Document-Based App Programming Guide for Mac

Developer

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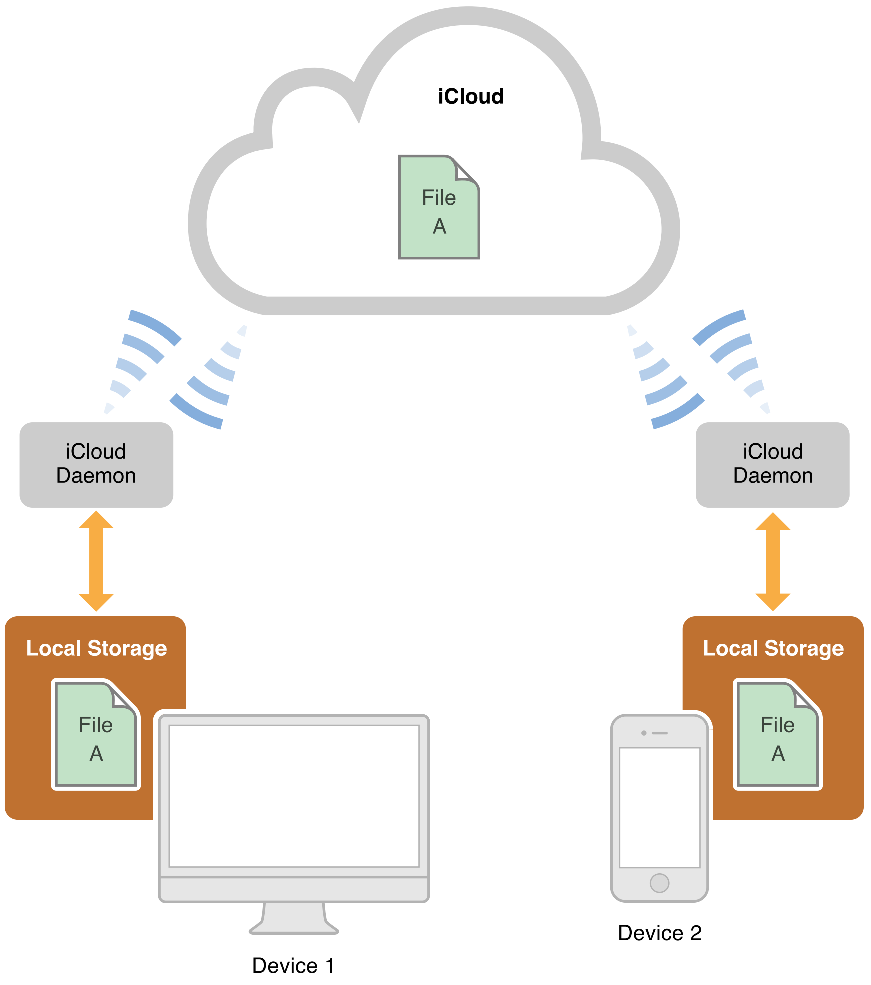
Figures, Tables, and Listings

About the Cocoa Document Architecture

In OS X, a Cocoa subsystem called the *document architecture* provides support for apps that manage documents, which are containers for user data that can be stored in files locally and in iCloud.



At a Glance

Document-based apps handle multiple documents, each in its own window, and often display more than one document at a time. Although these apps embody many complex behaviors, the document architecture provides many of their capabilities "for free," requiring little additional effort in design and implementation.

The Model-View-Controller Pattern Is Basic to a Document-Based App

The Cocoa document architecture uses the Model-View-Controller (MVC) design pattern in which model objects encapsulate the app's data, view objects display the data, and controller objects act as intermediaries between the view and model objects. A document, an instance of an `NSDocument` subclass, is a controller that manages the app's data model. Adhering to the MVC design pattern enables your app to fit seamlessly into the document architecture.

Relevant Chapters: Designing a Document-Based App (page 10) and The Classes That Support Document-Based Apps (page 16)

Xcode Supports Coding and Configuring Your App

Taking advantage of the support provided by Xcode, including a document-based application template and interfaces for configuring app data, you can create a document-based app without having to write much code. In Xcode you design your app's user interface in a graphical editor, specify entitlements for resources such as the App Sandbox and iCloud, and configure the app's property list, which specifies global app keys and other information, such as document types.

Relevant Chapter: App Creation Process Overview (page 26)

You Must Subclass NSDocument

Document-based apps in Cocoa are built around a subclass of `NSDocument` that you implement. In particular, you must override one document reading method and one document writing method. You must design and implement your app's data model, whether it is simply a single text-storage object or a complex object graph containing disparate data types. When your reading method receives a request, it takes data provided by the framework and loads it appropriately into your object model. Conversely, your writing method takes your app's model data and provides it to the framework's machinery for writing to a document file, whether it is located only in your local file system or in iCloud.

Relevant Chapters: Creating the Subclass of NSDocument (page 35) and The Classes That Support Document-Based Apps (page 16)

NSDocument Provides Core Behavior and Customization Opportunities

The Cocoa document architecture provides your app with many built-in features, such as autosaving, asynchronous document reading and writing, file coordination, and multilevel undo support. In most cases, it is trivial to opt-in to these behaviors. If your app has particular requirements beyond the defaults, the document architecture provides many opportunities for extending and customizing your app's capabilities through mechanisms such as delegation, subclassing and overriding existing methods with custom implementations, and integration of custom objects.

Relevant Chapters: Core App Behaviors (page 47) and Alternative Design Considerations (page 57)

Prerequisites

Before you read this document, you should be familiar with the information presented in *Mac App Programming Guide*.

See Also

See *Document-Based App Programming Guide for iOS* for information about how to develop a document-based app for iOS using the `UIDocument` class.

For information about iCloud, see *iCloud Design Guide*.

File Metadata Search Programming Guide describes how to conduct searches using the `NSMetadataQuery` class and related classes. You use metadata queries to locate an app's documents stored in iCloud.

For information about how to publish your app in the App Store, see *App Distribution Guide*.

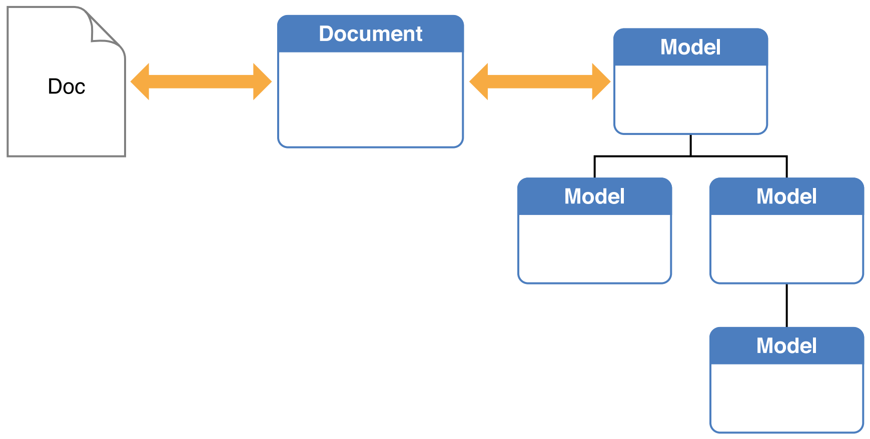
Designing a Document-Based App

Documents are containers for user data that can be stored in files locally and in iCloud. In a document-based design, the app enables users to create and manage documents containing their data. One app typically handles multiple documents, each in its own window, and often displays more than one document at a time. For example, a word processor provides commands to create new documents, it presents an editing environment in which the user enters text and embeds graphics into the document, it saves the document data to disk or iCloud, and it provides other document-related commands, such as printing and version management. In Cocoa, the document-based app design is enabled by a subsystem called the **document architecture**, which is part of of the AppKit framework.

Documents in OS X

There are several ways to think of a document. Conceptually, a document is a container for a body of information that can be named and stored in a file. In this sense, the document is an object in memory that owns and manages the document data. To users, the document is their information—such as text and graphics formatted on a page. In the context of Cocoa, a document is an instance of a custom `NSDocument` subclass that knows how to represent internally persistent data that it can display in a window. This document object knows how to read document data from a file and create an object graph in memory for the document data model. It also knows how to modify that data model consistently and write the document data back out to disk. So, the document object mediates between different representations of document data, as shown in Figure 1-1.

