App Extension Programming Guide

Developer

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App Extension Essentials

App Extensions Increase Your Impact

Starting in iOS 8.0 and OS X v10.10, an app extension lets you extend custom functionality and content beyond your app and make it available to users while they're using other apps or the system. You create an app extension to enable a specific task; after users get your extension, they can use it to perform that task in a variety of contexts. For example, if you provide an extension that enables sharing to your social sharing website, users can use it to post a remark while surfing the web. Or if you provide an extension that displays current sports scores, users can put it in Notification Center so that they can get the latest scores when they open the Today view. You can even create an extension that provides a custom keyboard that users can use in place of the iOS system keyboard.

There Are Several Types of App Extensions

iOS and OS X define several types of app extensions, each of which is tied to an area of the system, such as sharing, Notification Center, and the iOS keyboard. A system area that supports extensions is called an **extension point**. Each extension point defines usage policies and provides APIs that you use when you create an extension for that area. You choose an extension point to use based on the functionality you want to provide.

Table 1-1 lists the extension points in iOS and OS X and gives an example of tasks you might enable in an app extension for each extension point.

Table 1-1 Extension points in iOS and OS X

Extension point	Typical app extension functionality
Today (iOS and OS X)	Get a quick update or perform a quick task in the Today view of Notification Center (A Today extension is called a **widget**)
Share (iOS and OS X)	Post to a sharing website or share content with others
Action (iOS and OS X; UI and non-UI variants)	Manipulate or view content originating in a host app
Photo Editing (iOS)	Edit a photo or video within the Photos app
Finder Sync (OS X)	Present information about file sync state directly in Finder.

Extension point	Typical app extension functionality
Document Provider (iOS; UI and non-UI variants)	Provide access to and manage a repository of files.
Custom Keyboard (iOS)	Replace the iOS system keyboard with a custom keyboard for use in all apps

Because the system defines specific areas for app extensions, it's important to choose the area that best matches the functionality you want to deliver. For example, if you want to create an extension that enables a sharing experience, use the Share extension point, starting with the *Share Extension* Xcode template.

Important: Each app extension you create matches exactly one of the extension points listed in Table 1-1. You don't create a generic extension that matches more than one extension point.

Xcode and the App Store Help You Create and Deliver App Extensions

An app extension is different from an app. Although you must use an app to contain and deliver your extensions, each extension is a separate binary that runs independent of the app used to deliver it.

You create an app extension by adding a new target to an app. As with any target, an extension target specifies settings and files that combine to build a product within your app project. You can add multiple extension targets to a single app (an app that contains one or more extensions is called a **containing app**).

The best way to start developing an app extension is to use one of the templates that Xcode provides for each extension point on both platforms. Each template includes extension point–specific implementation files and settings, and produces a separate binary that gets added to your containing app's bundle.

To distribute app extensions to users, you submit a containing app to the App Store. When a user installs your containing app, the extensions it contains are also installed.

After installing an app extension, a user must take action to enable it. Often, users can enable an extension within the context of their current task. If your extension is a Today widget, for example, users can edit the Today view in Notification Center to enable your extension. In other cases, users can use Settings (in iOS) or System Preferences (in OS X) to enable and manage the extensions they install.

Users Experience App Extensions in Different Contexts

Although each type of app extension enables a different type of task, there are some parts of the user experience that are common to most extensions. As you think about designing an extension, it's important to understand the user experience that's intended by the extension point you choose. At a high level, the best user experience for all extensions is quick, streamlined, and focused on a single task.

Users open your app extension by interacting with some system-provided user interface (UI). For example, a user accesses a Share extension by activating the system-provided Share button in an app and choosing the extension from the list that's displayed.

Although most app extensions provide at least some custom UI elements, users don't see your custom UI until they enter your extension. When users enter your extension, your custom UI can help to show them that they're shifting into a new context. Because users can distinguish your extension from the current app, they can appreciate the unique functionality that you provide. Users' awareness of extensions as separate entities also means that they can identify and remove extensions that misbehave or don't perform well.

To give users a smooth transition into your app extension, you generally want to balance your custom design with the UI that's associated with the extension point. For example, it's a good idea to make your widget look like it belongs in the Today view. Similarly, in your Photo Editing extension, it works well to create a UI that harmonizes with Photos in iOS.

> **Note:** Even if your app extension doesn't display any custom UI (other than an icon), users still understand that your extension is different from the current app because they took a specific action to activate it.

Understand How an App Extension Works

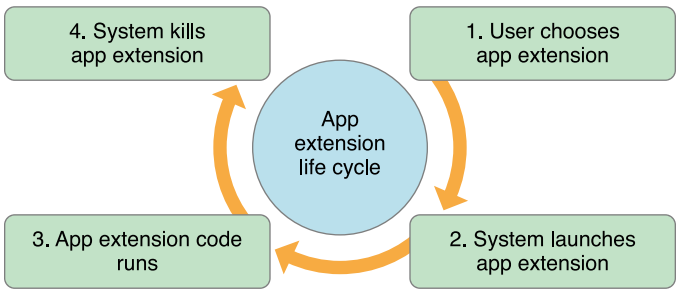
An app extension is not an app. It implements a specific, well scoped task that adheres to the policies defined by a particular extension point.

An App Extension's Life Cycle

Because an app extension is not an app, its life cycle and environment are different. In most cases, an extension launches when a user chooses it from an app's UI or from a presented activity view controller. An app that a user employs to choose an app extension is called a **host app**. A host app defines the context provided to the extension and kicks off the extension life cycle when it sends a request in response to a user action. An extension typically terminates soon after it completes the request it received from the host app.

For example, imagine that a user selects some text in an OS X host app, activates the Share button, and chooses an app extension from the sharing list to help them post the text to a social sharing website. The host app responds to the user's choice by issuing to the extension a request that contains the selected text. A generalized version of this situation is pictured in step 1 of Figure 2-1.

Figure 2-1 The basic life cycle of an app extension



In step 2 of Figure 2-1, the system instantiates the app extension identified in the host app's request and sets up a communication channel between them. The extension displays its view within the context of the host app and then uses the items it received in the host app's request to perform its task (in this example, the extension receives the selected text).

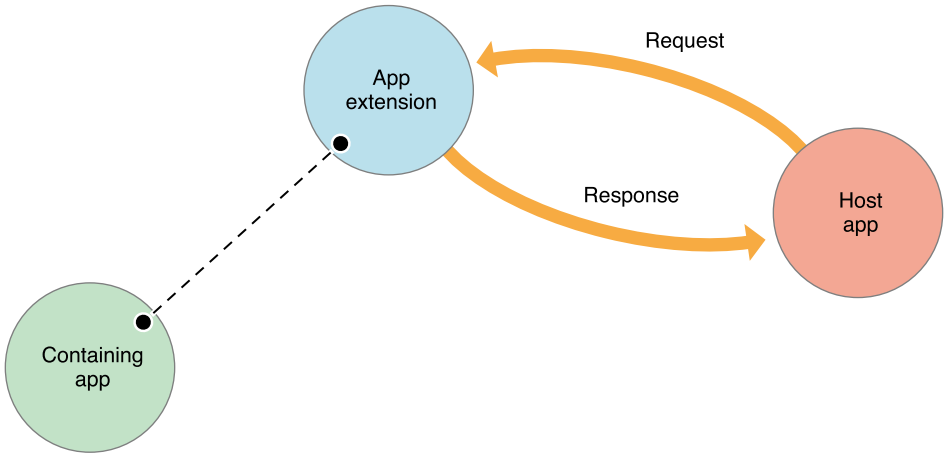
In step 3 of Figure 2-1, the user performs or cancels the task in the app extension and dismisses it. In response to this action, the extension completes the host app's request by immediately performing the user's task or, if necessary, initiating a background process to perform it. The host app tears down the extension's view and the user returns to their previous context within the host app. When the extension's task is finished, whether immediately or later, a result may be returned to the host app.

Shortly after the app extension performs its task (or starts a background session to perform it), the system terminates the extension, as shown in step 4.

How an App Extension Communicates

An app extension communicates primarily with its host app, and does so in terms reminiscent of transaction processing: There is a request from the host and a response from the extension. Figure 2-2 shows a simplified view of the relationship between a running extension, the host app that launched it, and the containing app.

Figure 2-2 An app extension communicates directly only with the host app



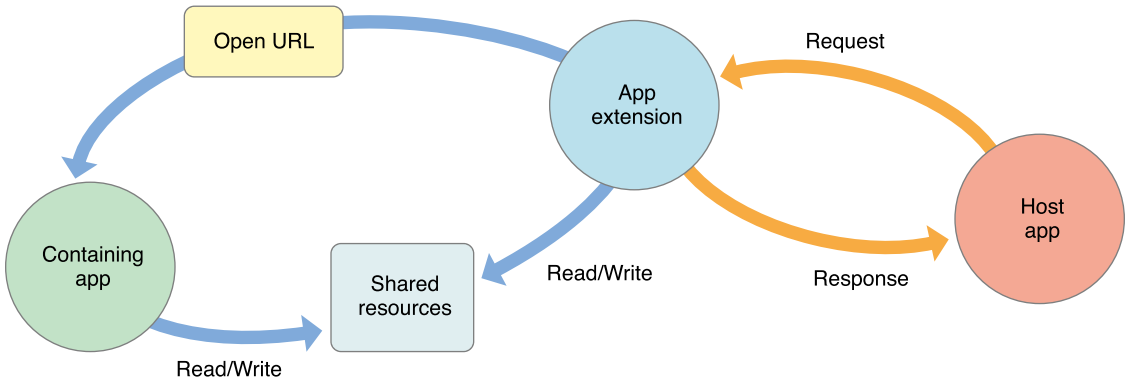
There is no direct communication between an app extension and its containing app; typically, the containing app isn't even running while a contained extension is running. An app extension's containing app and the host app don't communicate at all.

In a typical request/response transaction, the system opens an app extension on behalf of a host app, conveying data in an **extension context** provided by the host. The extension displays a user interface, performs some work, and, if appropriate for the extension's purpose, returns data to the host.

The dotted line in Figure 2-2 represents the limited interaction available between an app extension and its containing app. A Today widget (and no other app extension type) can ask the system to open its containing app by calling the `openURL:completionHandler:` method of the `NSExtensionContext` class. As indicated

by the Read/Write arrows in Figure 2-3, any app extension and its containing app can access shared data in a privately defined shared container. The full vocabulary of communication between an extension, its host app, and its containing app is shown in simple form in Figure 2-3.

Figure 2-3 An app extension can communicate indirectly with its containing app



Note: Behind the scenes, the system uses interprocess communication to ensure that the host app and an app extension can work together to enable a cohesive experience. In your code, you never have to think about this underlying communication mechanism, because you use the higher-level APIs provided by the extension point and the system.

Some APIs Are Unavailable to App Extensions

Because of its focused role in the system, an app extension is ineligible to participate in certain activities. An app extension cannot:

- Access a `sharedApplication` object, and so cannot use any of the methods on that object
- Use any API marked in header files with the `NS_EXTENSION_UNAVAILABLE` macro, or similar unavailability macro, or any API in an unavailable framework

  For example, in iOS 8.0, the HealthKit framework and EventKit UI framework are unavailable to app extensions.
- Access the camera or microphone on an iOS device
- Perform long-running background tasks

  The specifics of this limitation vary by platform, as described in the extension point chapters in this document.

  (An app extension can initiate uploads or downloads using an `NSURLSession` object, with results of those operations reported to the containing app.)

- Receive data using AirDrop

  (An app extension can *send* data using AirDrop in the same way an app does: by employing the `UIActivityViewController` class.)

Creating an App Extension

When you're ready to develop an app extension, begin by choosing the extension point that supports the user task you want to facilitate. Use the corresponding Xcode app extension template and enhance the default files with custom code and user interface (UI). After you optimize and test your app extension, you're ready to distribute it within your containing app.

Begin Development By Choosing the Right Extension Point

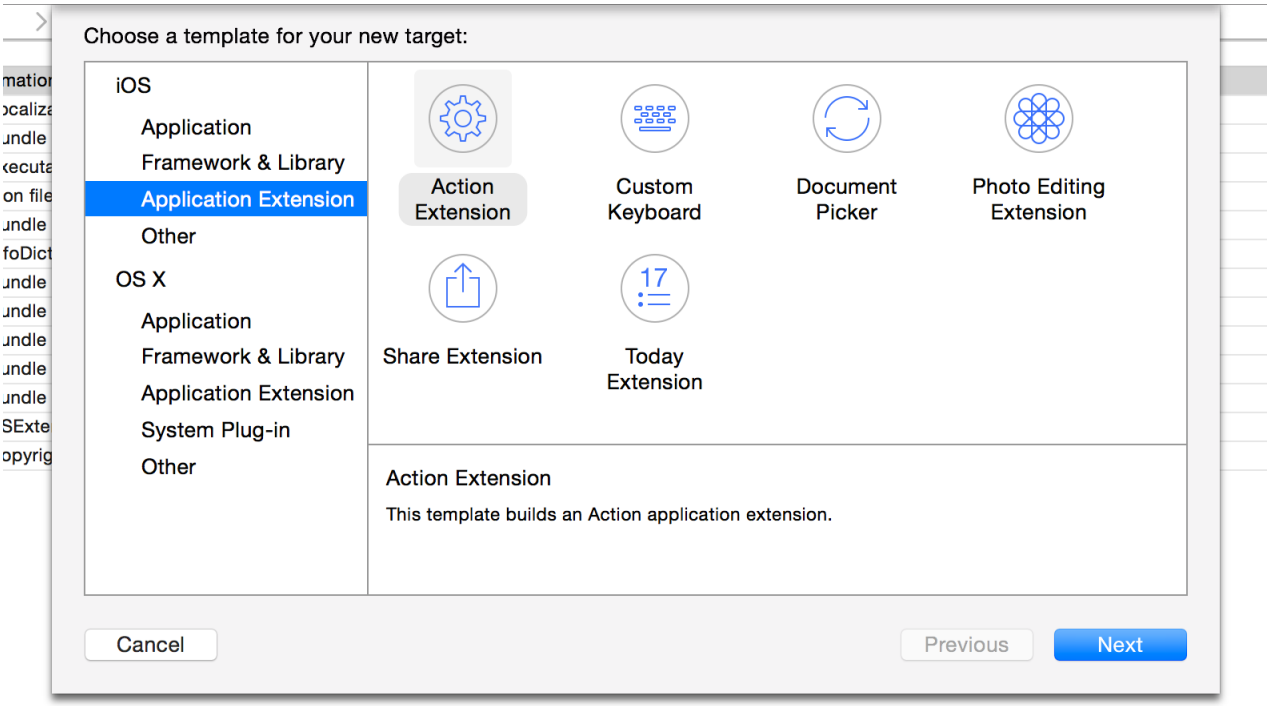
Because each extension point targets a well-defined user scenario, your first job is to choose the extension point that supports the type of functionality you plan to deliver. This choice is an important one because it determines the APIs that are available to you and, in some cases, the ways in which APIs behave.

The extension points supported in iOS and OS X, along with their `Info.plist` extension point identifier keys, are described in the section NSExtensionPointIdentifier in *Information Property List Key Reference* .

After you choose the extension point that makes sense for your app extension, add a new target to your containing app. The easiest way to add an app extension target is to use an Xcode template that provides a target preconfigured for your extension point.

To add a new target to your Xcode app project, choose File > New > Target. In the sidebar on the left side of the new target dialog, choose Application Extension for iOS or OS X. In the pane on the right side of the dialog, Xcode displays the templates you can choose. For example, Figure 3-1 shows the templates you can use to create an iOS app extension.

Figure 3-1 Xcode supplies several app extension templates you can use



After you choose a template and finish adding the target to your project, you should be able to build and run the project even before you customize the extension code. When you build an extension based on an Xcode template, you get an extension bundle that ends in `.appex`.

> **Note about 64-bit architecture:** An app extension target must include the arm64 (iOS) or x86_64 architecture (OS X) in its Architectures build settings or it will be rejected by the App Store. Xcode includes the appropriate 64-bit architecture with its "Standard architectures" setting when you create a new app extension target.
>
> If your containing app target links to an embedded framework, the app must also include 64-bit architecture or it will be rejected by the App Store.
>
> For more information about 64-bit development, see *64-Bit Transition Guide for Cocoa Touch* or *64-Bit Transition Guide for Cocoa*, depending on your target platform.

In most cases, you can test the default app extension by enabling it in System Preferences or Settings and then accessing it through another app. For example, you can test an OS X Share extension by opening a webpage in Safari, clicking the Share toolbar button, and choosing your extension in the menu that appears.

Examine the Default App Extension Template

Each app extension template includes a property list file (that is, an `Info.plist` file), a view controller class, and a default user interface, all of which are defined by the extension point. The default view controller class (or **principal class**) can contain stubs for the extension point methods you should implement.

An app extension target's `Info.plist` file identifies the extension point and may specify some details about your extension. At a minimum, the file includes the `NSExtension` key and a dictionary of keys and values that the extension point specifies. For example, the value of the required `NSExtensionPointIdentifier` key is the extension point's reverse DNS name, such as `com.apple.widget-extension`. Here are some of the other keys and values you may see in your extension's `NSExtension` dictionary:

- `NSExtensionAttributes`

  A dictionary of extension point–specific attributes, such as `PHSupportedMediaTypes` for a Photo Editing extension.

- `NSExtensionPrincipalClass`

  The name of the principal view controller class created by the template, such as `SharingViewController`. When a host app invokes your extension, the extension point instantiates this class.

- `NSExtensionMainStoryboard` (iOS extensions only)

  The default storyboard file for the extension, usually named `MainInterface`.

In addition to the property list settings, a template may set some capabilities by default. Each extension point can define capabilities that make sense for the type of task the extension point supports. For example, an iOS Document Provider extension includes the `com.apple.security.application-groups` entitlement.

