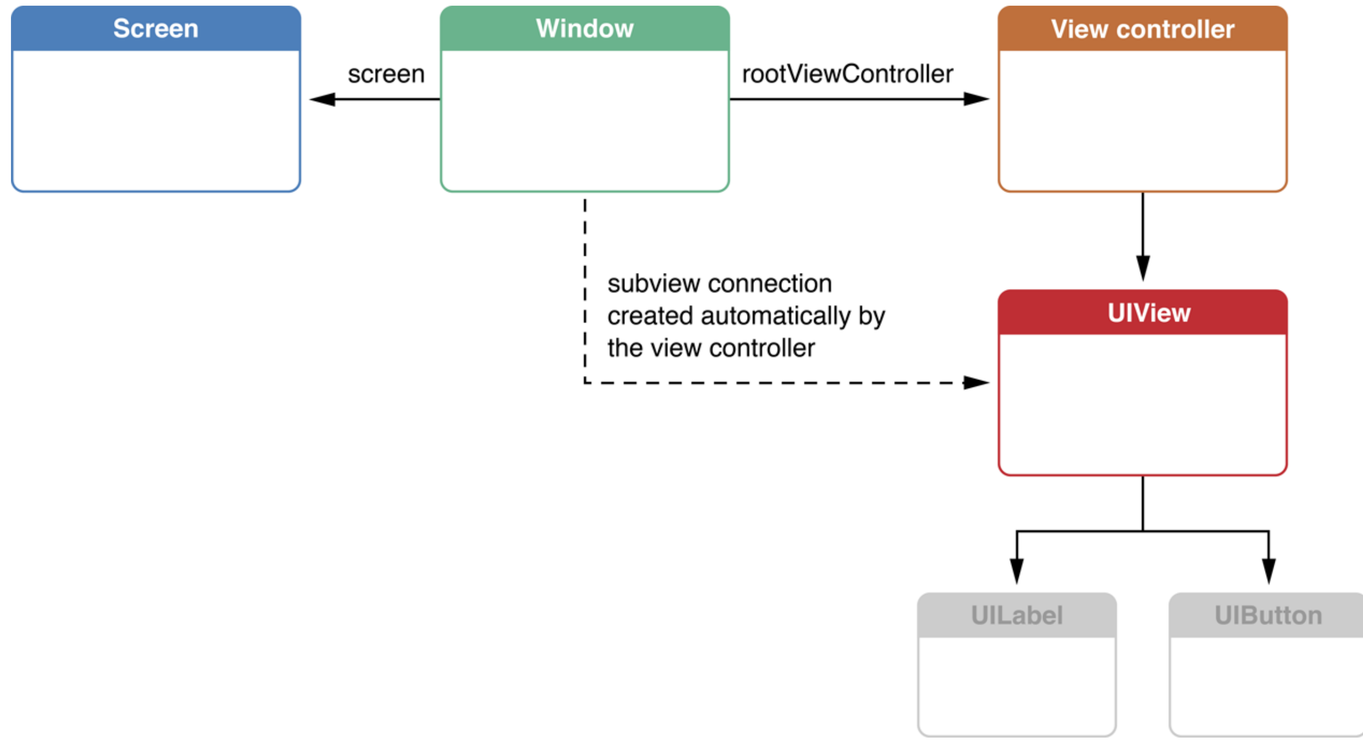
Views

- A view represents a user interface element; each view covers a specific area; within that area, it displays contents or responds to user events
- Views can be nested in a view hierarchy; subviews are positioned and drawn relative to their superview
- Views can animate their property values; animation are crucial to allow users understand changes in the user interface
- Views typically communicate with the controller through target/action, delegation, and data source patterns
- Complex apps are composed of many views, which can be grouped in hierarchies and animated
- Views that respond to user interaction are called **controls** (**UIControl**): `UIButton`s and `UISlider`s are controls

https://developer.apple.com/library/ios/documentation/UserExperience/Conceptual/UIKitUICatalog/index.html#//apple_ref/doc/uid/TP40012857

View Controllers

- A view controller organizes and controls a view
- A view controller is a controller in the application's MVC
- View controllers are subclasses of the `UIViewController` class
- View controllers also have specific tasks iOS expects them to perform, which are defined in the `UIViewController` class
- Normally, a view controller is attached to a window and automatically adds its view as a subview of the window



View Controllers

- View controller must carefully load views in order to optimize resource usage;
- A view controller should only load a view when the view is needed and it can also release the view under certain conditions (low memory)
- View controller coordinate actions occurring in its connected views
- Because of their generality (which is required for reusability), view objects are agnostic on their meaning in the application and typically send messages to their controller; view controllers, instead, are required to understand and react to certain events that occur in the views they manage

Views and View Controllers

- Every view is controlled by only one view controller
- A view controller has a `view` property; when a view is assigned to the `view` property, the view controller owns the view
- Subviews might be controlled by different view controllers: several view controllers might be involved in managing portions of a complex view
- Each view controller interacts with a subset of the app's data: they are responsible for displaying specific content and should know nothing about data other than what they show (e.g. Mail app)

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