Figure 1-1 Document file, object, and data model



Using iCloud, documents can be shared automatically among a user's computers and iOS devices. The system synchronizes changes to the document data without user intervention. See Storing Documents in iCloud (page 12) for more information.

The Document Architecture Provides Many Capabilities for Free

The document-based style of app is one design choice among several that you should consider when you design your app. Other choices include single-window utility apps, such as Calculator, and library-style "shoebox" apps, such as iPhoto. It's important to choose the basic app style early in the design process because development takes quite different paths depending on that choice. If it makes sense for your users to create multiple discrete sets of data, each of which they can edit in a graphical environment and store in files, then you should plan to develop a document-based app.

The Cocoa document architecture provides a framework for document-based apps to do the following things:

- **Create new documents.** The first time the user chooses to save a new document, it presents a dialog in which the user names and saves the document in a disk file in a user-chosen location.
- **Open existing documents stored in files.** A document-based app specifies the types of document files it can read and write, as well as read-only and write-only types. It can represent the data of different document types internally and display the data appropriately.
- **Automatically save documents.** Document-based apps can adopt autosaving in place, and its documents are automatically saved at appropriate times so that the data the user sees on screen is effectively the same as that saved on disk. Saving is done safely, so that an interrupted save operation does not leave data inconsistent. To avoid automatic saving of inadvertent changes, old files are locked from editing until explicitly unlocked by the user.
- **Asynchronously read and write document data.** Reading and writing are done asynchronously on a background thread, so that lengthy operations do not make the app's user interface unresponsive. In addition, reads and writes are coordinated using the `NSFilePresenter` protocol and the `NSFileCoordinator` class to reduce version conflicts.
- **Manage multiple versions of documents.** Autosave creates versions at regular intervals, and users can manually save a version whenever they wish. Users can browse versions and revert the document's contents to a chosen version using a Time Machine–like interface. The version browser is also used to resolve version conflicts from simultaneous iCloud updates.
- **Print documents.** Users can specify various page layouts in the print dialog and page setup dialog.
- **Track changes and set the document's edited status.** The document manages its edited status and implements multilevel undo and redo.
- **Validate menu items.** The document enables or disables menu items automatically, depending on its edited status and the applicability of the associated action methods.

- **Handle app and window delegation.** Notifications are sent and delegate methods called at significant life cycle events, such as when the app terminates.

Cocoa's document architecture implements most of its capabilities in three classes. These classes interoperate to provide an extensible app infrastructure that makes it easy for you to create document-based apps. Table 1-1 briefly describes these classes.

Table 1-1 Primary classes in the document architecture

Class	Purpose
`NSDocument`	Creates, presents, and stores document data
`NSWindowController`	Manages a window in which a document is displayed
`NSDocumentController`	Manages all of the document objects in the app

See The Classes That Support Document-Based Apps (page 16) for more detailed information.

Storing Documents in iCloud

The iCloud storage technology enables you to share documents and other app data among multiple computers that run your document-based app. If you have a corresponding iOS version of your app, you can share your documents and app data with your iOS devices as well. Once your app sets up the proper connections, iCloud automatically pushes documents and changes to all the devices running an instance of your app with no explicit user intervention.

There are two kinds of storage in iCloud: document storage and key-value data storage. Document storage is designed for storing large amounts of data such as that in a document file. Key-value storage is designed for small amounts of app data such as configuration data. For example, you might store the text and illustrations for a book in document storage, and you might store the reader's page location in key-value storage. That way, whenever the user opens the document on any device, the correct page is displayed.

Documents and key-value data designated for storage in iCloud are transferred to iCloud and to the user's other computers as soon as possible. On iOS devices, only file metadata is transferred from iCloud to devices as soon as possible, while the file data itself is transferred on demand. Once data has been stored initially in iCloud, only changes are transferred thereafter, to make synchronization most efficient.

`NSDocument` implements file coordination, version management, and conflict resolution among documents, so it provides the easiest path to using iCloud. For details explaining how to handle document storage in iCloud, see Moving Document Data to and from iCloud (page 40).

The Document Architecture Supports App Sandbox

The document architecture helps document-based apps adopt App Sandbox, an access control technology that provides a last line of defense against stolen, corrupted, or deleted user data if malicious code exploits your app. The `NSDocument` class automatically works with Powerbox to make items available to your app when the user opens and saves documents or uses drag and drop. `NSDocument` also provides support for keeping documents within your sandbox if the user moves them using the Finder. For more information about App Sandbox, see *App Sandbox Design Guide* .

Considerations for Designing Your Document Data Model

Your document data model is an object or graph of interconnected objects that contain the data displayed and manipulated by your document objects.

Cocoa Uses the Model-View-Controller Design Pattern

The Cocoa document architecture and many other technologies throughout Cocoa utilize the Model-View-Controller (MVC) design pattern. Model objects encapsulate the data specific to an app and manipulate and process that data. View objects display data from the app's model objects and enable the editing of that data by users. Controller objects act as intermediaries between the app's view objects and model objects. By separating these behaviors into discrete objects, your app code tends to be more reusable, the object interfaces are better defined, and your app is easier to maintain and extend. Perhaps most importantly, MVC-compliant app objects fit seamlessly into the document architecture.

A Data Model Corresponds to a Document Type

A document object is a controller dedicated to managing the objects in the document's data model. Each document object is a custom subclass of `NSDocument` designed specifically to handle a particular type of data model. Document-based apps are able to handle one or more types of documents, each with its own type of data model and corresponding `NSDocument` subclass. Apps use an information property list file, which is stored in the app's bundle and named, by default, `<appName>-Info.plist`, to specify information that can be used at runtime. Document-based apps use this property list to specify the document types the app can edit or view. For example, when the `NSDocumentController` object creates a new document or opens an existing document, it searches the property list for such items as the document class that handles a document type, the uniform type identifier (UTI) for the type, and whether the app can edit or only view the type. For more information about creating a property list for types of documents, see Complete the Information Property List (page 29).

Data Model Storage

Any objects that are part of the persistent state of a document should be considered part of that document's model. For example, the Sketch sample app has a subclass of `NSDocument` named `SKTDocument`. Objects of this class have an array of `SKTGraphic` objects containing the data that defines the shapes Sketch can draw, so they form the data model of the document. Besides the actual `SKTGraphic` objects, however, the `SKTDocument` object contains some additional data that should technically be considered part of the model, such as the order of the graphics within the document's array, which determines the front-to-back ordering of the `SKTGraphic` objects.

Like any document-based app, Sketch is able to write the data from its data model to a file and vice versa. The reading and writing are the responsibility of the `SKTDocument` object. Sketch implements the `NSDocument` data-based writing method that flattens its data model objects into an `NSData` object before writing it to a file. Conversely, it also implements the data-based `NSDocument` reading method to reconstitute its data model in memory from an `NSData` object it reads from one of its document files.

There are three ways you can implement data reading and writing capabilities in your document-based app:

- **Reading and writing native object types.** `NSDocument` has methods that read and write `NSData` and `NSFileWrapper` objects natively. You must override at least one writing method to convert data from the document model's internal data structures into an `NSData` object or `NSFileWrapper` object in preparation for writing to a file. Conversely, you must also override at least one reading method to convert data from an `NSData` or `NSFileWrapper` object into the document model's internal data structures in preparation for displaying the data in a document window. See Creating the Subclass of NSDocument (page 35) for more details about document reading and writing methods.
- **Using Core Data.** If you have a large data set or require a managed object model, you may want to use `NSPersistentDocument` to create a document-based app that uses the Core Data framework. Core Data is a technology for object graph management and persistence. One of the persistent stores provided by Core Data is based on SQLite. Although Core Data is an advanced technology requiring an understanding of Cocoa fundamental design patterns and programming paradigms, it brings many benefits to a document-based app, such as:
  - Incremental reading and writing of document data
  - Data compatibility for apps with iOS and OS X versions

  For more information, see *Core Data Starting Point* .
- **Custom object formats.** If you need to read and write objects without using `NSData` and `NSFileWrapper`, you can override other `NSDocument` methods to do so, but your code needs to duplicate what `NSDocument` does for you. Naturally, this means your code will have greater complexity and a greater possibility of error.