All templates for OS X app extensions include the App Sandbox and `com.apple.security.files.user-selected.read-only` entitlements by default. You might need to define additional capabilities for your extension if it needs to do things like use the network or access the user's photos or contact information.

> **Note:** In general, when users give a containing app access to their private data, all extensions in the containing app also receive access.

Respond to the Host App's Request

As you learned in Understand How an Extension Works (page 10), an app extension opens when a user chooses the extension within a host app and the host app issues a request. At a high level, your extension receives the request, helps the user perform a task, and completes or cancels the request, according to the user's action. For example, a Share extension receives a request from a host app and responds by displaying its view. After users compose content in the view, they choose to post the content or cancel the post, and the extension completes or cancels the request accordingly.

When a host app sends a request to an app extension, it specifies an extension context. For many extensions, the most important part of the context is the set of items a user wants to work with while they're in the extension. For example, the context for an OS X Share extension might include a selection of text that a user wants to post.

As soon as a host app issues its request (typically, by calling the `beginRequestWithExtensionContext:` method), your app extension can use the `extensionContext` property on its principal view controller to get the context. Child view controllers also have access to this property through chaining.

Next, you use the `NSExtensionContext` class to examine the context and get the items within it. Often, it works well to get the context and items in your view controller's `loadView` method so that you can display the information in your view. To get your extension's context you can use code like the following:

```
NSExtensionContext *myExtensionContext = self.extensionContext;
```

Of particular interest is the context object's `inputItems` property, which can contain the items your app extension needs to use. The `inputItems` property contains an array of `NSExtensionItem` objects, each of which contains an item the extension can work on. To get the items from the context object, you might use code like this:

```
NSArray *inputItems = myExtensionContext.inputItems;
```

Each `NSExtensionItem` object contains a number of properties that describe aspects of the item, such as its title, content text, attachments, and user info.

Note that the `attachments` property contains an array of media data that's associated with the item. For example, in an item associated with a sharing request, the `attachments` property might contain a representation of the webpage a user wants to share.

After users work with the input items (if doing so is part of using the app extension), an app extension typically gives users a choice between completing or canceling the task. Depending on the user's choice, you call either the `completeRequestReturningItems:completionHandler:` method, optionally returning `NSExtensionItem` objects to the host app, or the `cancelRequestWithError:` method, returning an error code.

Important: If your app extension calls the `completeRequestReturningItems:completionHandler:` method, provide a `completionHandler` block to, at minimum, suspend your app extension should the system ask you to. For details, read the documentation for the `completionHandler` block of this method, in *NSExtensionContext Class Reference*.

In iOS, your app extension might need a bit more time to complete a potentially lengthy task, such as uploading content to a website. When this is the case, you can use the `NSURLSession` class to initiate a transfer in the background. Because a background transfer uses a separate process, the transfer can continue, as a low priority task, after your extension completes the host app's request and gets terminated. To learn more about using `NSURLSession` in your extension, see Performing Uploads and Downloads (page 29).

Important: Although you can set up a background URL upload or download task, other types of background tasks, such as supporting VoIP or playing background audio, are not available to extensions.

If you include the `UIBackgroundModes` key in your app extension's `Info.plist` file, the extension will be rejected by the App Store. (To learn more about this key, see UIBackgroundModes in *Information Property List Key Reference*.)

Optimize Efficiency and Performance

App extensions should feel nimble and lightweight to users. Design your app extension to launch quickly, aiming for well under one second. An extension that launches too slowly is terminated by the system.

Memory limits for running app extensions are significantly lower than the memory limits imposed on a foreground app. On both platforms, the system may aggressively terminate extensions because users want to return to their main goal in the host app. Some extensions may have lower memory limits than others: For example, widgets must be especially efficient because users are likely to have several widgets open at the same time.

Your app extension doesn't own the main run loop, so it's crucial that you follow the established rules for good behavior in main run loops. For example, if your extension blocks the main run loop, it can create a bad user experience in another extension or app.

Keep in mind that the GPU is a shared resource in the system. App extensions do not get top priority for shared resources; for example, a Today widget that runs a graphics-intensive game might give users a bad experience. The system is likely to terminate such an extension because of memory pressure. Functionality that makes heavy use of system resources is appropriate for an app, not an app extension.

Design a Streamlined UI

Most extension points require you to supply at least some custom UI that users see when they open your app extension. An extension's UI should be simple, restrained, and focused on facilitating a single task. To improve performance and the user's experience, avoid including extraneous UI that doesn't support your extension's main task.

Most Xcode app extension templates provide a placeholder UI that you can use to get started.

Users identify your app extension by its icon and its name. An extension's icon must be the same as the app icon of its containing app. Using the containing app's icon helps a user be confident that an extension is in fact provided by the app they installed.

In iOS, a custom Action extension uses a template image version of its containing app's icon, which you must provide.

iOS Share extensions automatically employ the containing app's icon. If you provide a separate icon in your Share extension target, Xcode ignores it. For all other app extension types, you must provide an icon that matches the containing app's icon.

For information on how to add an icon to your app extension, see Creating an Asset Catalog and Adding an App Icon Set or Launch Image Set. For more about icon requirements for iOS app extensions, see "App Extensions" in *iOS Human Interface Guidelines*

An app extension needs a short, recognizable name that includes the name of the containing app, using the pattern <*Containing app name*>–<*App extension name*> . This makes it easier for users to manage extensions throughout the system. You can, optionally, use the containing app's name as-is for your extension, in the common case that your containing app provides exactly one extension.

The displayed name of your app extension is provided by the extension target's `CFBundleDisplayName` value, which you can edit in the extension's `Info.plist` file. If you don't provide a value for the `CFBundleDisplayName` key, your extension uses the name of its containing app, as it appears in the `CFBundleName` value.

Make sure you localize the app extension's name when you provide a localized app extension.

Some app extensions also need short descriptions. For example, an OS X widget displays a description to help users choose the widgets they want to see in the Today view. To provide this text, edit the value of the `widget.description` key in your widget's `InfoPlist.strings` file.

Ensure Your iOS App Extension Works on All Devices

You must ensure that your submitted app extension is universal: it must work on iPhone, iPod touch, and iPad. This requirement applies no matter which targeted device family you choose for your containing app. The app extension templates in Xcode are configured correctly for the universal targeted device family.

To declare that your app extension is universal, use the targeted device family build setting in Xcode, specifying the "iPhone/iPad" value.

To ensure that your app extension is universal

1. In the Xcode project navigator for your keyboard project, select the project file.

   If the project & targets list in the project editor is hidden, show it. To do this, click the button at the left of the project editor tab bar.

2. In the targets group in the project & targets list, select the target for your app extension.
3. Choose the Build Settings tab in the project editor.

   Ensure that the Basic and Combined buttons are selected, to make it easier for you to locate the settings you need here.
4. In the Deployment group in the project editor, view the Targeted Device Family setting. For both the Debug and Release configuration, the value should be "iPhone/iPad."

   If you find different values, correct them to be "iPhone/iPad."

Employ Auto Layout and size classes when designing and building your app extension. Test your app extension to ensure it behaves as you expect it to for all device sizes and orientations. Do this in iOS Simulator, as described in *iOS Simulator User Guide* , and, if possible, also test on physical devices in both orientations.

Important: To pass App Review, you must specify "iPhone/iPad" (sometimes called *universal*) as the targeted device family for your app extension, no matter which targeted device family you choose for your containing app.

Remember that even if your containing app targets only the iPad device family, your contained app extension can appear in the context of an iPhone app running in compatibility mode.

Debug, Profile, and Test Your App Extension

Note: You must code sign your containing app and its contained app extensions.

All the targets in your Xcode project must be code signed in the same way. For example, during testing you can employ ad hoc code signing or use your developer certificate, but must use the same approach for all the targets in your project. For submission to the App Store, use your distribution certificate for all the targets.

Using Xcode to debug an app extension is a lot like using Xcode to debug any other process, but with one important difference: In your extension scheme's Run phase, you specify a *host app* as the executable. Upon accessing the extension through that specified host's UI, the Xcode debugger attaches to the extension.

The scheme in an Xcode app extension template uses the Ask On Launch option for the executable. With this option, each time you build and run your project you're prompted to pick a host app. If you want to instead specify a particular host to use every time, open the scheme editor and use the Info tab for the app extension scheme's Run phase.

The steps for attaching the Xcode debugger to your app extension are:

1. Enable the app extension's scheme by choosing Product > Scheme > `MyExtensionName` or by clicking the scheme pop-up menu in the Xcode toolbar and choosing `MyExtensionName`.
2. Click the Build and Run button to tell Xcode to launch your specified host app.

   The Debug navigator indicates it is waiting for you to invoke the app extension.
3. Invoke the app extension by way of the host app's UI.

   The Xcode debugger attaches to the extension's process, sets active breakpoints, and lets the extension execute. At this point, you can use the same Xcode debugging features that you use to debug other processes.

Note: Before you build and run your app extension project, ensure the extension's scheme is selected.

If you instead build and run using the *containing app* scheme, Xcode does not attach to your app extension unless you invoke it from the containing app, which is an unusual scenario and might not be what you want.

If you access your app extension from a host app different from the one specified in the scheme, the Xcode debugger does not attach to the extension.

In OS X, you need to perform the user step of enabling an app extension before you can access it from a host app for testing and debugging. You enable most extension types by using the Extensions pane of System Preferences. You can also open the Extensions pane by choosing More in the Share or Action menu.

For an OS X Today widget, use the Widget Simulator to test and debug it. (There is no separate step for you to perform in System Preferences to enable the widget.)

For a custom keyboard in iOS, use Settings to enable the app extension (Settings > General > Keyboard > Keyboards).

Xcode registers a built app extension for the duration of the debugging session on OS X. This means that if you want to install the development version of your extension on OS X you need to use the Finder to copy it from the build location to a location such as the Applications folder.

Note: In the Xcode debug console logs, an app extension's binary might be associated with the value of the `CFBundleIdentifier` property, instead of the value of the `CFBundleDisplayName` property.

Because app extensions must be responsive and efficient, it's a good idea to watch the debug gauges in the debug navigator while you're running your extension. The debug gauges show how your extension uses the CPU, memory, and other system resources while it runs. If you see evidence of performance problems, such

as an unusual spike in CPU usage, you can use Instruments to profile your extension and identify areas for improvement. You can open Instruments while you're in a debugging session by clicking Profile in Instruments in any debug gauge report (to view a debug gauge report, click the gauge in the debug area). To learn more about the debug gauges, see Debug Your App in *Xcode Overview*; to learn how to use Instruments, see *Instruments User Guide*.

> **Note:** Choosing Product > Profile in Xcode builds and runs an app extension in Instruments directly. Instruments uses the executable set in the Profile section of the scheme as the host for the extension.

To test an app extension using the Xcode testing framework (that is, the XCTest APIs), write tests that exercise the extension code using your containing app as the host environment. To learn more about testing, see *Testing with Xcode*.

Distribute the Containing App

You can't submit an app extension to the App Store unless it's inside a containing app, and you can't transfer an extension from one app to another.

To deliver an iOS app extension, you must submit a containing app to the App Store.

To deliver an OS X app extension, it's recommended that you submit your containing app to the App Store, but it's not required.

> **Note:** If you distribute an OS X app extension outside of the Mac App Store, Gatekeeper prevents the extension from running until the user opens and approves the containing app. Further, if you code sign with a certificate other than your Developer ID, users must explicitly override Gatekeeper to open the containing app to make your extension available.

To pass app review, your containing app must provide functionality to users; it can't just contain app extensions.

Handling Common Scenarios

As you write custom code that performs your app extension's task, you may need to handle some scenarios that are common to many types of extensions. Use the code and recommendations in this chapter to help you implement your solutions.

Using an Embedded Framework to Share Code

You can create an embedded framework to share code between your app extension and its containing app. For example, if you develop an image filter for use in your Photo Editing extension as well as in its containing app, put the filter's code in a framework and embed the framework in both targets.

Make sure your embedded framework does not contain APIs unavailable to app extensions, as described in Some APIs Are Unavailable to App Extensions (page 12). If you have a custom framework that does contain such APIs, you can safely link to it from your containing app but cannot share that code with the app's contained extensions. The App Store rejects any app extension that links to such frameworks or that otherwise uses unavailable APIs.

To configure an app extension target to use an embedded framework, set the target's "Require Only App-Extension-Safe API" build setting to Yes. If you don't, Xcode reminds you to do so by displaying the warning *"linking against dylib not safe for use in application extensions"*.

> **Important:** A containing app that links to an embedded framework must include the arm64 (iOS) or x86_64 (OS X) architecture build setting or it will be rejected by the App Store. (As described in Creating an App Extension (page 14), all app extensions must include the appropriate 64-bit architecture build setting.)

When configuring your Xcode project, you must choose "Frameworks" as the destination for your embedded framework in the Copy Files build phase.

> **Important:** Always choose "Frameworks" as your Copy Files build phase destination. If you instead choose the "SharedFramework" destination, the App Sore will reject your submission.

You can make a containing app available to users running iOS 7 or earlier, but then must take precautions to safely link embedded frameworks when running in iOS 8 or later. Read Deploying a Containing App to Older Versions of iOS (page 33) for details.

For more on creating and using embedded frameworks, watch the WWDC 2014 video "Building Modern Frameworks," available at https://developer.apple.com/videos/wwdc/2014.

Sharing Data with Your Containing App

The security domains for an app extension and its containing app are distinct, even though the extension bundle is nested within the containing app's bundle. By default, your extension and its containing app have no direct access to each other's containers.

You can, however, enable data sharing. For example, you might want to allow your app extension and its containing app to share a single large set of data, such as prerendered assets.

To enable data sharing, use Xcode or the Developer portal to enable app groups for the containing app and its contained app extensions. Next, register the app group in the portal and specify the app group to use in the containing app. To learn about working with app groups, see Adding an App to an App Group in *Entitlement Key Reference*.

After you enable app groups, an app extension and its containing app can both use the `NSUserDefaults` API to share access to user preferences. To enable this sharing, use the `initWithSuiteName:` method to instantiate a new `NSUserDefaults` object, passing in the identifier of the shared group. For example, a Share extension might update the user's most recently used sharing account, using code like this:

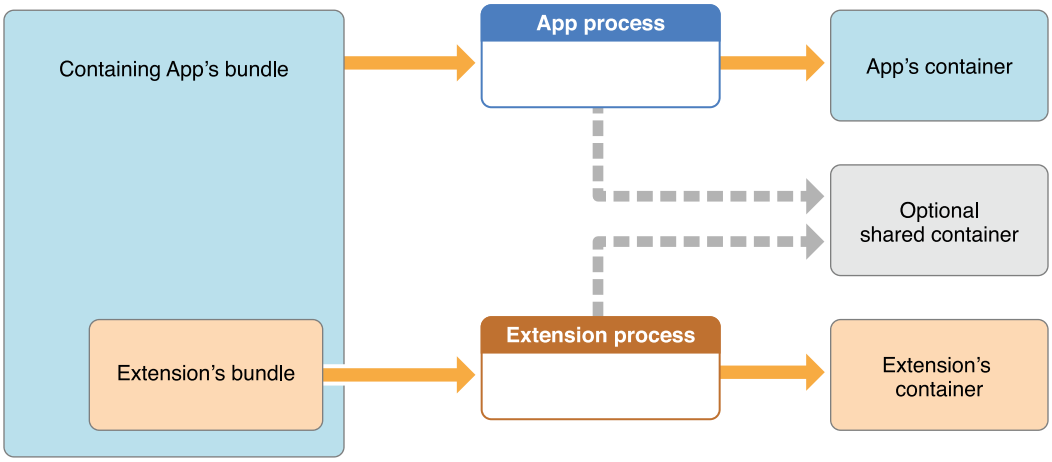
```
// Create and share access to an NSUserDefaults object.
NSUserDefaults *mySharedDefaults = [[NSUserDefaults alloc]
initWithSuiteName:@"com.example.domain.MyShareExtension"];



// Use the shared user defaults object to update the user's account.
[mySharedDefaults setObject:theAccountName forKey:@"lastAccountName"];
```

Figure 4-1shows how an extension and its containing app can use a shared container to share data.

Figure 4-1 An app extension's container is distinct from its containing app's container



Important: You must set up a shared container if your app extension uses the `NSURLSession` class to perform a background upload or download, so that both the extension and its containing app can access the transferred data. To learn how to perform an upload or download in the background, see Performing Uploads and Downloads (page 29).

When you set up a shared container, the containing app—and each contained app extension that you allow to participate in data sharing—have read and write access to the shared container. To avoid data corruption, you must synchronize data accesses. Use Core Data, SQLite, or Posix locks to help coordinate data access in a shared container.

Accessing a Webpage

In Share extensions (on both platforms) and Action extensions (iOS only), you can give users access to web content by asking Safari to run a JavaScript file and return the results to the extension. You can also use the JavaScript file to access a webpage before your extension runs (on both platforms), or to access or modify the webpage after your extension completes its task (iOS only). For example, a Share extension can help users share content from a webpage, or an Action extension in iOS might display a translation of the user's current webpage.

To add webpage access and manipulation to your app extension, perform the following steps:

- Create a JavaScript file that includes a global object named `ExtensionPreprocessingJS`. Assign a new instance of your custom JavaScript class to this object.

- In the `NSExtensionActivationRule` dictionary in your app extension's `Info.plist` file, give the `NSExtensionActivationSupportsWebPageWithMaxCount` key a nonzero value. (To learn more about the activation rule dictionary, see Declaring Supported Data Types for a Share or Action Extension (page 30).)
- When your app extension starts, use the `NSItemProvider` class to get the results returned by the execution of the JavaScript file.
- In an iOS app extension, pass values to the JavaScript file if you want Safari to modify the webpage when your extension completes its task. (You use the `NSItemProvider` class in this step, too.)