Handling a Shared Data Model in OS X and iOS

Using iCloud, a document can be shared between document-based apps in OS X and iOS. However, there are differences between the platforms that you must take into consideration. For an app to edit the same document in iOS and OS X, the document-type information should be consistent. Other cross-platform considerations for document-data compatibility are:

- Some technologies are available on one platform but not the other. For example, if you use rich text format (RTF) as a document format in OS X, it won't work in iOS because its text system doesn't have built-in support for rich text format (although you can implement that support in your iOS app).
- The default coordinate system for each platform is different, which can affect how content is drawn. See "Default Coordinate Systems and Drawing in iOS" in *Drawing and Printing Guide for iOS* for a discussion of this topic.
- If you archive a document's model object graph, you may need to perform suitable conversions using `NSCoder` methods when you encode and decode the model objects.
- Some corresponding classes are incompatible across the platforms. That is, there are significant differences between the classes representing colors (`UIColor` and `NSColor`), images (`UIImage` and `NSImage`), and Bezier paths (`UIBezierPath` and `NSBezierPath`). `NSColor` objects, for example, are defined in terms of a color space (`NSColorSpace`), but there is no color space class in UIKit.

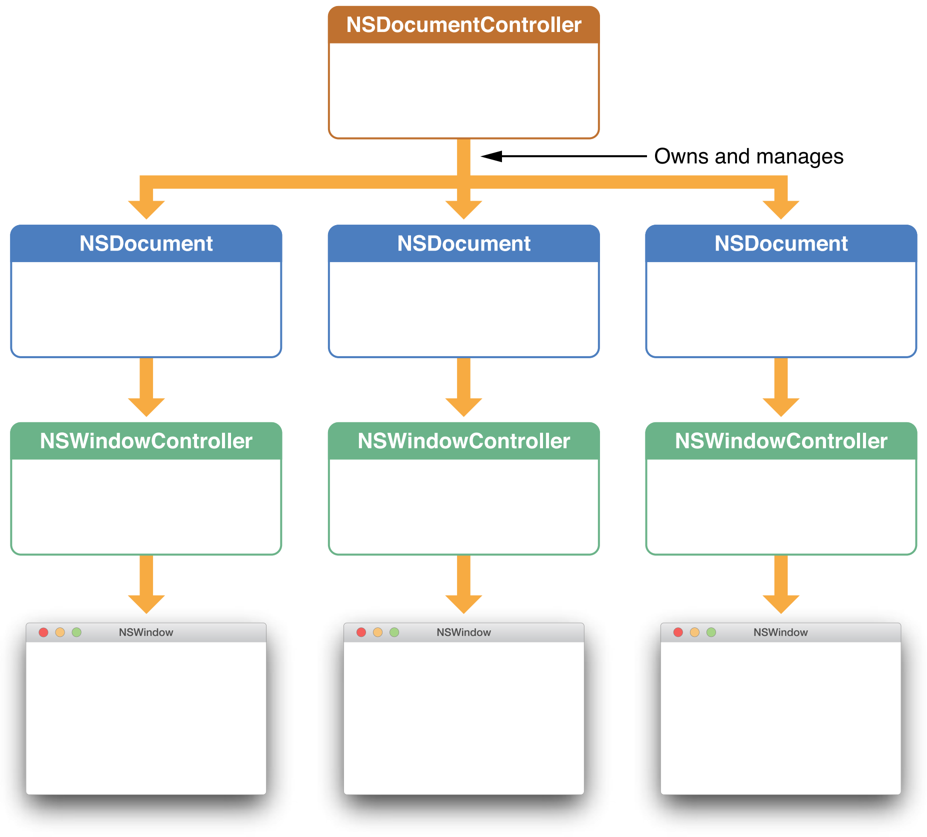
These cross-platform issues affect the way you store document data in the file that is shared between OS X and iOS as an iCloud document. Both versions of your app must be able to reconstitute a usable in-memory data model that is appropriate to its platform, using the available technologies and classes, without losing any fidelity. And, of course, both versions must be able to convert their platform-specific data model structures into the shared file format.

One strategy you can use is to drop down to a lower-level framework that is shared by both platforms. For example, on the iOS side, `UIColor` defines a `CIColor` property holding a Core Image object representing the color; on the OS X side, your app can create an `NSColor` object from the `CIColor` object using the `colorWithCIColor:` class method.

The Classes That Support Document-Based Apps

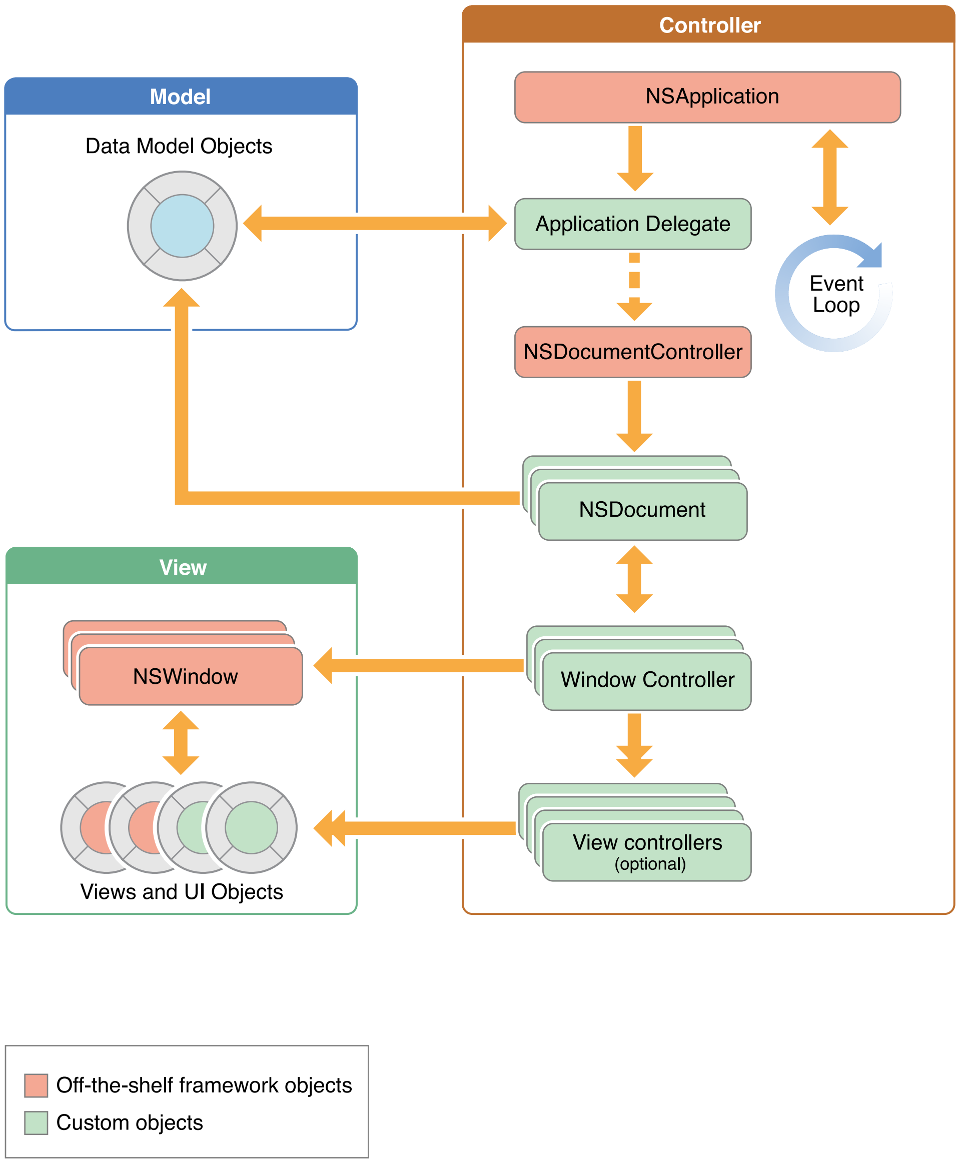
There are three major classes in the document architecture: `NSDocumentController`, `NSDocument`, and `NSWindowController`. Objects of these classes divide and orchestrate the work of creating, saving, opening, and managing the documents of an app. They are arranged in a tiered one-to-many relationship, as depicted in Figure 2-1. An app can have only one `NSDocumentController` object, which creates and manages one or more `NSDocument` objects (one for each New or Open operation). In turn, an `NSDocument` object creates and manages one or more `NSWindowController` objects, one for each of the windows displayed for a document. In addition, some of these objects have responsibilities analogous to `NSApplication` and `NSWindow` delegates, such as approving major events like closing and quitting.