To tell Safari that your app extension includes a JavaScript file, add the `NSExtensionJavaScriptPreprocessingFile` key to the `NSExtensionAttributes` dictionary. The value of the key should be the file that you want Safari to load before your extension starts. For example:

```
<key>NSExtensionAttributes</key>
        <dict>
            <key>NSExtensionJavaScriptPreprocessingFile</key>
          <string>MyJavaScriptFile</string> <!-- Do not include the ".js" filename
 extension -->
        </dict>
```

On both platforms, your custom JavaScript class can define a `run()` function that Safari invokes as soon as it loads the JavaScript file. In the `run()` function, Safari provides an argument named `completionFunction`, with which you can pass results to your app extension in the form of a key-value object.

In iOS, you can also define a `finalize()` function that Safari invokes when your app extension calls `completeRequestReturningItems:completion:` at the end of its task. A `finalize()` function can use items your extension passes in `completeRequestReturningItems:completion:` to change the webpage as desired.

For example, if your iOS app extension needs the base URI of a webpage when it starts and it changes the background color of the webpage when it stops, you might write JavaScript code like that shown in Listing 4-1.

Listing 4-1 Example `run()` and `finalize()` functions

```
var MyExtensionJavaScriptClass = function() {};


MyExtensionJavaScriptClass.prototype = {
    run: function(arguments) {
```

```
    // Pass the baseURI of the webpage to the extension.
        arguments.completionFunction({"baseURI": document.baseURI});
    },

// Note that the finalize function is only available in iOS.
    finalize: function(arguments) {
       // arguments contains the value the extension provides in [NSExtensionContext
 completeRequestReturningItems:completion:].
    // In this example, the extension provides a color as a returning item.
    document.body.style.backgroundColor = arguments["bgColor"];
    }
};

// The JavaScript file must contain a global object named "ExtensionPreprocessingJS".
var ExtensionPreprocessingJS = new MyExtensionJavaScriptClass;
```

On both platforms, you need to write code to handle the values that get passed back from your `run()` function. To get the dictionary of results, specify the `kUTTypePropertyList` type identifier in the `NSItemProvider` method `loadItemForTypeIdentifier:options:completionHandler:`. In the dictionary, use the `NSExtensionJavaScriptPreprocessingResultsKey` key to get the result item. For example, to get the base URI passed in the `run()` function in Listing 4-1 (page 27), you might use code like this:

```
[imageProvider loadItemForTypeIdentifier:kUTTypePropertyList options:nil
completionHandler:^(NSDictionary *item, NSError *error) {
    NSDictionary *results = (NSDictionary *)item;
        NSString *baseURI = [[results
objectForKey:NSExtensionJavaScriptPreprocessingResultsKey] objectForKey:@"baseURI"];
    }];
```

To pass a value to the `finalize()` function when your iOS app extension finishes its task, use the `NSItemProvider initWithItem:typeIdentifier:` method to pack the value in the dictionary for the `NSExtensionJavaScriptFinalizeArgumentKey` key. For example, to specify red for the background color used in the `finalize()` function in Listing 4-1 (page 27), your extension might use code like this:

```
 NSExtensionItem *extensionItem = [[NSExtensionItem alloc] init];
```

```
    extensionItem.attachments = @[[[NSItemProvider alloc] initWithItem:
@{NSExtensionJavaScriptFinalizeArgumentKey: @{@"bgColor":@"red"}}
typeIdentifier:(NSString *)kUTTypePropertyList]];

    [[self extensionContext] completeRequestReturningItems:@[extensionItem]
completion:nil];
```

Performing Uploads and Downloads

Users tend to return to the host app immediately after they finish their task in your app extension. If the task involves a potentially lengthy upload or download, you need to ensure that it can finish after your extension gets terminated. To perform an upload or download, use the `NSURLSession` class to create a URL session and initiate a background upload or download task.

> **Note:** Recall that other types of background tasks, such as supporting VoIP or playing background audio, are not available to app extensions. For more information, see Respond to the Host App's Request (page 17).

After your app extension initiates the upload or download task, the extension can complete the host app's request and be terminated without affecting the outcome of the task. To learn more about how an extension handles the request from a host app, see Respond to the Host App's Request (page 17). In iOS, if your extension isn't running when a background task completes, the system launches your containing app in the background and calls the `application:handleEventsForBackgroundURLSession:completionHandler:` app delegate method.

> **Important:** If your app extension initiates a background `NSURLSession` task, you must also set up a shared container that both the extension and its containing app can access. Use the `sharedContainerIdentifier` property of the `NSURLSessionConfiguration` class to specify an identifier for the shared container so that you can access it later.
>
> Refer to Sharing Data with Your Containing App (page 25) for guidance on setting up a shared container.

Listing 4-2 shows one way to configure a URL session and use it to initiate a download.

Listing 4-2 An example of configuring an `NSURLSession` object and starting a download

```
NSURLSession *mySession = [self configureMySession];
NSURL *url = [NSURL URLWithString:@"http://www.example.com/LargeFile.zip"];
NSURLSessionTask *myTask = [mySession downloadTaskWithURL:url];
```

```
    [myTask resume];



- (NSURLSession *) configureMySession {
    if (!mySession) {
        NSURLSessionConfiguration* config = [NSURLSessionConfiguration
backgroundSessionConfigurationWithIdentifier:@“com.mycompany.myapp.backgroundsession”];
// To access the shared container you set up, use the sharedContainerIdentifier
property on your configuration object.
config.sharedContainerIdentifier = @“com.mycompany.myappgroupidentifier”;
        mySession = [NSURLSession sessionWithConfiguration:config delegate:self
delegateQueue:nil];
    }
    return mySession;
}
```

Because only one process can use a background session at a time, you need to create a different background session for the containing app and each of its app extensions. (Each background session should have a unique identifier.) It's recommended that your containing app only use a background session that was created by one of its extensions when the app is launched in the background to handle events for that extension. If you need to perform other network-related tasks in your containing app, create different URL sessions for them.

If you need to complete the host app's request before you initiate a background URL session, make sure that the code that creates and uses the session is efficient. After your app extension calls `completeRequestReturningItems:completionHandler:` to tell the host app that its request is complete, the system can terminate your extension at any time.

Declaring Supported Data Types for a Share or Action Extension

In your Share or Action extension, it's likely that you can work with some types of data but not others. To ensure that a host app offers your extension only when the user has selected data of a type that you support, add the `NSExtensionActivationRule` key to your extension's `Info.plist` property list file. You can also use this key to specify a maximum number of items of each type that your extension can handle.

When your extension runs, the system compares the `NSExtensionActivationRule` key's values with the information in an extension item's `attachments` property. For a complete list of keys you can use with this key, see Action Extension Keys in *Information Property List Key Reference*.

For example, to declare that your Share extension can support up to ten images, one movie, and one webpage URL, you might use the following dictionary for the value of the `NSExtensionAttributes` key:

```
<key>NSExtensionAttributes</key>
    <dict>
        <key>NSExtensionActivationRule</key>
        <dict>
            <key>NSExtensionActivationSupportsImageWithMaxCount</key>
            <integer>10</integer>
            <key>NSExtensionActivationSupportsMovieWithMaxCount</key>
            <integer>1</integer>
            <key>NSExtensionActivationSupportsWebURLWithMaxCount</key>
            <integer>1</integer>
        </dict>
    </dict>
```

If you don't support a particular data type, use `0` for the value of the corresponding key or remove the key from your `NSExtensionActivationRule` dictionary.

> **Note:** If your Share or iOS Action extension needs to access a webpage, you must include the `NSExtensionActivationSupportsWebPageWithMaxCount` key with a nonzero value. (To learn how to use JavaScript to access a webpage from your extension, see Accessing a Webpage (page 26).)

The keys in the `NSExtensionActivationRule` dictionary are sufficient to meet the filtering needs of typical app extensions. If you need to do more complex or more specific filtering, such as distinguishing between `public.url` and `public.image`, you can create a predicate statement. Then, use the bare string that represents the predicate as the value of the `NSExtensionActivationRule` key. (At runtime, the system compiles this string into an `NSPredicate` object.)

For example, an app extension item's `attachments` property can specify a PDF file like this:

```
{extensionItems = ({
    attachments = ({
        registeredTypeIdentifiers = (
            "com.adobe.pdf",
            "public.file-url"
```

```
        );
    });
})}
```

To specify that your app extension can handle exactly one PDF file, you might create a predicate string like this:

```
SUBQUERY (
    extensionItems,
    $extensionItem,
    SUBQUERY (
        $extensionItem.attachments,
        $attachment,
        ANY $attachment.registeredTypeIdentifiers UTI-CONFORMS-TO "com.adobe.pdf"
    ).@count == $extensionItem.attachments.@count
).@count == 1
```

Here is an example of a more complex predicate statement:

```
SUBQUERY (
    extensionItems,
    $extensionItem,
    SUBQUERY (
        $extensionItem.attachments,
        $attachment,
        ANY $attachment.registeredTypeIdentifiers UTI-CONFORMS-TO
"org.appextension.action-one" ||
        ANY $attachment.registeredTypeIdentifiers UTI-CONFORMS-TO
"org.appextension.action-two"
    ).@count == $extensionItem.attachments.@count
).@count == 1
```

This statement iterates over an array of `NSExtensionItem` objects, and secondarily over the `attachments` array in each extension item. For each attachment, the predicate evaluates the uniform type identifier (UTI) for each representation in the attachment. When an attachment representation UTI conforms to any of of two

different specified UTIs (which you see on the right-hand side of each `UTI-CONFORMS-TO` operator), collect that UTI for the final comparison test. The final line returns `TRUE` if the app extension was given exactly one extension item attachment with a supported UTI.

During development only, you can use the `TRUEPREDICATE` constant (which always evaluates to `true`) as a stub predicate statement, to test your code path before you implement your predicate statement.

> **Important:** Before you submit your containing app to the App Store, be sure to replace all uses of `TRUEPREDICATE` stub predicates with functional predicate statements or with `NSExtensionActivationRule` keys. If any app extensions in your containing app include the string `TRUEPREDICATE`, the app will be rejected.

To learn more about the syntax of predicate statements, see Predicate Format String Syntax in *Predicate Programming Guide*.

Deploying a Containing App to Older Versions of iOS

If you link to an embedded framework from your containing app, you can still deploy it to versions of iOS older than 8.0, even though embedded frameworks are not available in those versions.

The mechanism that lets you do this is the dlopen command, which you use to conditionally link and load a framework bundle. You employ this command as an alternative to the build-time linking you can specify in the Xcode General or Build Phases target editor. The main idea is to link embedded frameworks into your containing app only when running in iOS 8.0 or newer.

You must use Objective-C, not Swift, in your code statements that conditionally load a framework bundle. The rest of your app can be written in either language, and the embedded framework itself can likewise be written in either language.

After calling `dlopen`, access the embedded framework classes using the following type of statement:

```
MyLoadedClass *loadedClass = [[NSClassFromString (@"MyClass") alloc] init];
```

> **Important:** If your containing app target links to an embedded framework, it must include the arm64 architecture or it will be rejected by the App Store.

To set up an app extension Xcode project to take advantage of conditional linking

1. For each of your contained app extensions, set the deployment target to be iOS 8.0 or later, as usual.

   Do this in the "Deployment info" section of the General tab in the Xcode target editor.

2. For your containing app, set the deployment target to be the oldest version of iOS that you want to support.
3. In your containing app, conditionalize calls to the `dlopen` command within a runtime check for the iOS version by using the `systemVersion` method.

   Call the `dlopen` command only if your containing app is running in iOS 8.0 or later. Be sure to use Objective-C, not Swift, when making this call.

Certain iOS APIs use embedded frameworks via the `dlopen` command. You must conditionalize your use of these APIs just as you do when calling `dlopen` directly. These APIs are from the `CFBundleRef` opaque type:

- `CFBundleGetFunctionPointerForName`
- `CFBundleGetFunctionPointersforNames`

And from the `NSBundle` class:

- `load`
- `loadAndReturnError:`
- `classNamed:`

In a containing app you are deploying to versions of iOS older than 8.0, call these APIs only within a runtime check that ensures you are running in iOS 8.0 or newer, and call these APIs using Objective-C.

App Extension Types

Today

App extensions in the Today view are called **widgets**. Widgets give users quick access to information that's important right now. For example, users open the Today view to check current stock prices or weather conditions, see today's schedule, or perform a quick task such as marking an item as done. Users tend to open the Today view frequently, and they expect the information they're interested in to be instantly available.

A Today widget can appear on the lock screen of an iOS device.

> **Before you begin:** Make sure that the Today extension point is appropriate for the functionality you want to provide. The best widgets give users quick updates or enable very simple tasks. If you want to create an app extension that enables a multistep task or helps users perform a lengthy task, such as uploading or downloading content, the Today extension point is not the right choice.
>
> To learn about other types of app extensions you can create, see Table 1-1 (page 7).

Understand Today Widgets

On both platforms, a Today widget should:

- Ensure that content always looks up to date
- Respond appropriately to user interactions
- Perform well (in particular, iOS widgets must use memory wisely or the system may terminate them)

Because user interaction with Today widgets is quick and limited, you should design a simple, streamlined UI that highlights the information users are interested in. In general, it's a good idea to limit the number of interactive items in a widget. In particular, note that iOS widgets don't support keyboard entry.

> **Note:** Avoid putting a scroll view inside a Today widget. It's difficult for users to scroll within a widget without inadvertently scrolling the Today view.

Users configure Today widgets differently depending on the platform they're using.

iOS. Because Today widgets don't allow keyboard entry, users need to be able to use the containing app to configure a widget's content and behavior. In the Stocks widget, for example, users can switch between different representations of a symbol's value, but they must open the Stocks app to manage the list of symbols.

OS X. The containing app might not perform any functions, so the Today widget may need to give users ways to configure it while it's running. For example, the Stocks widget in OS X lets users find and add market symbols they want to track. The Notification Center API in OS X includes methods you can use to let users configure widgets.

After users install an app that contains a Today widget, they can add the widget to the Today view. When users choose Edit in the Today view, Notification Center reveals a view that lets users add, reorder, and remove widgets.

Use the Xcode Today Template

The Xcode Today template provides default header and implementation files for the principal class (named `TodayViewController`), an `Info.plist` file, and an interface file (that is, a storyboard or xib file).

By default, the Today template supplies the following `Info.plist` keys and values (shown here for an OS X target):

```
<key>NSExtension</key>
    <dict>
        <key>NSExtensionPointIdentifier</key>
        <string>com.apple.widget-extension</string>
        <key>NSExtensionPrincipalClass</key>
        <string>TodayViewController</string>
    </dict>
```

If you use a custom view controller subclass, use the custom class name to replace the `TodayViewController` value for the `NSExtensionPrincipalClass` key.

iOS. If you don't want to use the storyboard file provided by the template, remove the `NSExtensionMainStoryboard` key and add the `NSExtensionPrincipalClass` key, using the name of your view controller for the value.

Most of the work you do to create a Today widget involves designing the UI and implementing a view controller subclass that performs your custom functionality.

Design the UI

Important: For best results, use Auto Layout to design the view of a Today widget.

Because space in the Today view is limited and the expected user experience is quick and focused, you shouldn't create a widget that's too big by default. On both platforms, a Today widget must fit within the width of the Today view, but it can increase in height to display more content.

A Today widget created using the Xcode Today template includes Auto Layout constraints for standard margin insets. To get the inset values for your calculations, implement the `widgetMarginInsetsForProposedMarginInsets:` method. (The template's principal view controller conforms to the `NCWidgetProviding` protocol, which provides this method.) Be sure to draw all your widget content within these standard margin insets. To learn more about designing the appearance of your widget, see Today Widgets in *iOS Human Interface Guidelines*.

If a widget has additional content to display, you can rely on Auto Layout constraints to adjust the widget's height as appropriate. If you don't use Auto Layout, you can use the `UIViewController` property `preferredContentSize` to request a height for the widget. For example:

```
- (void)receivedAdditionalContent {
    self.preferredContentSize = [self sizeNeededToShowAdditionalContent];
}
```

Note: Don't specify a height for your widget that would require a user to scroll to see all its content.

iOS. If you want to animate the display of your content to coincide with the resize animation, implement `viewWillTransitionToSize:withTransitionCoordinator:`, using `animateAlongsideTransition:completion:` to add your animations to the `coordinator` parameter.

To ensure that your widget gets the vibrancy effect that's appropriate for displaying items in the Today view, use `notificationCenterVibrancyEffect`.

OS X. Widgets inherit `NSAppearanceNameVibrantDark` from the view their view controller is placed in. When you use standard controls, you automatically get the right appearance. If you use custom colors, be sure to choose colors that look good in a vibrant dark view.

Updating Content

The Today extension point provides API for managing a widget's state and handling updates to its content (you can read about this API in the *Notification Center Framework Reference*). Although there are a few platform-specific differences in the Today API, the functionality supported on both platforms is mostly the same.

To help your widget look up to date, the system occasionally captures snapshots of your widget's view. When the widget becomes visible again, the most recent snapshot is displayed until the system replaces it with a live version of the view.

To update a widget's state before a snapshot is taken, be sure to conform to the `NCWidgetProviding` protocol. When your widget receives the `widgetPerformUpdateWithCompletionHandler:` call, update your widget's view with the most recent content and call the completion handler, using one of the following constants to describe the result of the update:

- `NCUpdateResultNewData`—The new content required you to redraw the view
- `NCUpdateResultNoData`—The widget doesn't require updating
- `NCUpdateResultFailed`—An error occurred during the update process

Specifying When a Widget Should Appear

If your widget should be visible in the Today view only in certain circumstances—such as when it has new or noteworthy content—use the `setHasContent:forWidgetWithBundleIdentifier:` method from `NCWidgetController` class. This method lets you declare the state of a widget's content, which in turn prompts the system to show or hide the widget.

You can call the `setHasContent:forWidgetWithBundleIdentifier:` method from your widget or from its containing app. Indeed, the containing app can call this method even while the widget isn't running. For example, you can employ a push notification to the containing app to trigger a call to this method. The next time a user opens the Today view, your widget is visible.

To declare that your widget has no content and can therefore be hidden, call the `setHasContent:forWidgetWithBundleIdentifier:` method with a `flag` parameter value of `NO`. Notification Center won't launch your widget again until the containing app calls this method passing `YES` in the `flag` parameter, to specify that the widget has content to display.

Opening the Containing App

In some cases, it can make sense for a Today widget to request its containing app to open. For example, the Calendar widget in OS X opens Calendar when users click an event. (Note that in iOS, a user may have to unlock the device before the containing app can open.) To ensure that your containing app opens in a way that makes sense in the context of the user's current task, you need to define a custom URL scheme that both the app and its widgets can use.

A widget doesn't directly tell its containing app to open; instead, it uses the `openURL:completionHandler:` method of `NSExtensionContext` to tell the system to open its containing app. When a widget uses this method to open a URL, the system validates the request before fulfilling it.

Supporting Edits (OS X Only)

To support an editing mode within your OS X widget, conform to the `NCWidgetProviding` protocol. When you set the `widgetAllowsEditing` property to `YES`, the Info button is automatically displayed in your widget's header area. (When users click the Info button, it automatically switches to a Done button.) When you use the `NCWidgetProviding` protocol to support editing, the Edit, Done, and Cancel buttons are automatically provided when the view goes into editing mode.

To observe changes between editing and nonediting modes in a widget, use the `widgetDidBeginEditing` and `widgetDidEndEditing` methods of the `NCWidgetProviding` protocol.

If you also want to present a modal search UI while users are editing your widget, use the `NCWidgetProvidingPresentationStyles` category on `NSViewController` to present your search view controller. When users indicate that they're done searching, use the `dismissViewControllerAnimated:completion:` method to dismiss the search view controller. (Note that you can also use the `presentViewControllerInWidget:` method to present a nonsearch modal view that needs a Cancel button in the header area.)

Testing a Today Widget

iOS. You can test an iOS widget in iOS Simulator or on a device.

OS X. To test a widget in OS X, it's easiest to use the Xcode Widget Simulator, because Notification Center dismisses as soon as you switch to another app, or click outside its bounds. You can specify the Widget Simulator in a scheme for the widget target.

To learn about debugging app extensions in general, see Debug, Profile, and Test Your App Extension (page 21).

Share

Share extensions give users a convenient way to share content with other entities, such as social sharing websites or upload services. For example, in an app that includes a Share button, users can choose a Share extension that represents a social sharing website and then use it to post a comment or other content.

> **Before you begin:** Make sure that the Share extension point is appropriate for your purpose. The best Share extensions make it easy for users to share content with websites. If you want to create an extension that lets users perform a different task with their content or that gives users updates on information they care about, the Share extension point is not the right choice.
>
> To find out about other types of app extensions you can create, see Table 1-1 (page 7).

Understand Share Extensions

On both platforms, a Share extension should:

- Make it easy for users to post content
- Let users preview, edit, annotate, and configure content, if appropriate
- Validate the user's content before sending it

> **Note:** You may want to specify the types of content your Share extension can work with so that users understand what they can share. You can learn more about specifying content types in Declaring Supported Data Types for a Share or Action Extension (page 30).

Users get access to Share extensions in the system-provided UI. In iOS, users tap the Share button and choose a Share extension from the sharing area of the activity view controller that appears. In OS X, users can reveal the list of sharing services in a few different ways. For example:

- Click the Share button in an app.
- View the Social area in Notification Center.
- Select some content, Control-click to reveal a contextual menu, and choose Share.

When users choose your Share extension, you display a view in which they compose their content and post it. You can base your view on the system-provided compose view controller, or you can create a completely custom compose view. The system-provided compose view controller builds in some support for common tasks, such as previewing and validating standard items, synchronizing content and view animation, and configuring a post.

Use the Xcode Share Template

The Xcode Share template provides default header and implementation files for the principal view controller class (called `SharingViewController`), an `Info.plist` file, and an interface file (that is, a storyboard or xib file).

> **Note:** To provide a custom compose view instead of the standard one, deselect "Use standard social compose interface" in the Xcode target-adding pane. When this checkbox is deselected, the default `SharingViewController` class is based on `NSViewController` or `UIViewController`, depending on the platform you chose.

When you create a target that uses the standard compose view UI, the principal view controller class inherits from `SLComposeServiceViewController` and the default files include stubs for methods such as `didSelectPost` and `isContentValid`.

By default, the Share template supplies the following `Info.plist` keys and values (shown here for an iOS target):

```
<key>NSExtension</key>
    <dict>
        <key>NSExtensionMainStoryboard</key>
        <string>MainInterface</string>
        <key>NSExtensionPointIdentifier</key>
        <string>com.apple.share-services</string>
    </dict>
```

Depending on the functionality of your Share extension, you might need to add keys and values to the default property list. For example, to provide a JavaScript file that accesses a webpage, add the `NSExtensionAttributes` key and a dictionary that specifies the file. (To learn more about how to use

JavaScript to access a webpage, see Accessing a Webpage (page 26).) You also add keys and values if you want to specify the data types your extension works with (to learn more, see Declaring Supported Data Types for a Share or Action Extension (page 30)).

A Share extension uses its principal view controller's `extensionContext` property to get the `NSExtensionContext` object that contains the user's initial text and any attachments for a post, such as links, images, or videos. The extension context object also contains information about the status of the posting operation. (To learn more about how an extension can interact with its context, see Respond to the Host App's Request (page 17).)

The default `SLComposeServiceViewController` object includes a text view that displays the user's editable text content. When a user chooses Post, a Share extension validates the text view's content (in addition to attachments, if any) and calls the `completeRequestReturningItems:expirationHandler:completion:` method of `NSExtensionContext`, using code like the following:

```
NSExtensionItem *outputItem = [[NSExtensionItem alloc] init];
// Set the appropriate value in outputItem
NSArray *outputItems = @[outputItem];
[self.extensionContext completeRequestReturningItems:outputItems
expirationHandler:nil completion:nil];
```

Design the UI

Important: For best results, use Auto Layout to design a Share extension.

The sharing UI on both platforms is constrained in size. In particular, your Share extension can't increase in width, and although it may increase in height, you don't want to force users to scroll too much.

If the system-supplied compose view meets your needs, you don't need to supply any custom UI.

In general, you don't want to overcomplicate a simple task, but you also want to give users the options they expect. For example, you want users to be able to post a simple remark with very little effort, but you may also want to help users preview an attachment, tag a post, or specify details, such as a privacy setting or an album to use.

When you have additional content to display, you can rely on Auto Layout constraints to adjust the view's height as appropriate. If you don't use Auto Layout, you can use the `UIViewController` property `preferredContentSize` to specify the view's new height.

iOS. If you want to animate the display of your content to coincide with the resize animation, implement `viewWillTransitionToSize:withTransitionCoordinator:`, using `animateAlongsideTransition:completion:` to add your animations to the `coordinator` parameter.

Posting Content

The primary purpose of a Share extension is to help users post content. When a user chooses the Post or Send button in your Share extension, a system-provided animation provides feedback that the action is being processed. The system then calls the `didSelectPost` method of the `SLComposeServiceViewController` class. Implement this method to:

- Set up a background-mode URL session (using the `NSURLSession` class) that includes the content to post
- Initiate the upload
- Call the `completeRequestReturningItems:completionHandler:` method, which signals the host app that its original request is complete
- Prepare to be terminated by the system

Listing 6-1 (page 45) shows one way to implement the `didSelectPost` method.

Listing 6-1 An example implementation of `didSelectPost`

```
- (void)didSelectPost {
    // Perform the post operation.
   // When the operation is complete (probably asynchronously), the Share extension
 should notify the success or failure, as well as the items that were actually
shared.

    NSExtensionItem *inputItem = self.extensionContext.inputItems.firstObject;

    NSExtensionItem *outputItem = [inputItem copy];
    outputItem.attributedContentText = [[NSAttributedString alloc]
initWithString:self.contentText attributes:nil];
    // Complete this implementation by setting the appropriate value on the output
 item.

    NSArray *outputItems = @[outputItem];
```

```
    [self.extensionContext completeRequestReturningItems:outputItems
expirationHandler:nil completion:nil];
// Or call [super didSelectPost] to use the superclass's default completion behavior.
}
```

> **Note:** Calling the `completeRequestReturningItems:completionHandler:` method can cause the associated compose view controller to be dismissed.

If a user cancels a post, or if a post is canceled for some other reason, the system calls the Share extension's `didSelectCancel` method when the feedback animation completes. Implement this method if it makes sense to customize the extension context's completion operation.

Validating Input

Share extensions should validate the user's content before posting it. It's best when the compose view gives users feedback about their content by enabling or disabling the Post button and, optionally, by displaying the current character count.

If you're using the standard compose view controller (an instance of the `SLComposeServiceViewController` class), check the validity of the user's current content by implementing the `isContentValid` method. The system calls `isContentValid` when the user changes the text in the standard compose view, so you can display the current character count and enable the Post button when appropriate. Listing 6-2 (page 46) shows an example implementation of the `isContentValid` method for a sharing service that requires posts to contain fewer than 100 characters.

Listing 6-2 An example implementation of `isContentValid`

```
- (BOOL)isContentValid {
    NSInteger messageLength = [[self.contentText
stringByTrimmingCharactersInSet:[NSCharacterSet whitespaceCharacterSet]] length];
    NSInteger charactersRemaining = 100 - messageLength;
    self.charactersRemaining = @(charactersRemaining);

    if (charactersRemaining >= 0) {
        return YES;
    }
```

```
    return NO;
}
```

If your Share extension needs to validate content in custom ways, do the validation in an implementation of the `validateContent` method. Depending on the result, you can return the correct value in your `isContentValid` method.

For example, if you need to shrink an asset before letting users upload it, you don't want to enable the Post button until the shrinking is complete. To find out if the shrinking is done, call `validateContent` within your `isContentValid` method and return the appropriate result.

Previewing Content (iOS Only)

To help users preview their selected content, the system-provided compose view controller (`SLComposeServiceViewController`) provides a default view that can automatically display previews of standard data types, such as photos, videos, and webpages. If your iOS Share extension can handle nonstandard data types, you can implement the `loadPreviewView` method to display them. Typically, an iOS Share extension checks the content in the `attachments` property of an extension item and provides a custom preview view, if appropriate.

iOS displays preview views next to the text-editing area in the sharing UI. As much as possible, you should create small preview views to avoid making the text area uncomfortably small. And although the sharing UI can expand in height, greater height can cause your content to display behind the keyboard, forcing users to scroll.

Configuring a Post (iOS Only)

The `SLComposeSheetConfigurationItem` class makes it easy for iOS Share extensions to provide a list of items that help users configure a post. For example, you might let users choose an account to post from, specify privacy settings, or autocomplete a custom text entry, such as a Twitter mention. By default, the standard compose view controller (`SLComposeServiceViewController`) displays your configuration items in a table view at the bottom of the sharing UI.

A Share extension uses the `configurationItems` property of the `SLComposeServiceViewController` class to return an array of `SLComposeSheetConfigurationItem` instances, each of which identifies a type of configuration the user can make. When a user taps a configuration item, the item can display a custom view controller that lets the user perform the configuration.

To display a custom configuration view controller, you typically define a block of type `SLComposeSheetConfigurationItemTapHandler` (in which you create the view controller) and then call `pushConfigurationViewController:` to display it. The standard compose view controller uses a `UINavigationController` instance to display your configuration view controller, so users can tap the Back button to return to the sharing UI. You can also call `popConfigurationViewController` to return to the sharing UI in response to some other user action.

If appropriate, you can replace the list of configuration items with a custom view controller that displays custom autocompletion suggestions while a user is entering text. You might want to do this if your sharing service defines certain textual items that users are likely to enter.

Action

An Action extension helps users view or transform content originating in a host app. For example, an Action extension might help users edit an image in a document that they're viewing in a text editor. Another type of Action extension might let users view a selected item in a different way, such as viewing an image in a different format or reading text in a different language.

The system offers an Action extension to users only when the extension declares it can work with the type of content a user is currently using. For example, if an Action extension declares it works only with text, it isn't made available when a user is viewing images.

To learn how to declare the types of content an Action extension can work with, read Declaring Supported Data Types for a Share or Action Extension (page 30)).

> **Before you begin:** Make sure the Action extension point is appropriate for your purpose. Action extensions enable targeted, lightweight tasks that display or change content. If you want to help users share content on a social website or give users updates on information they care about, the Action extension point is not the right choice.
>
> To find out about other types of app extensions you can create, see Table 1-1 (page 7).

Understand Action Extensions

Action extensions behave differently depending on the platform. In OS X, an Action extension:

- Can be an editor, in which users can make changes to selected content, or a viewer, in which users can view selected content in a new way
- Can transmit to the host app the content changes that users make within the app extension
- Can appear in a modal view that emerges from the host app's window or in a custom view that surrounds the user's selected items
- Automatically receives the user's selected content as part of the extension context

In iOS, an Action extension:

- Helps users view the current document in a different way

- Always appears in an action sheet or full-screen modal view
- Receives selected content only if explicitly provided by the host app

On both platforms, users get access to Action extensions in the system-provided UI. In iOS, an Action extension is listed in the action area of the activity view controller that appears when users tap the Share button. In OS X, there are a few ways in which users can reveal a list of Action extensions. For example, users can:

- Move the pointer over some selected content and click the button that appears
- Click the Share toolbar button
- Click the Action extension's custom toolbar button

> **Note:** In OS X, an Action extension that enables content viewing may work on multiple selected items, but an extension that enables editing can work on only one item at a time.

Use the Xcode Action Extension Template

The Xcode Action extension template provides default source files for the principal view controller class (called `ActionViewController`), an `Info.plist` file, and an interface file (that is, a storyboard or xib file).

By default, the Action template supplies the following `Info.plist` keys and values, shown here for an OS X target:

```
<key>NSExtension</key>
    <dict>
        <key>NSExtensionAttributes</key>
        <dict>
            <key>NSExtensionServiceRoleType</key>
            <string>NSExtensionServiceRoleTypeEditor</string>
        </dict>
        <key>NSExtensionPointIdentifier</key>
        <string>com.apple.ui-services</string>
        <key>NSExtensionPrincipalClass</key>
        <string>ActionViewController</string>
    </dict>
```

To specify the task your OS X Action extension enables, use one of the following values for the required `NSExtensionServiceRoleType` key:

- `NSExtensionServiceRoleTypeEditor`—The extension enables editing or other content transformation and returns the user's edits to the host app
- `NSExtensionServiceRoleTypeViewer`—The extension lets users view the selected content in a different way, such as in a different format

An Action extension uses the view controller's `extensionContext` property to get an `NSExtensionContext` object. In OS X, the extension context contains the user's selected content as well as the size and position of that content.

In iOS, an extension context has content specified explicitly by the host app; this can, at the discretion of the host, include user selected content.

To learn more about the extension context, see Respond to the Host App's Request (page 17).

Design the UI

> **Important:** For best results, use Auto Layout to design the UI of an Action extension.

OS X. Use the size and position of the selected content in the host app to inform the size and position of the Action extension's view.

Use the `preferredContentSize` property of `NSViewController` to specify the extension view's preferred size, based on the size of the selected content. (You can also specify minimum and maximum sizes for the extension's view, to ensure that a host app doesn't make unreasonable adjustments to your view.) To specify a preferred position for the extension view, set the `preferredScreenOrigin` property to the lower-left corner of the extension's view.

iOS. Create a template image that represents your Action extension. A template image is an image that iOS uses as a mask to create the final icon that users see in the activity view controller. To create a template image that looks good in the final UI, follow these guidelines:

- Use black or white with appropriate alpha transparency.
- Don't include a drop shadow.
- Use antialiasing.
- Create the image in two sizes:
  - For iPhone, the image should look good centered in an area that measures 60 x 60 points.

- For iPad, the image should look good centered in an area that measures 76 x 76 points.

If you want to present your iOS Action extension in full screen, add the following key-value pair to the extension's `NSExtension` dictionary:

```
<key>NSExtensionActionWantsFullScreenPresentation</key>
<true/>
```

Returning Edited Content to the Host

On both platforms, an Action extension uses an `NSExtensionContext` method to send the user's edits to the host app. Listing 7-1 (page 52) shows code that returns edited text to the host app when the user chooses a Done button.

Listing 7-1 Sending edited items to the host app

```
- (IBAction)done:(id)sender {
    NSExtensionItem *outputItem = [[NSExtensionItem alloc] init];
    outputItem.attributedContentText = self.myTextView.attributedString;

    NSArray *outputItems = @[outputItem];
    [self.extensionContext completeRequestReturningItems:outputItems];
}
```

Photo Editing

In iOS, a Photo Editing extension lets users edit a photo or video within the Photos app. After users confirm the changes they make in a Photo Editing extension, the adjusted content is available in Photos. Photos always keeps the original version of the content, too, so that users can revert the changes they make in an extension.

> **Before you begin:** Make sure that the Photo Editing extension point is appropriate for the functionality you want to provide. A Photo Editing extension should make it easy for users to make quick, targeted adjustments to a photo or video without requiring too much user interaction. If you want to enable a more generic task or help users share photos and videos with others, the Photo Editing extension point is not the right choice.
>
> To learn about other types of app extensions you can create, see Table 1-1 (page 7).