Figure 2-1 Relationships among `NSDocumentController`, `NSDocument`, and `NSWindowController` objects



A Cocoa app includes a number of key objects in addition to the three major types of objects of the document architecture. Figure 2-2 shows how these objects fit into the overall Cocoa object infrastructure.

Figure 2-2 Key objects in a document-based app



NSDocumentController Creates and Manages Documents

An app's `NSDocumentController` object manages the documents in an app. In the MVC design pattern, an `NSDocumentController` object is a **high-level controller.** It has the following primary responsibilities:

- Creates empty documents in response to the New item in the File menu
- Creates documents initialized with data from a file in response to the Open item in the File menu

- Tracks and manages those documents
- Handles document-related menu items, such as Open Recent

When a user chooses New from the File menu, the `NSDocumentController` object gets the appropriate `NSDocument` subclass from the app's Information property list and allocates and initializes an instance of this class. Likewise, when the user chooses Open, the `NSDocumentController` object displays the Open dialog, gets the user's selection, finds the `NSDocument` subclass for the file, allocates an instance of the class, and initializes it with data from the file. In both cases, the `NSDocumentController` object adds a reference to the document object to an internal list to help manage its documents.

Most of the time, you can use `NSDocumentController` as is to manage your app's documents. `NSDocumentController` is hard-wired to respond appropriately to certain app events, such as when the app starts up, when it terminates, when the system is shutting down, and when documents are opened or printed. Alternatively, you can create a custom delegate object and implement the delegate methods corresponding to the same events (see *NSApplicationDelegate Protocol Reference*).

NSDocument Presents and Stores Document Data

`NSDocument` is the base class for document objects in the app architecture—you must create an `NSDocument` subclass for each type of document your app handles. When your app is running, it has an `NSDocument`-based object for each open document. In the MVC design pattern, `NSDocument` is a **model controller** because it manages the data model, that is, the persistent data associated with its document. An `NSDocument` object has the following responsibilities:

- Manages the display and capture of the data in its windows (with the assistance of its window controllers)
- Loads and stores (that is, reads and writes) the persistent data associated with its document
- Responds to action messages to save, print, revert, and close documents
- Runs and manages the Save and Page Setup dialogs

A fully implemented `NSDocument` object also knows how to track its edited status, perform undo and redo operations, print document data, and validate its menu items. Although these behaviors aren't completely provided by default, the `NSDocument` object does assist the developer in implementing each, in the following ways:

- For tracking edited status, `NSDocument` provides a method for updating a change counter.
- For undo and redo operations, `NSDocument` lazily creates an `NSUndoManager` instance when one is requested, responds appropriately to Undo and Redo menu commands, and updates the change counter when undo and redo operations are performed.

- For printing, `NSDocument` facilitates the display of the Page Setup dialog and the subsequent modification of the `NSPrintInfo` object used in printing. To do this, subclasses of `NSDocument` must override `printOperationWithSettings:error:`.
- To validate menu items, `NSDocument` implements `validateUserInterfaceItem:` to manage the enabled state and titles of the menu items Revert Document and Save (which becomes Save a Version after the document is first saved). If you want to validate other menu items, you can override this method, but be sure to invoke the superclass implementation. For more information on menu item validation, see *NSUserInterfaceValidations Protocol Reference*.

When designing your document objects, you should always maintain a clean separation between these data-handling activities of the document object itself and the code for managing the visual presentation of that data. The document object is responsible for the data, including the reading and writing of that data to disk. The visual presentation of that data is the responsibility of the associated window controller object. Keeping a clean separation between these two activities makes for a more modular design that can be updated more easily in the future.

Nonetheless, managing the document's data and its user interface are closely related, which is why the document object owns and manages its window controllers. The document object also manages its menu, which is part of the user interface, because the state of its user commands—what commands are available and whether they are enabled—is determined by the state of the document data.

An `NSDocument` object should not contain or require the presence of any objects that are specific to the app's user interface. Although a document can own and manage `NSWindowController` objects—which present the document visually and allow the user to edit it—it should not depend on these objects being there. For example, it might be desirable to have a document open in your app without having it visually displayed.

For details about subclassing `NSDocument`, see Creating the Subclass of NSDocument (page 35).

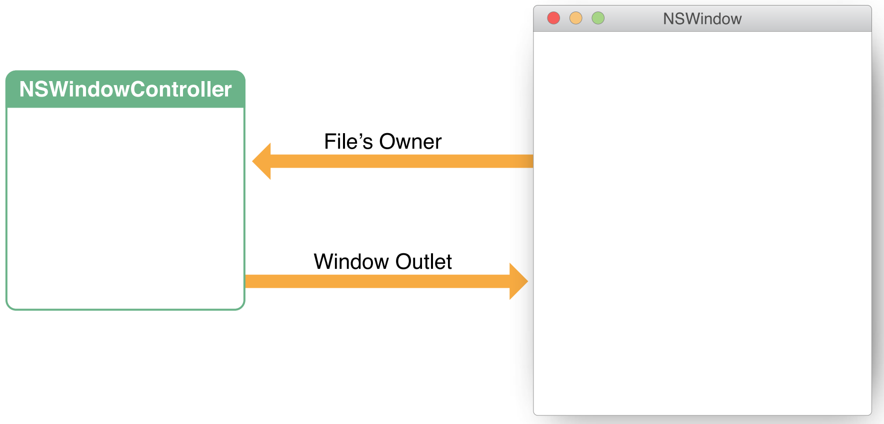
If you have a large data set or require a managed object model, you may want to use `NSPersistentDocument`, a subclass of `NSDocument`, to create a document-based app that uses Core Data. For more information, see *Core Data Starting Point*.

NSWindowController Manages One Document Window

An `NSWindowController` object manages one window associated with a document. That window is typically stored in a nib file. As such, in the MVC design pattern, it is a **view controller.** When an `NSWindowController` object receives a request from its owning `NSDocument` object, it loads the nib file containing a window, displays the window, and sets itself as the File's Owner of the nib file. It also assumes responsibility for closing windows properly.

A window controller keeps track of its window using its window outlet. The window outlet should be connected to the window for which your window controller is responsible, as shown in Figure 2-3.

Figure 2-3 Window outlet of window controller



Although not required, it’s often convenient to set up your window controller as the delegate of the window it manages. In your nib file, connect the delegate outlet of the window your window controller is managing to the object that represents your window controller—specifically, the File’s Owner object.

Note: `NSWindowController` does not depend on being the controlled window's delegate to do its job, and it doesn't implement any `NSWindow` delegate methods. A subclass of `NSWindowController`, however, is a fine place to put implementations of `NSWindow` delegate methods, and if you do so you'll probably need to connect the delegate outlet of the window to the File's Owner of the nib file as described. But you do not have to do so for `NSWindowController` itself to work properly.

The Xcode document-based app template does not subclass `NSWindowController`, and you do not need to do so if you are writing a simple app. However, if you are writing an app with more advanced requirements, as is typical, you will almost certainly want to do so. In addition, subclassing `NSWindowController` promotes better encapsulation of your view and model code. For more information, see You Should Subclass NSWindowController (page 22).

Subclassing Objects in the Document Architecture

You can create a document-based app without writing much code. You have only to create a document project, compose the human interface, implement a subclass of `NSDocument`, and add any other custom classes or behavior required by your app. However, most app requirements are more complex, so you can customize the default object architecture through subclassing and delegation, as described in this section.

Table 2-1 summarizes the object architecture and subclass requirements of a document-based app.

Table 2-1 Document architecture objects and subclasses

Class	Number of objects	Subclassing
`NSDocument`	1 per document	Required
`NSWindowController`	1 per window	Optional (but recommended)
`NSDocumentController`	1 per app	Optional (and unlikely)

You Must Subclass NSDocument

Every app that uses the document architecture must create at least one subclass of `NSDocument`. To create a document-based Cocoa app, you choose the Xcode template for a Cocoa application presented in the New Project dialog and select the option Create Document-Based Application in the next pane. When you do this, you get a new app project that already contains a subclass of `NSDocument` and nib files for your document and app menu. Minimal or empty method implementations are provided for:

- **Reading and writing document data.** Comments explain what you need to fill in, how to handle an error condition, and alternate reading and writing methods to override instead. The method bodies include code that throws an "unimplemented method" exception if you don't change anything.
- **Initialization of the document object.** The implementation contains the proper Cocoa initialization pattern, which calls the superclass initializer and provides a place for subclass-specific initialization.
- **Returning the document nib file name.** This code overrides the `windowNibName` method to return the nib file name used for documents of this type. Comments explain situations where you should do alternate overrides.
- **Post-nib-loading code.** This override provides a place for code to be executed after the document window nib file is loaded. For example, objects in the nib cannot be initialized until after the nib is loaded.
- **Opting into autosaving.** By leaving this override as written in the template to return `YES`, you ensure that your document saves its data to disk automatically.

See Creating the Subclass of NSDocument (page 35) for information about implementing the required methods in your `NSDocument` subclass.

You Should Subclass NSWindowController

Even if your document has only one window, it may be complex enough that you'd like to split up some of the logic in the controller layer to have a view controller as well as a model controller object. In this case, you should subclass `NSWindowController` as well as `NSDocument`. In this way, you can add specific knowledge of the app's view layer that the window controller is responsible for managing. Any outlets and actions, and any other behavior that is specific to the management of the user interface, goes into the `NSWindowController` subclass. Especially for larger apps, splitting the controller duties between two classes makes a lot of sense. This strategy allows you to have documents that are open, but not onscreen, to avoid having to allocate memory and other resources of a front-end that may not be used in some circumstances.

Reasons to Subclass NSWindowController

If your document requires or allows multiple windows for a single document, that is a good reason to subclass `NSWindowController`. For example, a CAD program could need to present front, top, and side views, as well as a rendered 3D view of a document. When it does, you might want to have one or more subclasses of `NSWindowController` to manage the different kinds of windows that your document needs, and so you must create one of each in `makeWindowControllers`.

Some apps need only one window for a document but want to allow the user to create several copies of the window for a single document (sometimes this is called a multiple-view document) so that the user can have each window scrolled to a different position or displayed differently, such as at a different scale. In this case, your `makeWindowControllers` override would create only one `NSWindowController` object, and there would be a menu command or other control that allows the user to create others.

Another reason to subclass `NSWindowController` is to customize your document window titles. To customize a document's window title properly, subclass `NSWindowController` and override `windowTitleForDocumentDisplayName:`. If your app requires even deeper customization, override `synchronizeWindowTitleWithDocumentName`.

How to Subclass NSWindowController

Once you've decided to subclass `NSWindowController`, you need to change the default document-based app setup. First, add any Interface Builder outlets and actions for your document's user interface to the `NSWindowController` subclass instead of to the `NSDocument` subclass. The `NSWindowController` subclass instance should be the File's Owner for the nib file because that creates better separation between the view-related logic and the model-related logic. Some menu actions can still be implemented in the `NSDocument` subclass. For example, Save and Revert Document are implemented by `NSDocument`, and you might add other menu actions of your own, such as an action for creating new views on a document.

Second, instead of overriding `windowNibName` in your `NSDocument` subclass, override `makeWindowControllers`. In `makeWindowControllers`, create at least one instance of your custom `NSWindowController` subclass and use `addWindowController:` to add it to the document. If your document always needs multiple controllers, create them all here. If a document can support multiple views but by default has one, create the controller for the default view here and provide user actions for creating other views.

You should not force the windows to be visible in `makeWindowControllers`. `NSDocument` does that for you if it's appropriate.

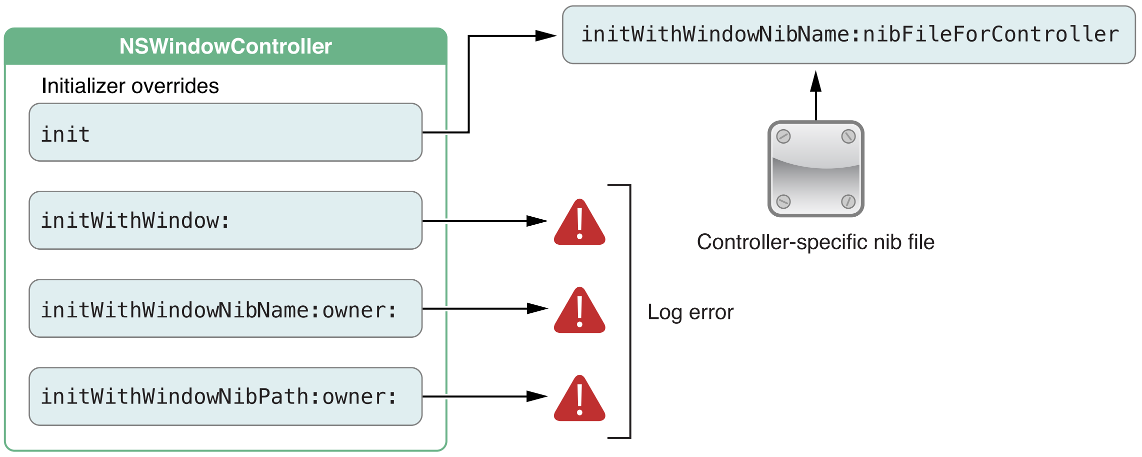
An NSWindowController Subclass Manages Nib Files

An `NSWindowController` object expects to be told what nib file to load (through its `initWithWindowNib...` methods) because it is a generic implementation of the default behavior for all window controllers. However, when you write a subclass of `NSWindowController`, that subclass is almost always designed to control the user interface contained in a particular nib file, and your subclass would not work with a different nib file. It is therefore inconvenient and error-prone for the instantiator of the subclass to have to tell it which nib file to load.

This problem is solved by overriding the `init` method to call the superclass's `initWithWindowNibName:` method with the correct nib name. Then instantiators just use `init`, and the controller has the correct nib file. You can also override the `initWithWindowNib...` methods to log an error, as shown in Figure 2-4, because no instantiator should ever try to tell your subclass which nib file to use. It is a good idea for any

`NSWindowController` subclass designed to work with a specific nib file to use this technique. You should do otherwise only if you are extending just the basic functionality of `NSWindowController` in your subclass and have not tied that functionality to any particular nib file.

Figure 2-4 Loading a nib file that is controller specific


NSWindowController
Initializer overrides
init
initWithWindow:
initWithWindowNibName:owner:
initWithWindowNibPath:owner:
initWithWindowNibName:nibFileForController
Controller-specific nib file
Log error

An `NSWindowController` object without an associated `NSDocument` object is useful by itself. `NSWindowController` can be used as the base class for auxiliary panel controllers in order to gain the use of its nib management abilities. One common standalone use of `NSWindowController` subclasses is as controllers for shared panels such as find panels, inspectors, or preferences panels. For example, the Sketch sample app uses `NSWindowController` subclasses for its various secondary panels. In this case, you can make an `NSWindowController` subclass that implements a "shared-instance" method to create a singleton window controller object. For example, you could create a `PreferencesController` subclass with a `sharedPreferenceController` class method that creates a single instance the first time it is called and returns that same instance on all subsequent calls.

Because your subclass derives from `NSWindowController`, you can just tell it the name of your preferences nib file and it handles loading the nib file and managing the window automatically. You add your own outlets and actions, as usual, to hook up the specific user interface for your panel and add methods to manage the panel's behavior.

You Rarely Need to Subclass NSDocumentController

Most apps do not need to subclass `NSDocumentController`. Almost anything that can be done by subclassing can be done just as easily by the app's delegate. However, it is possible to subclass `NSDocumentController` if you need to.

For example, if you need to customize the Open dialog, an `NSDocumentController` subclass is needed. You can override the `NSDocumentController` method `runModalOpenPanel:forTypes:` to customize the dialog or add an accessory view. The `addDocument:` and `removeDocument:` methods are provided for subclasses that want to know when documents are opened or closed.

There are two ways to subclass `NSDocumentController`:

- You can make an instance of your subclass in your app's main nib file. This instance becomes the shared instance.
- You can create an instance of your subclass in your app delegate's `applicationWillFinishLaunching:` method.