Understand How a Photo Editing Extension Works with Photos

To support a consistent editing experience, Photos keeps multiple versions of each media asset's image or video data, in addition to adjustment data, which describes past edits made to the asset. For each asset, Photos stores the original version, the current version (which includes the most recent adjustments), and the set of adjustments that were applied to the original version to create the current version.

When a user chooses a Photo Editing extension, Photos asks the extension if it can read the adjustment data. If the app extension supports the adjustment data, Photos provides the original version of the asset as input to the editing session. After the extension reads the adjustment data and reconstructs the past edits, it can allow users to alter or revert past edits or add new edits. For example, if the adjustment data describes filters applied to a photo, the extension reapplies those filters to the original asset and can let users change filter parameters, add new filters, or remove filters.

If the extension doesn't support an asset's adjustment data, Photos provides the current version of the asset as input to the editing session. Because the current version contains the rendered output of all past edits, the extension can let users apply new edits to the asset but not alter or revert past edits.

Important: Photos does not store a current version of video assets. If your extension can't read a video asset's adjustment data, it must work with the original version of the video, overwriting past edits.

When a user finishes using a Photo Editing extension, the extension returns the edited asset and the adjustment data.

iOS users get access to Photo Editing extensions in the Photos app. When a user chooses your extension, display a view that provides a custom editing interface. To present this view, use a view controller that adopts the `PHContentEditingController` protocol.

Important: Embed no more than one Photo Editing extension for each media type (photo, video) in a containing app. The Photos app displays to the user, at most, one extension of each type from a given containing app.

Use the Xcode Photo Editing Template

The Xcode Photo Editing template provides default header and implementation files for the principal view controller class (called `PhotoEditingViewController`), an `Info.plist` file, and an interface file (that is, a storyboard file).

By default, the Photo Editing template supplies the following `Info.plist` keys and values:

```
<key>NSExtension</key>
    <dict>
        <key>NSExtensionAttributes</key>
        <dict>
            <key>PHSupportedMediaTypes</key>
            <array>
                <string>Image</string>
            </array>
        </dict>
        <key>NSExtensionMainStoryboard</key>
        <string>MainInterface</string>
        <key>NSExtensionPointIdentifier</key>
        <string>com.apple.photo-editing</string>
    </dict>
```

In particular, make sure that the `PHSupportedMediaTypes` array specifies the types of media assets your app extension can edit. The default value is `Image`, but you can also use `Video`.

Design the UI

Important: For best results, use Auto Layout to design the view of a Photo Editing extension.

The Photos app displays a Photo Editing extension within a navigation bar, so you should avoid designing a navigation bar–based UI for your extension.

Photos automatically displays your extension's view so that it occupies the full height of the screen, including the area behind the navigation bar. If you want your content view to appear below the bar, and not underneath it, be sure to use the view's top layout guide appropriately.

It's best when a Photo Editing extension lets users preview the results of their edits. Giving users a preview while they're still using your extension means that they can get the effect they want without repeatedly exiting and reentering the extension.

Because users are likely to spend time editing a photo or movie in your app extension, you don't want them to lose their work if they accidentally choose Cancel. To improve the user experience, be sure to implement the `shouldShowCancelConfirmation` method in your view controller, returning `YES` if there are unsaved changes. When this method returns `YES`, Photos displays confirmation UI so that users can confirm if they really want to cancel their changes.

Handling Memory Constraints

Because a Photo Editing extension often needs to work with large high-resolution images and videos, the extension is likely to experience memory pressures when running on a device. It's recommended that you examine your existing image-processing code and make sure that it performs to a high standard before you use it in your app extension.

Testing a Photo Editing Extension

Avoid making assumptions about the media formats that your app extension may receive. Be sure to test your filtering and other image-processing code with a wide range of media formats; don't just test with content from the device camera.

To learn about debugging app extensions in general, see Debug, Profile, and Test Your App Extension (page 21).

Finder Sync

In OS X, the Finder Sync extension point lets you cleanly and safely modify the Finder's user interface to express file synchronization status and control. Unlike most extension points, Finder Sync does not add features to a host app. Instead, it lets you modify the behavior of the Finder itself.

Understand Finder Sync

With a Finder Sync extension you register one or more folders for the system to monitor. Your Finder Sync extension then sets badges, labels, and contextual menus for any items in the monitored folders. You can also use the extension point's API to add a toolbar button to the Finder window.

Finder Sync supports apps that synchronize the contents of a local folder with a remote data source. It improves user experience by providing immediate visual feedback directly in the Finder. Badges display the sync state of each item, and contextual menus let users manage folder contents. Custom toolbar buttons can invoke global actions, such as opening a monitored folder or forcing a sync operation.

> **Note:** The Finder Sync extension point lets you modify an item's appearance in the Finder. It does not provide support for syncing the files. You are responsible for creating your own syncing component.

A Finder Sync extension can:

- Register a set of folders to monitor.
- Receive notifications when the user starts or stops browsing the content of a monitored folder.

  For example, the extension receives notification when the user opens a monitored folder in the Finder or in an Open or Save dialog.
- Add, remove, and update badges and labels on items in a monitored folder.
- Display a contextual menu when the user Control-clicks an item inside a monitored folder.
- Add a custom button to the Finder's toolbar.

  Unlike badges and contextual menu items, this button is always available, even when the user is not currently browsing a monitored folder.

Before You Begin: Make sure the Finder Sync extension point is appropriate for the functionality you plan to provide. The best Finder Sync extensions support apps that sync the contents of a local folder with a remote data source. Finder Sync is not intended as a general tool for modifying the Finder's user interface.

To learn about other types of app extensions you can create, see Table 1-1 (page 7).

Creating a Finder Sync Extension in Xcode

To create a Finder Sync extension, add a new target to your OS X project using the Finder Sync Extension template. This template contains a custom subclass of the `FIFinderSync` class. This subclass acts as your extension's primary class. The system automatically instantiates this class and calls the protocol methods in response to user actions.

For detailed information on adding extensions, see Creating an Extension (page 14).

Set the Required Property List Values

For OS X to recognize and automatically load the Finder Sync extension, the extension target's `info.plist` file must contain the following entries:

```
<key>NSExtension</key>
<dict>
    <key>NSExtensionAttributes</key>
    <dict/>
    <key>NSExtensionPointIdentifier</key>
    <string>com.apple.FinderSync</string>
    <key>NSExtensionPrincipalClass</key>
    <string>$(PRODUCT_MODULE_NAME).FinderSync</string>
</dict>
```

In particular, the `NSExtensionPrincipalClass` key must provide the name of your `FIFinderSync` subclass. The system automatically instantiates this class when the Finder first launches. It instantiates an additional copy whenever an Open or Save dialog is displayed. Each copy runs in its own process.

The Finder Sync Extension Xcode template configures these `Info.plist` keys automatically. If you want to change the principal class, modify the value of the `NSExtensionPrincipalClass` key.

Specify Folders to Monitor

You specify the folders you want to monitor in your Finder Sync extension's `init` method, using the default `FIFinderSyncController` object. In most cases, you want to let the user specify these folders in UI provided by the containing app. You can pass this data between the containing app and your Finder Sync extension using shared user defaults.

To enable shared user defaults, first add both your Finder Sync extension and its containing app to an app group. This group creates a shared container that both processes can access. For each target, open the Xcode capabilities pane and turn on the App Groups capability. Provide a unique identifier for the shared group. Be sure to use the same identifier for both the Finder Sync extension and the containing app.

This process adds a `com.apple.security.application-groups` entry to the targets' entitlements.

```
<key>com.apple.security.application-groups</key>
<array>
    <string>com.example.domain.MyFirstFinderSyncApp</string>
</array>
```

For more information about app groups, see Adding an App to an App Group in *Entitlement Key Reference*.

Next, instantiate a new `NSUserDefaults` object by calling `initWithSuiteName:` and passing in the shared group's identifier. This `init` method creates a user default object that loads and saves data to the shared container.

```
// Set up the folder we are syncing.
NSUserDefaults *sharedDefaults =
[[NSUserDefaults alloc]
initWithSuiteName:@"com.example.domain.MyFirstFinderSyncExtension"];


self.myFolderURL = [sharedDefaults URLForKey:MyFolderKey];


if (self.myFolderURL == nil) {
    self.myFolderURL = [NSURL
fileURLWithPath:[@"~/Documents/MyFirstFinderSyncExtension Documents"
stringByExpandingTildeInPath]];;
}


[FIFinderSyncController defaultController].folderURLs = [NSSet
setWithObject:self.myFolderURL];
```

Set Up Badge Images

Create your badge images so that each can be drawn at up to 320x320 pixels. For each image, fill the entire frame edge-to-edge with your artwork (in other words, use no padding). The system determines the size and placement of a badge image on a monitored item. The pixel size ranges at which your badge might be displayed are as follows:

Retina screens 12x12 through 320x320

Nonretina screens 8x8 through 160x160

To add a badge image to your Finder Sync controller's configuration, use the `setBadgeImage:label:forBadgeIdentifier:` method, as shown here:

```
[[FIFinderSyncController defaultController]
 setBadgeImage: uploadedImage
 label: NSLocalizedString(@"Uploaded", nil)
 forBadgeIdentifier: @"UploadComplete"];
```

```
FIFinderSyncController.defaultController().setBadgeImage(uploadedImage,
    label: NSLocalizedString("Uploaded", comment: "Upload complete label"),
    forBadgeIdentifier: "UploadComplete")
```

You would typically do this in the sync controller's initialization method. You can set up as many badge images as you need. The badge identifier string that you specify here allows you to later retrieve the image for applying it to a monitored item, as described in A Typical Finder Sync Use Case (page 62).

Implement FIFinderSync methods

The `FIFinderSync` class declares a number of methods that you can override to monitor and control the Finder.

Receiving Notifications When Users Observe Monitored Items

Override these methods to receive notifications as the user browses through the contents of the monitored folders.

- `beginObservingDirectoryAtURL:`

  The system calls this method when the user begins looking at the contents of a monitored folder or one of its subfolders. It passes the URL of the currently open folder as an argument.

The system calls `beginObservingDirectoryAtURL:` only once for each unique URL. As long as the content remains visible in at least one Finder window, any additional Finder windows that open to the same URL are ignored.

> **Note:** The system creates additional instances of your extension for any Open and Save dialogs. These extensions receive their own calls to `beginObservingDirectoryAtURL:`, even if the folder is already open in a Finder window.

- `endObservingDirectoryAtURL:`

  The system calls this method when the user is no longer looking at the contents of the given URL. As with `beginObservingDirectoryAtURL:`, the Open and Save dialogs are tracked separately from the Finder.

- `requestBadgeIdentifierForURL:`

  The system calls this method when a new item inside the monitored folder becomes visible to the user. This method is called once for each file initially shown in the Finder's view. The system continues to call this method as each new file scrolls into view.

  You typically implement this method to check the state of the item at the provided URL, and then call the Finder Sync controller's `setBadgeIdentifier:forURL:` method to set the appropriate badge. You might also want to track these URLs, in order to update their badges whenever their state changes.

Adding Contextual Menu Items

Override the `menuForMenuKind:` method to provide a custom contextual menu. The `menu` argument indicates the type of menu that your extension should create. Each menu kind corresponds to a different type of user interaction.

- `FIMenuKindContextualMenuForItems`

  The user Control-clicked one or more items inside your monitored folder. Your extension should present menu items that affect the selected items.

- `FIMenuKindContextualMenuForContainer`

  The user Control-clicked the Finder window's background while browsing the monitored folder. Your extension should present menu items that affect the contents of the current folder.

- `FIMenuKindContextualMenuForSidebar`

  The user Control-clicked a sidebar item that represents the monitored folder or part of its contents. Your extension should present menu items that effect the contents of the selected item.

- `FIMenuKindToolbarItemMenu`

The user clicked on the toolbar button provided by the extension. Because the toolbar button is always available, the user may or may not be browsing the monitored folder at this time. Your extension may present menu items that represent global actions that should always be available to the user. It can also present menu items that affect selected items inside your monitored folder, if any exist.

You can get additional information about the currently selected items using the Finder Sync controller's `targetedURL` and `selectedItemURLs` methods. The `targetedURL` method returns the URL of the file or folder that the user Control-clicked. The `selectedItemURLs` method returns an array containing the URLs of all the currently selected items in the Finder window.

`targetedURL` and `selectedItemURLs` return valid values only inside the `menuForMenuKind:` method or inside one of its menu actions. If the user is not browsing the monitored folder (for example, if the user clicked the toolbar button while outside the monitored folder), both of these methods return `nil`.

Adding a Custom Toolbar Button

To add a custom toolbar button to the Finder window, override the getter methods for the following properties:

- `toolbarItemName`—Return the button's name
- `toolbarItemImage`—Return the button's image
- `toolbarItemToolTip`—Return the tooltip text for the button

When the user clicks the toolbar button, the system calls your primary class's `menuForMenuKind:` method, passing `FIMenuKindToolbarItemMenu` as the menu kind. Your extension must return an appropriate menu. The system then displays this menu.

A Typical Finder Sync Use Case

This section presents a typical use case. Your app manages and badges all the items inside the monitored folder. Because the user can populate the monitored folder with an arbitrary number of subfolders and files, the list of monitored items could grow to be very large. You must therefore consider the performance implications of adding and updating all of these badges. Specifically, avoid adding or updating the badge of any item that is not currently visible.

When dealing with a potentially large number of items, always provide the badges on demand. Provide badges to items only as they appear in the Finder window, and record all the URLs for the badges you set, so that you can update them as necessary.

1. The system calls `beginObservingDirectoryAtURL:` when the user first opens the monitored folder or one of its subfolders.

2. The system calls `requestBadgeIdentifierForURL:` for each item that is currently being drawn onscreen. Inside this method, do the following:
    a. Check the state of the item and set its badge by calling `setBadgeIdentifier:forURL:`.

       Your app is responsible for defining the states and their corresponding badges. For example, a typical syncing app might have badges that indicate unsynced local changes, syncing operations in progress, successfully synced items, and items with syncing errors or conflicts.

    b. Record the URL of every item that has received a badge.

       Your app must to continue to monitor the state of these items and update their badges as necessary. When an item's state changes, update its badge by calling `setBadgeIdentifier:forURL:`.
3. The system calls `endObservingDirectoryAtURL:` when the user closes the folder. Delete all the URLs for the badged items inside that folder and stop monitoring their state.

Performance Concerns

Finder Sync extensions may have a much longer lifespan than most other extensions. Because of this long lifespan, you must take particular care to avoid any possible performance issues. Ideally, Finder Sync extensions should spend most of their time running but idle. Limit the number of resources the extension consumes. Most important, be sure to avoid leaking any resources. Over time, even a small trickle can grow into a serious problem.

The system may also launch additional copies of your extension whenever an Open or Save dialog is displayed. This means that the user may have multiple copies of your extension running at once. Therefore, it's generally best if the extension focuses on handling the badges, contextual menus, and toolbar buttons. Place in a separate XPC service any code that performs the sync, updates state, or communicates with remote data sources. This approach ensures that there is only one syncing service running at a time.

For more information about XPC services, see Creating XPC Servicesin *Daemons and Services Programming Guide*.

Document Provider

In iOS, any app that remotely stores commonly used document formats should consider creating a Document Provider extension. This extension (sometimes shortened here to *document provider*) allows other apps to access the documents managed by your app. Additionally, apps that are strongly associated with a specific document type may benefit from creating a document provider for their documents. Here, the document provider act as a local repository for a particular type of document, letting the user gather all those documents into one place.

Documents managed by your Document Provider extension can be accessed by any app using a document picker view controller. This combination gives users a lot of flexibility when it comes to managing and sharing their documents.

Understand Document Provider Extensions

The Document Provider extension acts as the interface between the files that your app manages and the other apps on the users' devices. It lets other apps *import* or *open* the files, uploading and downloading them from your server as needed. Apps can also *export* or *move* their documents into your extension's shared container.

The Document Provider extension consists of two separate parts: the Document Picker View Controller extension and the File Provider extension. The Document Picker View Controller extension provides your document provider's user interface. The system displays this interface when the host app presents a document picker view controller for your document provider. This interface should let users browse through and select documents and destinations from inside your document provider. This extension can also perform basic import and export operations without any additional support.

To support open and move operations, you must also create a File Provider extension. This extension grants the host app access to files outside its sandbox. It also creates placeholders for remote files, downloads local copies when needed, and uploads any changes made by the host app.

Ideally your document provider should support all four operations, giving your users the most flexibility when it comes to working with your documents. However, producing a robust document provider with a solid user experience is a nontrivial task.

If you want only to share documents from your app, you can create a `UIDocumentPickerViewController` object to export or move your documents. Alternatively, you can share your documents using iCloud Drive.

To opt-in to iCloud Drive support, open the Xcode capabilities pane and turn on iCloud documents. Next, open the app's `info.plist` file. You will need to add an entry for your iCloud containers, and then define how you wish to share each container. A sample entry is shown below:

```
<key>NSUbiquitousContainers</key>
    <dict>
        <key>iCloud.com.example.MyApp</key>
        <dict>
            <key>NSUbiquitousContainerIsDocumentScopePublic</key>
            <true/>
            <key>NSUbiquitousContainerSupportedFolderLevels</key>
            <string>Any</string>
            <key>NSUbiquitousContainerName</key>
            <string>MyApp</string>
        </dict>
    </dict>
```

These settings let iCloud Drive provide access to the files stored in your app's iCloud container. For a detailed description of the valid keys and values, See Cocoa Keys in *Information Property List Key Reference* chapter in *Information Property List Key Reference* .

Important: When using iCloud Drive in iOS 8.0, do not use file presenters or the `UIDocument` class to access files. You can use file coordinators, Posix locks, Core Data, or SQLite.

Before You Begin: Make sure the document provider extension point is appropriate for the functionality you plan to provide. The best document providers act as a public document repository for other apps. If you just want to share your app's files, a document provider is not the right choice.

To learn about other types of extensions you can create, see Table 1-1 (page 7).

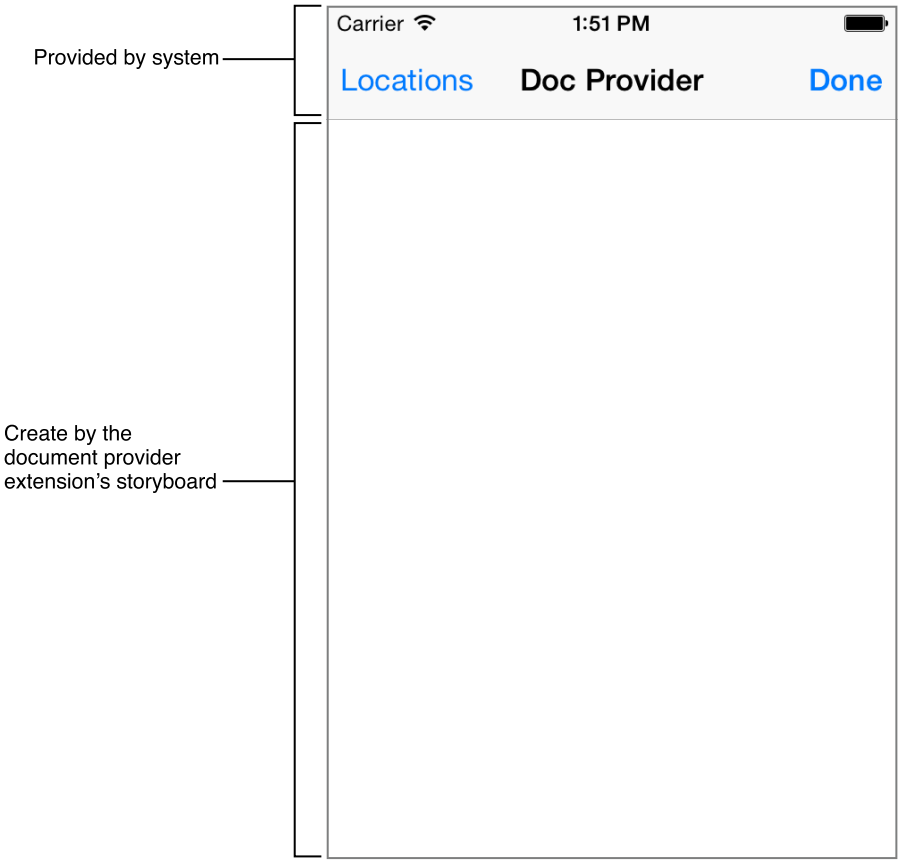
Document Picker View Controller Extension

The Document Picker View Controller extension provides the user interface for import, export, open, and move operations to or from your extension's shared container. To create a Document Picker View Controller extension (sometimes shortened here to *document picker*), subclass the `UIDocumentPickerExtensionViewController`

class. Your subclass is instantiated when the user selects your document provider from a `UIDocumentMenuViewController` object or when the host app opens your document provider directly using a `UIDocumentPickerViewController` object.

In either case, the host app presents a document picker view controller. The system then imbeds your Document Picker View Controller extension inside the app's view controller. The app's view controller provides a navigation bar with the document provider's name, a location switcher, and a Done button. Your extension must provide the rest of the user interface. Figure 10-1 (page 66) shows the relative position of these UI elements.

Figure 10-1 Layout of the Document Picker View Controller



Life Cycle

1. The host app presents a `UIDocumentMenuViewController`.
2. The user selects your document provider from the list.
3. Your `UIDocumentPickerViewExtensionViewController` subclass is instantiated.

4. The `prepareForPresentationInMode:` method is called on your extension. The extension must present an appropriate user interface for the given mode. The open and import modes often require a different set of controls than the move or export modes. Your extension should therefore check the mode and present the correct user interface.

   The `UIDocumentPickerExtensionViewController` object acts as the root view controller for your user interface; therefore, it is often convenient to make it a container controller. You can then create a separate child view controllers for each mode, and your extension simply presents the appropriate child view controller in your `prepareForPresentationInMode:` method.

5. Your extension is presented within the host app.

6. When the user makes their selection, your extension calls its `dismissGrantingAccessToURL:` method. This method dismisses the user interface and passes the provided URL back to the host app, calling its `-[UIDocumentPickerViewControllerDelegate documentPicker:didPickDocumentAtURL:]` method.

7. The `UIDocumentPickerExtensionViewController` instance is dismissed

Creating the Document Picker View Controller Extension

To create a new Document Picker View Controller extension in Xcode, add a new target to your iOS project using the Document Picker Extension template. For detailed information, see Creating an Extension (page 14).

When creating the Document Picker View Controller extension, you have the option of creating the corresponding File Provider extension at the same time. For more information, see Creating the File Provider Extension (page 71).

The Document Picker Extension template adds a `UIDocumentPickerExtensionViewController` subclass to your project. It also adds a storyboard for your document picker's user interface and an `info.plist` file.

Setting the Required Property List Entries

For the system to automatically recognize and load your extension, its property list must contain the following entries:

```
<key>NSExtension</key>
<dict>
    <key>NSExtensionAttributes</key>
    <dict>
        <key>UIDocumentPickerModes</key>
        <array>
            <string>UIDocumentPickerModeImport</string>
```

```
            <string>UIDocumentPickerModeOpen</string>
            <string>UIDocumentPickerModeExportToService</string>
            <string>UIDocumentPickerModeMoveToService</string>
        </array>
        <key>UIDocumentPickerSupportedFileTypes</key>
        <array>
            <string>public.content</string>
        </array>
    </dict>
    <key>NSExtensionMainStoryboard</key>
    <string>MainInterface</string>
    <key>NSExtensionPointIdentifier</key>
    <string>com.apple.fileprovider-ui</string>
</dict>
```

These entries are automatically set by the Document Picker Extension template. Edit them only if you plan to change your extension's default behavior. In particular, the `UIDocumentPickerModes` array contains entries for all the modes that your document picker supports. If you don't plan to implementing a File Provider extension, remove the entries for `UIDocumentPickerModeOpen` and `UIDocumentPickerModeMoveToService`.

Similarly, if you want to create a secure drop box—where users can export files to your extension but can't open, browse, or otherwise view them—remove all the modes except `UIDocumentPickerModeExportToService`.

The `UIDocumentPickerSupportedFileTypes` array contains a list of uniform type identifiers that your extension supports. Your extension appears as an option only when the type of files being transferred match at least one of the UTIs listed in this array. By default, the `public.content` UTI matches all document types.

The `NSExtensionMainStoryboard` entry holds the name of your extension's storyboard. The storyboard's initial view controller must be your `UIDocumentPickerExtensionViewController` subclass. You can edit this key to change how your extension instantiates its view controller and how it creates its view hierarchy.

For example, if you replace the `NSExtensionMainStoryboard` entry with an `NSExtensionPrincipalClass` key whose value is the name of your `UIDocumentPickerExtensionViewController` subclass, the extension then loads the view controller directly. This approach allows you to load your user interface from a `.xib` file, or to create your user interface programmatically.

Subclassing UIDocumentPickerExtensionViewController

The Document Picker Extension template provides a simple `UIDocumentPickerExtensionViewController` subclass. Modify this subclass to manage your user interface and respond to user interactions, just as you would for most view controllers. Still, there are a couple of `UIDocumentPickerExtensionViewController` specific methods and properties worth noting.

- `prepareForPresentationInMode:`

  If necessary, override this method to set up any required resources. In particular, if your app uses different view hierarchies for the different modes, set up the correct view hierarchy in your implementation.

- `dismissGrantingAccessToURL:`

  Call this method to dismiss the document picker view controller and grant access to the provided URL. Each mode has its own requirements for the URL. For the complete details, see Dismissing the User Interface (page 70).

- `documentPickerMode`

  This read-only property returns the document picker's mode. It is valid only after the system calls your `prepareForPresentationInMode:` method.

- `originalURL`

  This read-only property contains the original file's URL when in export or move mode. Otherwise it contains `nil`.

- `validTypes`

  This read-only property contains the array of valid UTIs when in import or open mode. Otherwise it contains `nil`.

- `providerIdentifier`

  This read-only property contains the value returned by your File Provider extension's `providerIdentifier` method. If you do not provide a File Provider extension, it returns `nil`.

- `documentStorageURL`

  This read-only property contains the value returned by your File Provider extension's `documentStorageURL` method. If you do not provide a File Provider extension, it returns `nil`.

Creating the User Interface

The Document Picker View Controller extension's main purpose is to let users select files for import or open operations, and select destinations for export and move operations.

When importing or opening, your extension should create a list of all the available files and present this list to the user. Users should only be able to select files that match one of the UTIs from your `validTypes` property. If other files are included in the list, they must be clearly marked as unavailable. You may also want to provide

useful metadata about the files, including size, creation date, and whether it's local or remote. You may even want to create and display thumbnail images of the file. For more information about working with metadata and thumbnails, see *NSURL Class Reference*.

Your document picker can present a flat list of all the available files or it can display a complex hierarchy with directories and subdirectories. It all depends on your app's needs. Regardless, after the user chooses a file, dismiss the user interface and pass the URL back to the host app.

For export and move operations, let the user select the destination for their file. For simple extensions, you might just provide a confirmation button. More complex extensions might let the user navigate through a hierarchy of directories and even create his or her own subdirectories. After the user has chosen a destination, dismiss the user interface.

You may also decide to handle logins, downloads, and similar tasks directly in the Document Picker View Controller extension. There are only two places where you can directly interact with the user: in the containing app and in the Document Picker View Controller extension. This means that all account management, error notifications and progress updates must be handled by one of these two components.

If you want to handle these tasks in the containing app, you can use notifications and badges to notify the user. The extensions can contact your server and request an appropriate push notification. This notification then launches the containing app in the background, letting it run in response. The containing app can also use local notifications and badges to alert the user to important events. However, the user must either select one of the notifications or open the containing app to bring it to the foreground. Therefore, this approach often requires active participation by the user, and users can miss, ignore, or even disable these notifications and badges.

Often, you can provide a better user experience by handling these tasks in the Document Picker View Controller extension directly. For more informations, see Providing a Great User Experience in an Uncertain World (page 75).

Dismissing the User Interface

When the user makes an appropriate selection, call `dismissGrantingAccessToURL:` and return a properly formatted URL. The URL must meet all of the following conditions:

- **Import Document Picker mode.** Provide a URL for the selected file. The URL must point to a local file that the Document Picker View Controller extension can access. If the user selected a remote file, your extension should download the file and save a local copy before calling `dismissGrantingAccessToURL:`. Alternatively, if you are also providing a File Provider extension, you can just provide a URL that meets the requirements for the open operation and let the file provider download it for you.

- **Open Document Picker mode.** Provide a URL for the selected file. If the file does not yet exist at this location, your File Provider extension is called to create a placeholder or to produce the file as needed. The URL must point to a location inside the directory hierarchy referred to by your `documentStorageURL` property. This property simply calls your file provider's `documentStorageURL` method and returns its value.
- **Export Document Picker mode.** Provide a URL for the selected destination. This URL needs to be accessible only by the Document Picker View Controller extension. The system saves a copy of the document at this URL and returns the URL to the host app to indicate success. The host app cannot access the document at this URL.
- **Move Document Picker mode.** Provide a URL for the selected destination. The URL needs to be contained inside the hierarchy referred to by your `documentStorageURL` property. The system moves the document to this URL and returns the URL to the host app. The host app can then access the document at the new URL.

File Provider Extension

The File Provider extension grants access to files outside the host app's sandbox with the open and move actions. This extension (sometimes shortened here to *file provider*) also allows the host app to download files without presenting a document picker view controller. This feature lets the host app access previously opened documents using secure URL bookmarks, even if those files are no longer stored on the device.

The File Provider extension uses placeholders to represent remote files. When the host app tries to access one of these placeholders using a coordinated read, the extension begins downloading the file. After the download is finished, the coordinated read proceeds. If the download fails, the error is propagated back to the file coordinator.

This extension also receives notifications when a file has changed, letting you upload the changes back to your remote server. It also receives notifications when the host app is no longer editing the document. At this point, your extension can delete the file and replace it with a placeholder to free up storage space.

Creating the File Provider Extension

You can create the File Provider extension as part of the Document Picker Extension template. See Creating the Document Picker Extension (page 67). When you include the File Provider extension, the template creates a separate target for the extension. It also creates an `NSFileProviderExtension` subclass for this target and an `info.plist` file with the required entries.

Setting the Required Property List Entries

For the system to automatically recognize and load your extension, its property list must contain the following entries:

```
<key>NSExtension</key>
<dict>
    <key>NSExtensionAttributes</key>
    <key>NSExtensionFileProviderDocumentGroup</key>
    <string>com.apple.devpubs</string>
    <key>NSExtensionPointIdentifier</key>
    <string>com.apple.fileprovider-nonui</string>
    <key>NSExtensionPrincipalClass</key>
    <string>FileProvider</string>
</dict>
```

These entries are automatically created by the Document Picker Extension template. Modify them only if you want to change the extension's default settings.

The `NSExtensionPrincipalClass` key must hold the name of an `NSFileProviderExtension` subclass. The system automatically instantiates this class whenever it needs to provide documents to the host app.

The `NSExtensionFileProviderDocumentGroup` entry must hold the identifier for a shared container that can be accessed by both the Document Picker and the File Provider extension. This is used by the extension's `documentStorageURL` method. If you change your shared container's identifier, be sure to update this setting as well.

Setting up the Shared Container

By default, the extension template sets up a shared container that can be accessed by both the Document Picker View Controller extension and the File Provider extension. Typically, though, you want to share this container with the containing app as well.

Open the Xcode capabilities pane and turn on the App Groups capability for your containing app. Add the identifier for the shared group. You can copy this identifier from the File Provider extension's target.

This capability adds a `com.apple.security.application-groups` entry to the targets' entitlements.

```
<key>com.apple.security.application-groups</key>
<array>
```

```
    <string>com.example.domain.MyFirstDocumentPickerExtension</string>
</array>
```

For more information about app groups, see Adding an App to an App Group in *Entitlement Key Reference*.

Subclass NSFileProviderExtension

The `NSFileProviderExtension` class provides a number of different methods—some that you must not override, a few that you may override, and several that you must override. These methods are described below.

Do Not Overwrite These Class Methods

- `writePlaceholderAtURL:withMetadata:error:`

  Call this method whenever you need to create a placeholder. Use `placeholderURLForURL:` to generate the correct URL based on the local file's URL. The metadata that you provide depends largely on the needs of your document picker's user interface, but the common options include file size, filename, and thumbnails.

- `placeholderURLForURL:`

  This method maps file URLs into their corresponding placeholder URLs. You typically call this method to generate the placeholder URL before calling `writePlaceholderAtURL:withMetadata:error:`

You May Overwrite These Methods

The default implementation of these methods should work for most extensions; however, you may want to override them to fine-tune your extension's behavior.

- `providerIdentifier`

  An identifier unique to this `NSFileProviderExtension` subclass. By default, this method returns the bundle identifier of the containing app.

  At least four separate processes may be trying to access the files provided by this extension at any one time; therefore, you must use file coordinators for all read and write operations.

  Both the Document Picker View Controller extension and the File Provider extension should pass the provider identifier to their file coordinator's `setPurposeIdentifier:` method. Sharing the purpose identifier lets the extensions coordinate with each other and prevents possible deadlocks between them.

- `documentStorageURL`

  The root URL for all provided documents. The URL must be writeable by this extension, and it should probably be in a container shared by both the `UIDocumentPickerExtensionViewController` and the containing app.

By default, this method returns a subdirectory of the app group container directory shared by the `UIDocumentPickerExtensionViewController` and `NSFileProviderExtension` extensions. Specify the shared container by using the `NSExtensionFileProviderDocumentGroup` key in the File Provider extension's `info.plist` file.

- `persistentIdentifierForItemAtURL:`

  Defines a static mapping between URLs and their persistent identifiers. By default, the identifier is simply the path relative to URL returned by the `documentStorageURL` method. You can override the `persistentIdentifierForItemAtURL:` method to provide a different mapping.

- `URLForItemWithPersistentIdentifier:`

  This is the inverse of `persistentIdentifierForItemAtURL:`. It provides a URL for the given identifier.

You Must Overwrite These Methods

You must override these methods, even if you provide only an empty method. Do not call `super` in your implementations.

- `providePlaceholderAtURL:completionHandler:`

  The system calls this method when the file is accessed. Both the `providePlaceholderAtURL:completionHandler:` and `startProvidingItemAtURL:completionHandler:` methods may be triggered as the user interacts with the document picker view controller or with a coordinated read.

  Exactly which methods get triggered, and what their sequence is, depend on the intent of the access. For example, a coordinated read using the`NSFileCoordinatorReadingImmediatelyAvailableMetadataOnly` option just triggers the creation of a placeholder. As a result, your extension should not create any dependencies between these methods. They may be called any order.

- `startProvidingItemAtURL:completionHandler:`

  When this method is called, your extension should begin to download, create, or otherwise make a local file ready for use. As soon as the file is available, call the provided completion handler. If any errors occur during this process, pass the error to the completion handler. The system then passes the error back to the original coordinated read.

- `itemChangedAtURL:`

  The system calls this method after the host app completes a coordinated write. You can override this method to upload the changes back to your server or to otherwise respond to the change.

- `stopProvidingItemAtURL:`

  The system calls this method as soon as no processes are accessing the provided URL. You can override this method to remove the document from the local file system, freeing up storage space.

Note: If your extension deletes files to free up space, it must replace them with placeholders by calling `placeholderURLForURL:` and `writePlaceholderAtURL:withMetadata:error:`.