The first `NSDocumentController` object to be created becomes the shared instance. The AppKit framework creates the shared instance (using the `NSDocumentController` class) during the "finish launching" phase of app startup. So if you need a subclass instance, you must create it before AppKit does.

App Creation Process Overview

It is possible to put together a document-based app without having to write much code. You have only to create a document project, compose the human interface, complete the information property list for your document types, implement a subclass of `NSDocument`, and add any other custom classes or behavior required by your app.

If you intend to sell your app through the Mac App Store or use iCloud storage, you also need to create an explicit App ID, create provisioning profiles, and enable the correct entitlements for your app. These procedures are explained in *App Distribution Guide* .

Xcode Provides a Document-Based App Template

To expedite the development of document-based apps, Xcode provides a Cocoa Application template, which has the option to make the app document based. The template provides the following things:

- **A skeletal NSDocument subclass implementation.** The document subclass implementation (`.m`) file includes commented blocks for important methods, including an `init` method that initializes and returns `self`. This method provides a location for subclass-specific initialization. The template also includes a fully implemented `windowNibName` method that returns the name of the document window nib file. An override of `windowControllerDidLoadNib:` provides a place for code to be executed after the document's window nib has finished loading. In addition, the template includes skeletal implementations of the `dataOfType:error:` and `readFromData:ofType:error:` basic writing and reading methods; these methods throw an exception if you don't supply a working implementation. Finally, the template includes an override of the `autosavesInPlace` class method that returns `YES` to turn on automatic saving of changes to your documents.
- **A nib file for the app's document.** This nib file is named with your `NSDocument` subclass name with the extension `.xib`. The subclass of `NSDocument` is made File's Owner of the nib file. It has an outlet named `window` connected to its window object, which in turn has a delegate outlet connected to the File's Owner, as shown in Figure 2-3 (page 20). The window has only one user interface object in it initially, a text field with the words "Your document contents here".
- **The app's menu bar nib file.** The menu bar nib file, named `MainMenu.xib`, contains an app menu (named with the app's name), a File menu (with all of its associated document commands), an Edit menu (with text editing commands and Undo and Redo menu items), and Format, View, Window, and Help menus

(with their own menu items representing commands). These menu items are connected to the appropriate first-responder action methods. For example, the About menu item is connected to the `orderFrontStandardAboutPanel:` action method that displays a standard About window.

See Review Your App Menu Bar Commands (page 28) for more information about the menu bar nib file provided by the Xcode app templates.

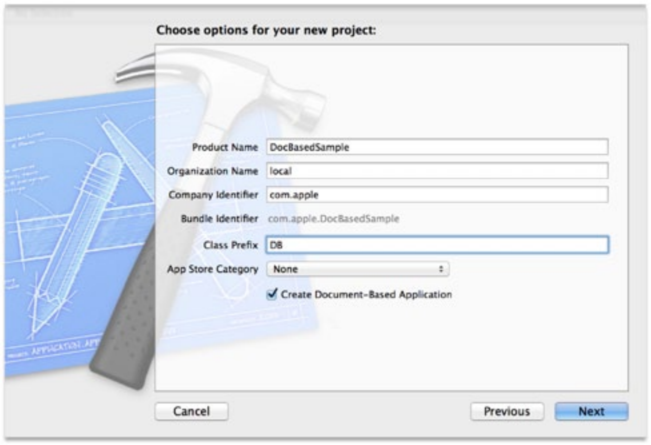
- **The app's information property list.** The `<appName>-Info.plist` file contains placeholder values for global app keys, as well as for the `CFBundleDocumentTypes` key, whose associated value is a dictionary containing key-value pairs specifying information about the document types the app works with, including the `NSDocument` subclass for each document type.

The following sections describe the process of selecting and utilizing the document-based app template.

Create the Project

To create your project in Xcode, choose File > New > New Project. Select the Cocoa Application icon from the OS X Application choices. In the next pane, select the Create Document-Based Application option, as shown in Figure 3-1. In this pane you also name your app, give your `NSDocument` subclass a prefix, and specify your documents' filename extension, in addition to other options. If you intend to use Core Data for your data model, select the Use Core Data option, which automatically inserts `NSPersistentDocument` as the immediate superclass of your document subclass.

Figure 3-1 New Project dialog


Choose options for your new project:

Product Name	DocBasedSample
Organization Name	local
Company Identifier	com.apple
Bundle Identifier	com.apple.DocBasedSample
Class Prefix	DB
App Store Category	None

✓ Create Document-Based Application

The final pane of the New Project dialog enables you to place your project in the file system and create a source control repository if you wish. For more details about the Xcode project creation process, see Start a Project in *Xcode Overview*.

Without writing any additional code, you can compile and run the app. When you first launch the app, you see an untitled document with an empty window. The File menu commands all do something reasonable, such as bringing up a Save dialog or Open dialog. Because you have not yet defined any types or implemented loading and saving, you can't open or save anything, and the default implementations throw an exception.

Create Your Document Window User Interface

To create the user interface for your document window, in the project navigator area, click the nib file named with your `NSDocument` subclass name with the extension `.xib`. This opens the file in Interface Builder, an Xcode editor that provides a graphical interface for the creation of user interface files. You can drag user interface elements onto the document window representation from the Interface Builder Object library in the utility area. If the objects in the document window require outlets and actions, add them to your `NSDocument` subclass. Connect these actions and outlets via the File's Owner icon in the list of placeholders in the Interface Builder dock. If your document objects interact with other custom objects, such as model objects that perform specialized computations, define those objects in Interface Builder and make any necessary connections to them.

Step-by-step instructions for connecting menu items to action methods in your code are given in Edit User Interfaces in *Xcode Overview* .

Review Your App Menu Bar Commands

Table 3-1 lists the File menu first-responder action connections that exist in the template.

Table 3-1 File Menu commands in the document-based app template

File menu command	First-responder action
New	`newDocument:`
Open	`openDocument:`
Open Recent > Clear Menu	`clearRecentDocuments:`
Close	`performClose:`
Save/Save a Version	`saveDocument:`
Revert Document	`revertDocumentToSaved:`
Page Setup	`runPageLayout:`

File menu command	First-responder action
Print	`printDocument:`

After a document has been saved for the first time, the Save command changes to Save a Version. In applications that have enabled autosaving in place, the Save As and Save All items in the File menu are hidden, and a Duplicate menu item is added. The template has similar ready-made connections for the Edit, Format, View, Window, and Help menus.

Warning: If your app does not support any of the supplied actions, such as printing, for example, you must remove the associated menu items from the nib. Otherwise, when a user chooses the action, your app could raise an exception or crash.

For your app's custom menu items that are not already connected to action methods in objects or placeholder objects in the nib file, there are two common techniques for handling menu commands in an OS X app:

- Connect the corresponding menu item to a first responder method.
- Connect the menu item to a method of your custom app object or your app delegate object.

Of these two techniques, the first is more common because many menu commands act on the current document or its contents, which are part of the responder chain. The second technique is used primarily to handle commands that are global to the app, such as displaying preferences or creating a new document. In addition to implementing action methods to respond to your menu commands, you must also implement the methods of the `NSMenuValidation` protocol to enable the menu items for those commands.

For more information about menu validation and other menu topics, see *Application Menu and Pop-up List Programming Topics* .