Providing a Great User Experience in an Uncertain World

Even with the simplest tasks, networking introduces uncertainty and unexpected problems. Suddenly you have to deal with bad networks, slow connections, server errors, and even file-system errors. Your Document Provider extension must carefully handle these complications.

Furthermore, your extension does not have complete control over its environment. It is launched to support an unknown host app. Multiple processes can access the files you provide, and your extension must effectively communicate its progress and any errors back to user in the host app.

Remember that your Document Provider extension has broad implications across the entire device, because every app with a document picker view controller can access it. Therefore, you want to provide a solid, polished, and reliable user experience.

File Coordination

Important: When using iCloud Drive in iOS 8.0, do not use file presenters or the `UIDocument` class to access files. You can use file coordinators, Posix locks, Core Data, or SQLite.

Because multiple processes can access these files, use file coordination to perform all read and write operations. This applies to the containing app, the Document Picker View Controller extension, the File Provider extension, and the host app.

For the document picker and file provider, you must also set the file coordinator's purpose identifier. Both extensions provide a `providerIdentifier` method. You pass this method's return value to the file coordinator's `purposeIdentifier` property before performing your coordinated read or write. By sharing a purpose identifier, the two app extensions can coordinate with each other, preventing any possible deadlocks between them.

File coordination plays a number of important roles. First and foremost, it guarantees that each process can safely read and write to the provided files. However, because file coordination can also act as triggers for a number of other actions, coordinated reads may cause the creation of placeholders or the downloading of files from a remote server. Coordinated writes may likewise trigger an upload back to the remote server. Finally, file coordinators permit the propagation of error messages across process boundaries.

Downloading Files

Even downloading small files can take an arbitrarily long amount of time. Things may work perfectly when you test it on your office's Wi-Fi connection—but anything might happen when a user opens your document provider in the basement of a parking garage.

Because downloading is inherently unreliable, provide useful feedback wherever possible. For example, let the user know which files are local and which are remote. Let them know when files are downloading, and display the download's progress. Finally, present meaningful error messages when problems occur.

Because you have access to the user interface only from the containing app and from the Document Picker View Controller extension, you may want to provide a user interface to download files directly in the document picker. Downloading files in the document picker has several advantages over downloading files in the file provider.

- You can display the file's size, setting the user's expectation for how long the download might take.
- You can display the progress during the download.
- You have full control over how errors are handled.

However, downloading data from the document picker presents its own set of problems. If the user dismisses the document picker view controller, the system may terminate your app extension.

You can use an `NSURLSession` background transfer to download the files, but be sure to set the `NSURLSessionConfiguration` object's `sharedContainerIdentifier` property to a container shared by the app extension and the containing app. This ensures that the results can be accessed by either the extension or the containing app, as necessary.

Background transfers perform the download in a separate process, and the download continues even if your document picker is terminated. If your document picker is not running when the download completes, the system launches your containing app in the background and calls its `application:handleEventsForBackgroundURLSession:completionHandler:` method.

Your containing app can use local notifications and badges to alert the user. If the user reopens the document picker before the download completes, you can reconnect with your background transfers, presenting the current status to the user, and handling the download's completion directly.

Even if you download documents from within the Document Picker View Controller extension, you still need to support downloading from the file provider's `startProvidingItemAtURL:completionHandler:` method. The host app may not always access your documents through a document picker view controller. Any time the user opens a file, the host app can save a security-scoped bookmark for that file. This bookmark lets the host app open that file directly. However, if the file provider has already deleted the local copy to free up storage space, it must now download a new copy.

When downloading files in the File Provider extension, you do not have access to the user interface. If an error occurs, you cannot display a message directly. Instead, you pass an `NSError` object to the `startProvidingItemAtURL:completionHandler:` method's completion handler. The system then passes this error back to the host app's coordinated read.

There is also no way to report the download's progress back to the user. The coordinated read that triggered the download won't run until after the download is complete. If not handled properly, the download can lead to unexpected delays for the user.

This means that you may want to carefully balance the desire to conserve storage space with the desire to avoid unnecessary downloads. If your extension is overeager about replacing files with placeholders in the File Provider extension's `stopProvidingItemAtURL:` method, your users may be surprised when an app suddenly needs to redownload a file they were just working on. Also, if you know your user will want a given file, you may want to preemptively download it to the shared container from your containing app. This makes the file instantly available when the user asks for it.

Detecting and Communicating Conflicts

Whenever a user can modify a file on multiple devices, conflicts become inevitable. Therefore be prepared to both detect and handle conflicts when they occur. For example, when your containing app or File Provider extension downloads an updated version of a file, you must check and see if the updated file conflicts with any local changes. Similarly, whenever you upload local changes back to the server, the server must be able to detect and handle any conflicts it might find.

There is no way to directly alert the host app about these conflicts. Instead, your extension should contact your server. You can either upload the local changes back to your server and handle the conflict there, or the server can send a push notification to the containing app, letting the app handle the conflict.

Logging in and out

Think carefully about how your Document Picker View Controller extension is going to log users into and out of your service.

You typically prompt the user to log in when your Document Picker View Controller extension is first displayed. However, you also want to save your user's credentials. As described earlier, the File Provider extension may need to download or upload files without going through the document picker view controller. Therefore, it also needs access to your user's credentials.

Save the user credentials in a shared keychain using a Keychain Access group. In the Xcode capabilities pane, turn on keychain sharing for the containing app and its extensions. Be sure to use the same group identifier for all three targets. Then, when you create a shared keychain item, include the `kSecAttrAccessGroup` key in the item's attributes dictionary. The value of this key must be your shared identifier.

For more information on saving data to the keychain, see iOS Keychain Services Tasks in *Keychain Services Programming Guide*.

When a user logs out, delete their login credentials and remove any placeholders to documents that they can no longer access. You may also want to remove all the local copies of files stored on the server. In general, users shouldn't be able to access those files until they log back in.

Custom Keyboard

A custom keyboard replaces the system keyboard for users who want capabilities such as a novel text input method or the ability to enter text in a language not otherwise supported in iOS. The essential function of a custom keyboard is simple: Respond to taps, gestures, or other input events and provide text, in the form of an unattributed `NSString` object, at the text insertion point of the current text input object.

> **Before you begin:** Make sure a custom, systemwide keyboard is indeed what you want to develop. To provide a fully custom keyboard for just your app or to supplement the system keyboard with custom keys in just your app, the iOS SDK provides other, better options. Read about custom input views and input accessory views in Custom Views for Data Input in *Text Programming Guide for iOS*.

After a user chooses a custom keyboard, it becomes the keyboard for every app the user opens. For this reason, a keyboard you create must, at minimum, provide certain base features. Most important, your keyboard must allow the user to switch to another keyboard.

Understand User Expectations for Keyboards

To understand what users expect of your custom keyboard, study the system keyboard—it's fast, responsive, and capable. And it never interrupts the user with information or requests. If you provide features that require user interaction, add them not to the keyboard but to your keyboard's containing app.

Keyboard Features That iOS Users Expect

There is one feature that iOS users expect and that every custom keyboard *must* provide: a way to switch to another keyboard. On the system keyboard, this affordance appears as a button called the *globe key*. iOS 8 provides specific API for your "next keyboard" control, described in Providing a Way to Switch to Another Keyboard (page 89).

The system keyboard presents an appropriate key set or layout based on the `UIKeyboardType` trait of the current text input object. With the insertion point in the To: field in Mail, for example, the system keyboard period key changes: When you press and hold that key, you can pick from among a set of top-level domain suffixes. Design your custom keyboard with keyboard type traits in mind.

iOS users also expect autocapitalization: In a standard text field, the first letter of a sentence in a case-sensitive language is automatically capitalized.

These features and others are listed next.

Appropriate layout and features based on keyboard type trait

Autocorrection and suggestion

Automatic capitalization

Automatic period upon double space

Caps lock support

Keycap artwork

Multistage input for ideographic languages

You can decide whether or not to implement such features; there is no dedicated API for any of the features just listed, so providing them is a competitive advantage.

System Keyboard Features Unavailable to Custom Keyboards

Your custom keyboard does not have access to most of the general keyboard settings in the Settings app (Settings > General > Keyboard), such as Auto-Capitalization and Enable Caps Lock. Nor does your keyboard have access to the dictionary reset feature (Settings > General > Reset > Reset Keyboard Dictionary). To give your users flexibility, create a standard settings bundle, as described in Implementing an iOS Settings Bundle in *Preferences and Settings Programming Guide*. Your custom settings then appear in the Keyboard area in Settings, associated with your keyboard.

There are certain text input objects that your custom keyboard is not eligible to type into. First is any *secure* text input object. Such an object is defined by its `secureTextEntry` property being set to `YES` and is distinguished by presenting typed characters as dots.

When a user taps in a secure text input object, the system temporarily replaces your custom keyboard with the system keyboard. When the user then taps in a nonsecure text input object, your keyboard automatically resumes.

Your custom keyboard is also ineligible to type into so-called phone pad objects, such as the phone number fields in Contacts. These input objects are exclusively for strings built from a small set of alphanumeric characters specified by telecommunications carriers and are identified by having one or another of the following two keyboard type traits:

- `UIKeyboardTypePhonePad`
- `UIKeyboardTypeNamePhonePad`

When a user taps in a phone pad object, the system temporarily replaces your keyboard with the appropriate, standard system keyboard. When the user then taps in a different input object that requests a standard keyboard via its type trait, your keyboard automatically resumes.

An app developer can elect to reject the use of all custom keyboards in their app. For example, the developer of a banking app, or the developer of an app that must conform to the HIPAA privacy rule in the US, might do this. Such an app employs the `application:shouldAllowExtensionPointIdentifier:` method from the `UIApplicationDelegate` protocol (returning a value of `NO`), and thereby always uses the system keyboard.

Because a custom keyboard can draw only within the primary view of its `UIInputViewController` object, it cannot select text. Text selection is under the control of the app that is using the keyboard. If that app provides an editing menu interface (such as for Cut, Copy, and Paste), the keyboard has no access to it. A custom keyboard cannot offer inline autocorrection controls near the insertion point.

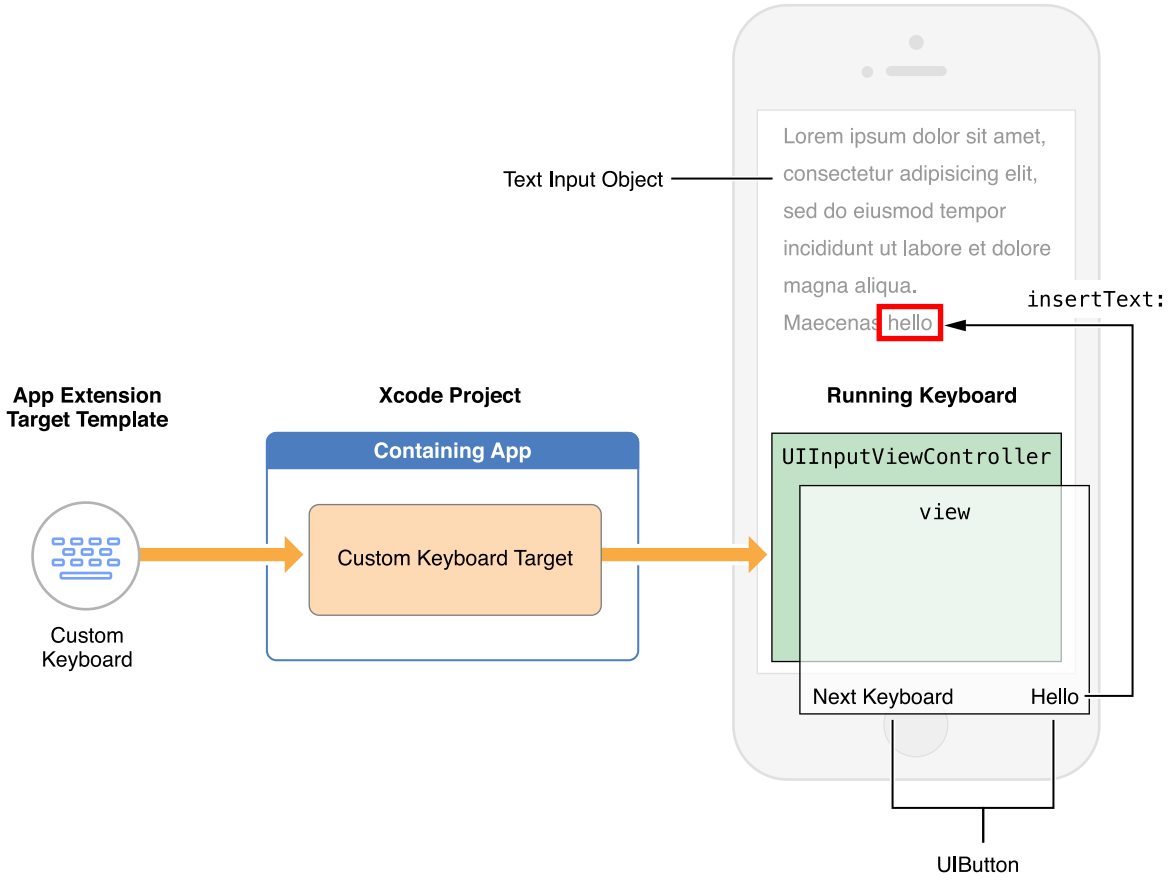
Custom keyboards, like all app extensions in iOS 8.0, have no access to the device microphone, so dictation input is not possible.

Finally, it is not possible to display key artwork above the top edge of a custom keyboard's primary view, as the system keyboard does on iPhone when you tap and hold a key in the top row.

API Quick Start for Custom Keyboards

This section gives you a quick tour of the APIs for building a keyboard. Figure 11-1 shows some of the important objects in a running keyboard and where they come from in a typical development workflow.

Figure 11-1 Basic structure of a custom keyboard



The Custom Keyboard template (in the iOS "Application Extension" target template group) contains a subclass of the `UIInputViewController` class, which serves as your keyboard's primary view controller. The template also includes a basic implementation of the required "next keyboard" button, which calls the `advanceToNextInputMode` method of the `UIInputViewController` class. Add objects such as views, controls, and gesture recognizers to the input view controller's primary view (in its `inputView` property), as suggested in Figure 11-1. As with other app extensions, there is no window in the target, and, therefore, no root view controller per se.

The template's `Info.plist` file comes preconfigured with the minimal values needed for a keyboard. See the `NSExtensionAttributes` dictionary key in the keyboard target's `Info.plist` file. The keys for configuring a keyboard are described in Configuring the Info.plist file for a Custom Keyboard (page 92).

By default, a keyboard has no network access and cannot share a container with its containing app. To enable these things, set the value of the `RequestsOpenAccess` Boolean key in the `Info.plist` file to `YES`. Doing this expands the keyboard's sandbox, as described in Establishing and Maintaining User Trust (page 85).

An input view controller conforms to various protocols for interacting with the content of a text input object:

- To insert or delete text in response to touch events, employ the `UIKeyInput` protocol methods `insertText:` and `deleteBackward`. Call these methods on the input view controller's `textDocumentProxy` property, which represents the current text input object and which conforms to the `UITextDocumentProxy` protocol. For example:

```
[self.textDocumentProxy insertText:@"hello "]; // Inserts the string "hello
 " at the insertion point
```

```
[self.textDocumentProxy deleteBackward];       // Deletes the character
to the left of the insertion point
```

```
[self.textDocumentProxy insertText:@"\n"];     // In a text view, inserts
 a newline character at the insertion point
```

- To get the data you need to determine how much text is appropriate to delete when you call the `deleteBackward` method, obtain the textual context near the insertion point from the `documentContextBeforeInput` property of the `textDocumentProxy` property, as follows:

```
NSString *precedingContext =
self.textDocumentProxy.documentContextBeforeInput;
```

  You can then delete the appropriate text—for example, a single character, or everything back to a whitespace character. To delete by semantic unit, such as by word, sentence, or paragraph, employ the functions described in *CFStringTokenizer Reference* and refer to related documentation. Note that each language has its own tokenization rules.

- To control the insertion point position, such as to support text deletion in a forward direction, call the `adjustTextPositionByCharacterOffset:` method of the `UITextDocumentProxy` protocol. For example, to delete forward by one character, use code similar to this:

```
- (void) deleteForward {
    [self.textDocumentProxy adjustTextPositionByCharacterOffset: 1];
    [self.textDocumentProxy deleteBackward];
```

```
}
```

- To respond to changes in the content of the active text object, or to respond to user-initiated changes in the position of the insertion point, implement the methods of the `UITextInputDelegate` protocol.

To present a keyboard layout appropriate to the current text input object, respond to the object's `UIKeyboardType` property. For each trait you support, change the contents of your primary view accordingly.

To support more than one language in your custom keyboard, you have two options:

- Create one keyboard per language, each as a separate target that you add to a common containing app
- Create a single multilingual keyboard, dynamically switching its primary language as appropriate

  To dynamically switch the primary language, use the `primaryLanguage` property of the `UIInputViewController` class.

Depending on the number of languages you want to support and the user experience you want to provide, pick the option that makes the most sense.

Every custom keyboard (independent of the value of its `RequestsOpenAccess` key) has access to a basic autocorrection lexicon through the `UILexicon` class. Make use of this class, along with a lexicon of your own design, to provide suggestions and autocorrections as users are entering text. The `UILexicon` object contains words from various sources, including:

- Unpaired first names and last names from the user's Address Book database
- Text shortcuts defined in the Settings > General > Keyboard > Shortcuts list
- A common words dictionary

You can adjust the height of your custom keyboard's primary view using Auto Layout. By default, a custom keyboard is sized to match the system keyboard, according to screen size and device orientation. A custom keyboard's width is always set by the system to equal the current screen width. To adjust a custom keyboard's height, change its primary view's height constraint.

The following code lines show how you might define and add such a constraint:

```
CGFloat _expandedHeight = 500;

NSLayoutConstraint *_heightConstraint =
    [NSLayoutConstraint constraintWithItem: self.view
                                 attribute: NSLayoutAttributeHeight
                                 relatedBy: NSLayoutRelationEqual
                                    toItem: nil
```

```
                                attribute: NSLayoutAttributeNotAnAttribute
                               multiplier: 0.0
                                 constant: _expandedHeight];
[self.view addConstraint: _heightConstraint];
```

> **Note:** In iOS 8.0, you can adjust a custom keyboard's height any time after its primary view initially draws on screen.

Development Essentials for Custom Keyboards

There are two development essentials for every custom keyboard:

- **Trust.** Your custom keyboard gives you access to what a user types, so trust between you and your user is essential.
- **A "next keyboard" key.** The affordance that lets a user switch to another keyboard is part of a keyboard's user interface; you must provide one in your keyboard.

Designing for User Trust

Your first consideration when creating a custom keyboard must be how you will establish and maintain user trust. This trust hinges on your understanding of privacy best practices and knowing how to implement them.

> **Note:** This section provides guidelines to help you create a custom keyboard that respects user privacy, in terms of factors under your control and described here as responsibilities. To learn about iOS program requirements, read *App Store Review Guidelines*, *iOS Human Interface Guidelines*, and *iOS Developer Program License Agreement*, all linked to from Apple's App Review Support page. Also review Supporting User Privacy in *App Programming Guide for iOS*.

For keyboards, the following three areas are especially important for establishing and maintaining user trust:

Safety of keystroke data. Users want their keystrokes to go to the document or text field they're typing into, and not to be archived on a server or used for purposes that are not obvious to them.

Appropriate and minimized use of other user data. If your keyboard employs other user data, such as from Location Services or the Address Book database, the burden is on you to explain and demonstrate the benefit to your users.

Accuracy. Accuracy in converting input events to text is not a privacy issue per se but it impacts trust: With every word typed, users see the accuracy of your code.

To design for trust, first consider whether to request open access. Although open access makes many things possible for a custom keyboard, it also increases your responsibilities (see Table 11-1).

Table 11-1 Standard and open access (network-enabled) keyboards—capabilities and privacy considerations

Open access	Capabilities and restrictions	Privacy considerations
Off (default)	• Keyboard can perform all the normal duties expected of a basic keyboard • Access to a common words lexicon for autocorrect and text suggestion • Access to the text shortcuts list in Settings • No shared container with containing app • No access to file system apart from keyboard's own container • No ability to participate directly or indirectly in iCloud, Game Center, or In-App Purchase	• Users know that keystrokes go only to the app that is using the keyboard

Open access	Capabilities and restrictions	Privacy considerations
On	• All capabilities of a nonnetworked custom keyboard • Keyboard can access Location Services and Address Book, with user permission • Keyboard and containing app can employ a shared container • Keyboard can send keystrokes and other input events for server-side processing • Containing app can provide editing interface for keyboard's custom autocorrect lexicon • Via containing app, keyboard can employ iCloud to ensure settings and autocorrect lexicon are up to date on all devices • Via containing app, keyboard can participate in Game Center and In-App Purchase • If keyboard supports mobile device management (MDM), it can work with managed apps	• Users know that keystrokes are available to the keyboard developer • You must adhere to networked keyboard guidelines in *App Store Review Guidelines* and *iOS Developer Program License Agreement*, linked from Apple's App Review Support page.

If you build a keyboard without open access, the system ensures that keystrokes cannot be sent back to you or anywhere else. Use a nonnetworked keyboard if your goal is to provide normal keyboard functionality. Because of its restricted sandbox, a nonnetworked keyboard gives you a head start in meeting Apple's data privacy guidelines and in gaining user trust.

If you enable open access (as described Configuring the Info.plist file for a Custom Keyboard (page 92)), a variety of possibilities open up but your responsibilities increase as well.

> **Note:** To submit an open-access keyboard to the App Store, you must adhere to all pertinent guidelines in the documents linked from Apple's App Review Support page.

Each keyboard capability associated with open access carries responsibilities on your part as a developer, as indicated in Table 11-2. In general, treat user data with the greatest possible respect and do not use it for any purpose that is not obvious to the user.

Table 11-2 Open-access keyboard user benefits and developer responsibilities

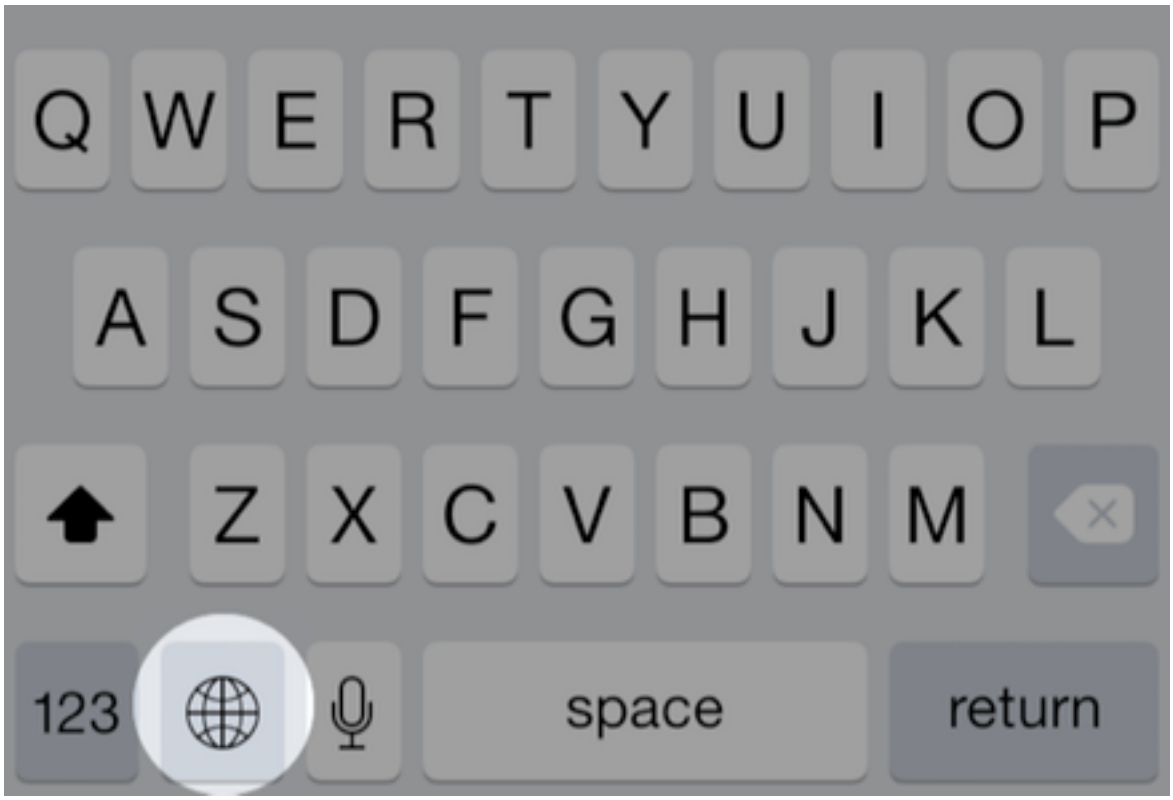
Capability	Example user benefit	Developer responsibility
Shared container with containing app	Management UI for keyboard's autocorrect lexicon	Consider the autocorrect lexicon to be private user data. Do not send it to your servers for any purpose that is not obvious to the user.
Sending keystroke data to your server	Enhanced touch-event processing and input prediction via developer's computing resources	Do not store received keystroke or voice data except to provide services that are obvious to the user.
Dynamic autocorrect lexicon based on network supplied data	Names of people, places, and current events in the news added to autocorrection lexicon	Do not associate the user's identity with their use of trending or other network-based information, for any reason that is not obvious to the user.
Address Book access	Names, places, and phone numbers relevant to the user added to autocorrection lexicon	Do not use Address Book data for any purpose that is not obvious to the user.
Location Services access	Nearby place names added to autocorrection lexicon	Do not use Location Services in the background. Do not send location data to your servers for any purpose that is not obvious to the user.

An open-access keyboard and its containing app can send keystroke data to your server, which enables you to apply your computing resources to such features as touch-event processing and input prediction. If you employ this capability, do not store received keystroke or voice data beyond the time needed to provide text back to the user or to provide features that you explain to the user. Refer to Table 11-2 for additional responsibilities you have when using open-access-keyboard capabilities.

Providing a Way to Switch to Another Keyboard

The system keyboard's globe key lets a user choose a keyboard when more than one keyboard is enabled. See Figure 11-2.

Figure 11-2 The system keyboard's globe key



Your custom keyboard must also provide a way to switch to another keyboard.

> **Note:** To pass App Review, you must provide obvious UI in your custom keyboard to allow a user to switch to another keyboard.

To ask the system to switch to another keyboard, call the `advanceToNextInputMode` method of the `UIInputViewController` class. The system picks the appropriate "next" keyboard; there is no API to obtain a list of enabled keyboards or for picking a particular keyboard to switch to.

The Xcode Custom Keyboard template includes the `advanceToNextInputMode` method as the action of its Next Keyboard button. For best user experience, place your next-keyboard control close to the same screen location as the system keyboard's globe key.

Getting Started with Custom Keyboard Development

In this section you learn how to create a custom keyboard, configure it according to your goals, and run it in iOS Simulator or on a device. You'll also learn about some UI factors to bear in mind when replacing the system keyboard.

Using the Xcode Custom Keyboard Template

The steps to create a keyboard and its containing app differ slightly from those for other app extensions. This section walks you through getting a basic keyboard up and running.

To create a custom keyboard in a containing app

1. In Xcode, choose File > New > Project, and in the iOS Application template group choose the Single View Application template.
2. Click Next.
3. Name the project (for example, "ContainingAppForKeyboard"), then click Next.
4. Navigate to the location you want to save the project in, then click Create.

   At this point, you have an empty app for your project to serve the simple role, for now, of containing the keyboard target. Before you submit a containing app to the App Store, it must perform some useful function. See *App Store Review Guidelines*, linked from Apple's App Review Support page.
5. Choose File > New > Target, and in the iOS template group choose the Custom Keyboard template, then click Next.
6. Name the target as you'd like the keyboard's name to appear in the iOS user interface (for example, Custom Keyboard).
7. Ensure that the Project and the "Embed in Application" pop-up menus display the name of the containing app, then click Finish.

   If you are prompted to activate the scheme for the new keyboard target, click Activate.

You can now optionally customize the keyboard group name as it appears in the Purchased Keyboards list in Settings, as described next.

To customize the keyboard group name

1. In the Xcode project navigator, choose the containing app's `Info.plist` file, located in the app's Supporting Files folder. The property list editor opens, showing the contents of the file.
2. Hover the cursor over the "Bundle name" row, then click the "+" button that appears. This creates a new, empty property list row and selects its Key field.

3. Start typing `Bundle display name` and when the name autocompletes, press Return.
4. Double-click in the Value field in the same row to obtain a cursor there, then enter the keyboard group name you want.
5. Choose File > Save to save your changes to property list file.

Table 11-3summarizes the UI strings for your custom keyboard that you can configure in the `Info.plist` files for the keyboard and its containing app.

Table 11-3 User interface strings specified in target and containing app `Info.plist` files

iOS user interface text	`Info.plist` key
• Keyboard group name in Purchased Keyboards list in Settings	Bundle display name in *containing app's* `Info.plist` file
• Keyboard name in Settings • Keyboard name in globe key menu	Bundle display name in *custom keyboard target's* `Info.plist` file

Now you can run the template-based keyboard in iOS Simulator, or on a device, to explore its behavior and capabilities.

To run the custom keyboard and attach the Xcode debugger

1. In Xcode, set a breakpoint in your view controller implementation.

   For example, set a breakpoint in the `viewDidLoad` method.
2. Use the Xcode toolbar to ensure that the active scheme popup menu specifies the keyboard's scheme and an iOS Simulator or attached device.
3. Choose Product > Run, or click the Play button at the upper left of the Xcode project window.

   Xcode prompts you to select a host app. Select an app with a readily-available text field, such as Contacts or Safari.
4. Click Run.

   Xcode runs your specified host app. If this is your first time deploying your keyboard extension to iOS Simulator or a device, use Settings to add and enable the keyboard, as follows:

   a. Go to Settings > General > Keyboard > Keyboards.

   b. Tap Add New Keyboard.

   c. In the Purchased Keyboards group, tap the name of your new keyboard. A modal view appears with a switch to enable your keyboard.

d. Tap the switch to enable your keyboard. A warning alert appears.

e. In the warning alert, tap Add Keyboard to finish enabling your new keyboard. Then tap Done.

5. In iOS Simulator or on the attached device, invoke your custom keyboard.

   To do this, tap to place the insertion point in a text field—in any app, or in the Spotlight field in Springboard—to display the system keyboard. Then press and hold the globe key and choose your custom keyboard.

   Now you can explore your custom keyboard's behavior, but the debugger is not yet attached. The bare-bones keyboard built from the template has only one behavior, indicated by its Next Keyboard button: allowing you to switch back to the previously used keyboard.

   Before continuing, ensure that your custom keyboard is active.

6. Dismiss your keyboard (so that in step 8 you can hit the `viewDidLoad` breakpoint by again invoking the keyboard).

7. In Xcode, choose Debug > Attach to Process > By Process Identifier (PID) or Name.

   In the sheet that appears, enter the name of your keyboard extension (including spaces) as you specified it when creating it. By default, this is the name for the app extension's group in the project navigator.

8. Click Attach.

   Xcode indicates in the Debug navigator that it is waiting to attach.

9. In any app in iOS Simulator or the device (depending on which you are using), invoke the keyboard by tapping in a text field.

   As your keyboard's main view begins to load, the Xcode debugger attaches to your keyboard and Xcode hits your breakpoint.

Configuring the Info.plist file for a Custom Keyboard

The information property list (`Info.plist` file) keys that are specific to a custom keyboard let you statically declare the salient characteristics of your keyboard, including its primary language and whether it requires open access.

To examine these keys, open an Xcode project to which you've added a Custom Keyboard target template. Now select the `Info.plist` file in the Project navigator (the `Info.plist` file is in the Supporting Files folder for the keyboard target).

In source text form, the keys for a custom keyboard are as follows:

```
<key>NSExtension</key>
<dict>
```

```
    <key>NSExtensionAttributes</key>
    <dict>
        <key>IsASCIICapable</key>
        <false/>
        <key>PrefersRightToLeft</key>
        <false/>
        <key>PrimaryLanguage</key>
        <string>en-US</string>
        <key>RequestsOpenAccess</key>
        <false/>
    </dict>
    <key>NSExtensionPointIdentifier</key>
    <string>com.apple.keyboard-service</string>
    <key>NSExtensionPrincipalClass</key>
    <string>KeyboardViewController</string>
</dict>
```

Each of these keys is explained in the App Extension Keys in *Information Property List Key Reference* chapter in *Information Property List Key Reference* . Use the keys in the `NSExtensionAttributes` dictionary to express the characteristics and needs of your custom keyboard, as follows:

`IsASCIICapable`—This Boolean value, `NO` by default, expresses whether a custom keyboard can insert ASCII strings into a document. Set this value to `YES` if you provide a keyboard type specifically for the `UIKeyboardTypeASCIICapable` keyboard type trait.

`PrefersRightToLeft`—This Boolean value, also `NO` by default, expresses whether a custom keyboard is for a right-to-left language. Set this value to `YES` if your keyboard's primary language is right-to-left.

`PrimaryLanguage`—This string value, `en-US` (English for the US) by default, expresses the primary language for your keyboard using the pattern `<language>-<REGION>`. You can find a list of strings corresponding to languages and regions at http://www.opensource.apple.com/source/CF/CF-476.14/CFLocaleIdentifier.c.

`RequestsOpenAccess`—This Boolean value, `NO` by default, expresses whether a custom keyboard wants to enlarge its sandbox beyond that needed for a basic keyboard. If you request open access by setting this key's value to `YES`, your keyboard gains the following capabilities, each with a concomitant responsibility in terms of user trust:

- Access to Location Services, the Address Book database, and the Camera Roll, each requiring user permission on first access

- Option to use a shared container with the keyboard's containing app, which enables features such as providing a custom lexicon management UI in the containing app
- Ability to send keystrokes and other input events over the network for server-side processing
- Ability to use the `UIPasteboard` class
- Ability to play audio, including keyboard clicks using the `playInputClick` method
- Access to iCloud, which you can use, for example, to ensure that keyboard settings and your custom autocorrect lexicon are up to date on all devices owned by the user
- Access to Game Center and In-App Purchase, via the containing app
- Ability to work with managed apps, if you design your keyboard to support mobile device management (MDM)

When considering whether to set the `RequestsOpenAccess` key's value to `YES`, be sure to read Designing for User Trust (page 85), which describes your responsibilities for respecting and protecting user data.

Document Revision History

This table describes the changes to *App Extension Programming Guide*.

Date	Notes
2014-10-20	Expanded the discussion in the "Specifying When a Widget Should Appear" section. Improved the list of capabilities enabled by the `RequestsOpenAccess` Info.plist key, in Configuring the Info.plist file for a Custom Keyboard (page 92). Added a new section: Ensure Your iOS App Extension Works on All Devices (page 20).
2014-10-16	In the API Quick Start for Custom Keyboards (page 82) section, added a code snippet for deleting forward and added a link to *CFStringTokenizer Reference*. Expanded the discussion in Specifying When a Widget Should Appear (page 39).
2014-09-17	New document that describes how to develop an app extension, which is a bundle that provides functionality to other apps in a specific context.

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