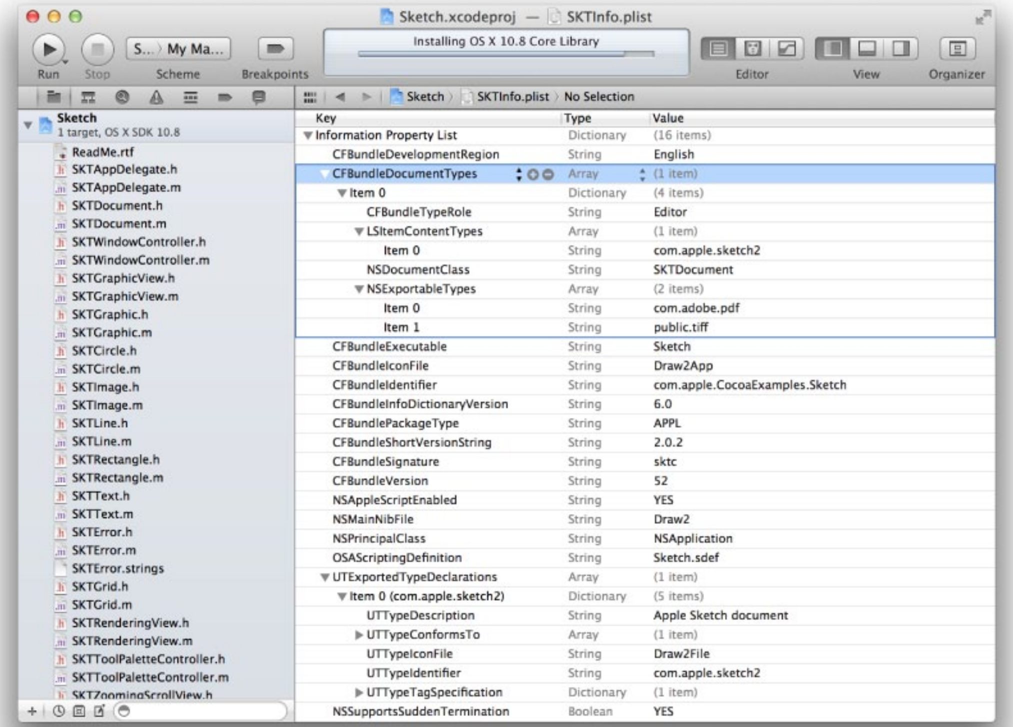
Complete the Information Property List

You need to configure the project's information property list so that the app knows what kinds of documents it can handle. You specify this information in the Xcode information property list file, which is shown in Figure 3-2. The property list file is stored in the app's bundle and named `<appName>-Info.plist` by default.

When the `NSDocumentController` object creates a new document or opens an existing document, it searches the property list for such items as the document class that handles a document type, the uniform type identifier (UTI) for the type, and whether the app can edit or only view the type. Similarly, Launch Services uses information about the icon file for the type and to know which app to launch when the user double-clicks a document file. Document type information is associated with the `CFBundleDocumentTypes` key as an array of dictionaries, each of which contains the key-value pairs that define the document type.

Xcode provides a property list file with every Mac app project. The property list editor appears when you select the `Info.plist` file in the project navigator or select the target and choose the Info pane of the project editor. In the Info pane, there's a list of target properties. You can edit the property values and add new key-value pairs. By default, Xcode displays a user-friendly version of each key name. To see the actual key names that are in the `Info.plist` file, Control-click an item in the editor and choose Show Raw Keys/Values from the contextual menu that appears.

Figure 3-2 The information property list editor



Key	Type	Value
▼ Information Property List	Dictionary	(16 items)
CFBundleDevelopmentRegion	String	English
▼ CFBundleDocumentTypes	Array	(1 item)
▼ Item 0	Dictionary	(4 items)
CFBundleTypeRole	String	Editor
▼ LSItemContentTypes	Array	(1 item)
Item 0	String	com.apple.sketch2
NSDocumentClass	String	SKTDocument
▼ NSExportableTypes	Array	(2 items)
Item 0	String	com.adobe.pdf
Item 1	String	public.tiff
CFBundleExecutable	String	Sketch
CFBundleIconFile	String	Draw2App
CFBundleIdentifier	String	com.apple.CocoaExamples.Sketch
CFBundleInfoDictionaryVersion	String	6.0
CFBundlePackageType	String	APPL
CFBundleShortVersionString	String	2.0.2
CFBundleSignature	String	sktc
CFBundleVersion	String	52
NSAppleScriptEnabled	String	YES
NSMainNibFile	String	Draw2
NSPrincipalClass	String	NSApplication
OSAScriptingDefinition	String	Sketch.sdef
▼ UTExportedTypeDeclarations	Array	(1 item)
▼ Item 0 (com.apple.sketch2)	Dictionary	(5 items)
UTTypeDescription	String	Apple Sketch document
▶ UTTypeConformsTo	Array	(1 item)
UTTypeIconFile	String	Draw2File
UTTypeIdentifier	String	com.apple.sketch2
▶ UTTypeTagSpecification	Dictionary	(1 item)
NSSupportsSuddenTermination	Boolean	YES

For a new document-based app, you should create a document type with a name and extension that make sense for your app. You can add more types as well, one for each of the document types your app handles. The app's most important document type must be listed first in the list of types. This is the type that `NSDocumentController` uses by default when the user asks for a new document.

The most important document type value is its Uniform Type Identifier (UTI), a string that uniquely identifies the type of data contained in the document for all apps and services to rely upon. A document's UTI corresponds to the `LSItemContentTypes` key in the information property list. The UTI is used as the programmatic type name by `NSDocument` and `NSDocumentController`. By using UTIs, apps avoid much of the complexity previously required to handle disparate kinds of file-type information in the system, including filename extensions, MIME types, and HFS type codes (OS types).

A document UTI can be defined by the system, as shown in System-Declared Uniform Type Identifiers in *Uniform Type Identifiers Reference*, or a document-based app can declare its own proprietary UTI. Such custom UTIs must also be exported to make the system aware of them, as described in Export Custom Document Type Information (page 32).

To declare a document type in Xcode, perform the following steps:

1. Select the project in the project navigator.
2. Select the target and click the Info tab.
3. Click the Add (+) button at the bottom right of the editor area and choose Add Document Type from the pop-up menu.
4. Click the triangle next to "Untitled" to disclose the property fields.

Alternatively, you can select the `Info.plist` file in the project navigator, click in the editor area, and choose Editor > Add Item to add document type properties directly to the property list file, as shown in Figure 3-2 (page 30). Choose Editor > Show Raw Keys & Values to reveal the actual key names.

Add the properties shown in Table 3-2.

Table 3-2 Properties defining a document type (`CFBundleDocumentTypes`)

Key	Xcode field (Info.plist identifier)	Value
`LSItemContentTypes`	Identifier	An array of UTI strings. Typically, only one is specified per document type. The UTI string must be spelled out explicitly.
`NSDocumentClass`	Class (Cocoa NSDocument Class)	A string specifying the `NSDocument` subclass name corresponding to this document type.
`CFBundleTypeRole`	Role	A string specifying the role the app with respect to this document type. Possible values are Editor, Viewer, Shell, Quick Look Generator, or None.

Key	Xcode field (Info.plist identifier)	Value
`NSExportableTypes`	(Exportable Type UTIs)	An array of strings specifying UTIs that define a supported file type to which this document can export its content.
`LSTypeIsPackage`	Bundle (Document is a package or bundle)	A Boolean value specifying whether the document is distributed as a bundle. If `NO`, omit this value.
`CFBundleTypeIconFile`	Icon (Icon File Name)	A string specifying the name of the icon resource file (extension `.icns`) to associate with this document type. An icon resource file contains multiple images at different resolutions.
`CFBundleTypeName`	Name (Document Type Name)	A string specifying the abstract name of the document type.
`LSHandlerRank`	Handler rank	A string specifying how Launch Services ranks this app among those that declare themselves editors or viewers of documents of this type. Possible values, in order of precedence, are `Owner`, `Alternate`, and `None`.

For more information about these and other document type keys, see "CFBundleDocumentTypes" in *Information Property List Key Reference* .

Export Custom Document Type Information

If you define a custom document type with its own UTI, you must export the UTI. To declare a document type in Xcode, perform the following steps:

1. Select the project in the project navigator area.
2. Select the target and click the Info tab.
3. Click the Add (+) button at the bottom right of the editor area and choose Add Exported UTI from the pop-up menu.
4. Click the triangle next to "Untitled" to disclose the property fields.

Add the properties shown in Table 3-3.

Table 3-3 Properties defining an exported document type (`UTExportedTypeDeclarations`)

Key	Xcode field (Info.plist identifier)	Value
`UTTypeDescription`	Description	A string describing this document type.
`UTTypeIdentifier`	Identifier	The exported document type's UTI.
`UTTypeIconFile`	Icon (Icon file name)	A string specifying the name of the document type's icon file.
`UTTypeConformsTo`	Conforms to (Conforms to UTIs)	An array of strings representing the UTIs to which the document type conforms.
`UTTypeTag-Specification`	Extensions (Equivalent Types)	An array of strings named `public.filename-extension` containing filename extensions corresponding to the document type.

For more information about these and other exported type property keys, see Declaring New Uniform Type Identifiers in *Uniform Type Identifiers Overview* .

For information about document types in alternate document-based app designs, see Multiple Document Types Use Multiple NSDocument Subclasses (page 62) and Additional Document Type Considerations (page 63).

Implement the NSDocument Subclass

Every document-based app that uses the document architecture must create at least one subclass of `NSDocument`. You must override some `NSDocument` methods (among several choices), and you should override several others in certain situations. Details explaining how to implement your `NSDocument` subclass are in Creating the Subclass of NSDocument (page 35).

Create Any Additional Custom Classes

The Cocoa document architecture, as embodied primarily in `NSDocument`, `NSDocumentController`, and `NSWindowController`, provides an operating framework for apps, including sophisticated document handling mechanisms. However, you must add the behaviors that differentiate your app and suit it to its particular purpose. Much customized behavior can be implemented in your `NSDocument` subclass, in delegate methods, custom classes added to your project, and subclasses of `NSDocumentController` and `NSWindowController` if you need to extend the capabilities of either of those classes. Generally, you should use custom classes to encapsulate the program logic of your data model and controllers, maintaining a healthy MVC separation.

For more information about app design, see *Mac App Programming Guide* .

Creating the Subclass of NSDocument

The `NSDocument` subclass provides storage for the model and the ability to load and save document data. It also has any outlets and actions required for the user interface. The `NSDocument` object automatically creates an `NSWindowController` object to manage that nib file, but the `NSDocument` object serves as the File's Owner proxy object for the nib file.

When you subclass `NSDocument`, you must override certain key methods and implement others to do at least the following things:

- Read data of existing documents from files
- Write document data to files
- Initialize new documents
- Put documents into iCloud and remove them

In particular, you must override one reading and one writing method. In the simplest case, you can override the data-based reading and writing methods, `readFromData:ofType:error:` and `dataOfType:error:`.

Reading Document Data

Opening existing documents stored in files is one of the most common operations document-based apps perform. Your override's responsibility is to load the file data into your app's data model.

If it works for your application, you should override the data-based reading method, `readFromData:ofType:error:`. Overriding that method makes your work easier because it uses the default document-reading infrastructure provided by `NSDocument`, which can handle multiple cases on your behalf.

Note: You should disable undo registration during document reading.

How to Override the Data-Based Reading Method

You can override the `readFromData:ofType:error:` method to convert an `NSData` object containing document data into the document's internal data structures and display that data in a document window. The document architecture calls `readFromData:ofType:error:`, passing in the `NSData` object, during its document initialization process.

Listing 4-1 shows an example implementation of the `readFromData:ofType:error:` document-reading method. This example assumes that the app has an `NSTextView` object configured with an `NSTextStorage` object to hold the text view's data. The `NSDocument` object has a `setMString:` accessor method for the document's `NSAttributedString` data model, declared as a property named `mString`.

Listing 4-1 Data-based document-reading method implementation

```
- (BOOL)readFromData:(NSData *)data ofType:(NSString *)typeName
                                  error:(NSError **)outError {
    BOOL readSuccess = NO;
    NSAttributedString *fileContents = [[NSAttributedString alloc]
            initWithData:data options:NULL documentAttributes:NULL
            error:outError];
    if (!fileContents && outError) {
        *outError = [NSError errorWithDomain:NSCocoaErrorDomain
                                 code:NSFileReadUnknownError userInfo:nil];
    }
    if (fileContents) {
        readSuccess = YES;
        [self setMString:fileContents];
    }
    return readSuccess;
}
```

If you need to deal with the location of the file, override the URL reading and writing methods instead. If your app needs to manipulate document files that are file packages, override the file-wrapper reading and writing methods instead. For information about overriding the URL-based and file-wrapper-based reading methods, see Overriding the URL and File Package Reading Methods (page 57).

The flow of messages during document data reading is shown in Figure 6-5 (page 69).

It's Easy to Support Concurrent Document Opening

A class method of `NSDocument`, `canConcurrentlyReadDocumentsOfType:`, enables your `NSDocument` subclass to load documents concurrently, using background threads. This override allows concurrent reading of multiple documents and also allows the app to be responsive while reading a large document. You can override `canConcurrentlyReadDocumentsOfType:` to return `YES` to enable this capability. When you do, `initWithContentsOfURL:ofType:error:` executes on a background thread when opening files via the Open dialog or from the Finder.

The default implementation of this method returns `NO`. A subclass override should return `YES` only for document types whose reading code can be safely executed concurrently on non-main threads. If a document type relies on shared state information, you should return `NO` for that type.

Don't Rely on Document-Property Getters in Overrides of Reading Methods

Don't invoke `fileURL`, `fileType`, or `fileModificationDate` from within your overrides. During reading, which typically happens during object initialization, there is no guarantee that `NSDocument` properties like the file's location or type have been set yet. Your overridden method should be able to determine everything it needs to do the reading from the passed-in parameters. During writing, your document may be asked to write its contents to a different location or using a different file type.

If your override cannot determine all of the information it needs from the passed-in parameters, consider overriding another method. For example, if you see the need to invoke `fileURL` from within an override of `readFromData:ofType:error:`, you should instead override `readFromURL:ofType:error:` and use the passed-in URL value.

Writing Document Data

In addition to implementing a document-reading method, you must implement a document-writing method to save your document data to disk. In the simplest case, you can override the data-based writing method, `dataOfType:error:`. If it works for your application, you should override `dataOfType:error:`. Overriding that method makes your work easier because it uses the default document-reading infrastructure provided by `NSDocument`. The responsibility of your override of the `dataOfType:error:` method is to create and return document data of a supported type, packaged as an `NSData` object, in preparation for writing that data to a file.

Listing 4-2 shows an example implementation of `dataOfType:error:`. As with the corresponding example implementation document-reading method, this example assumes that the app has an `NSTextView` object configured with an `NSTextStorage` object to hold the document's data. The document object has an outlet property connected to the `NSTextView` object and named `textView`. The document object also has synthesized `mString` and `setMString:` accessors for the document's `NSAttributedString` data model, declared as a property named `mString`.

Listing 4-2 Data-based document-writing method implementation

```
- (NSData *)dataOfType:(NSString *)typeName error:(NSError **)outError {
    NSData *data;
    [self setMString:[self.textView textStorage]]; // Synchronize data model with
 the text storage
    NSMutableDictionary *dict = [NSDictionary
dictionaryWithObject:NSRTFTextDocumentType

forKey:NSDocumentTypeDocumentAttribute];
    [self.textView breakUndoCoalescing];
    data = [self.mString dataFromRange:NSMakeRange(0, [self.mString length])
                   documentAttributes:dict error:outError];
    if (!data && outError) {
        *outError = [NSError errorWithDomain:NSCocoaErrorDomain
                                code:NSFileWriteUnknownError userInfo:nil];
    }
    return data;
}
```

The override sends the `NSTextView` object a `breakUndoCoalescing` message when saving the text view's contents to preserve proper tracking of unsaved changes and the document's dirty state.

If your app needs access to document files, you can override `writeToURL:ofType:error:` instead. If your document data is stored in file packages, you can override `fileWrapperOfType:error:` instead. For information about overriding the other `NSDocument` writing methods, see Overriding the URL and File Package Writing Methods (page 60).

The actual flow of messages during this sequence of events is shown in detail in Figure 6-6 (page 70).

Initializing a New Document

The `init` method of `NSDocument` is the designated initializer, and it is invoked by the other initializers `initWithType:error:` and `initWithContentsOfURL:ofType:error:`. If you perform initializations that must be done when creating new documents but not when opening existing documents, override `initWithType:error:`. If you have any initializations that apply only to documents that are opened, override `initWithContentsOfURL:ofType:error:`. If you have general initializations, override `init`. In all three cases, be sure to invoke the superclass implementation as the first action.

If you override `init`, make sure that your override never returns `nil`. Returning `nil` could cause a crash (in some versions of AppKit) or present a less than useful error message. If, for example, you want to prevent the creation or opening of documents under circumstances unique to your app, override a specific `NSDocumentController` method instead. That is, you should control this behavior directly in your app-level logic (to prevent document creation or opening in certain cases) rather than catching the situation after document initialization has already begun.

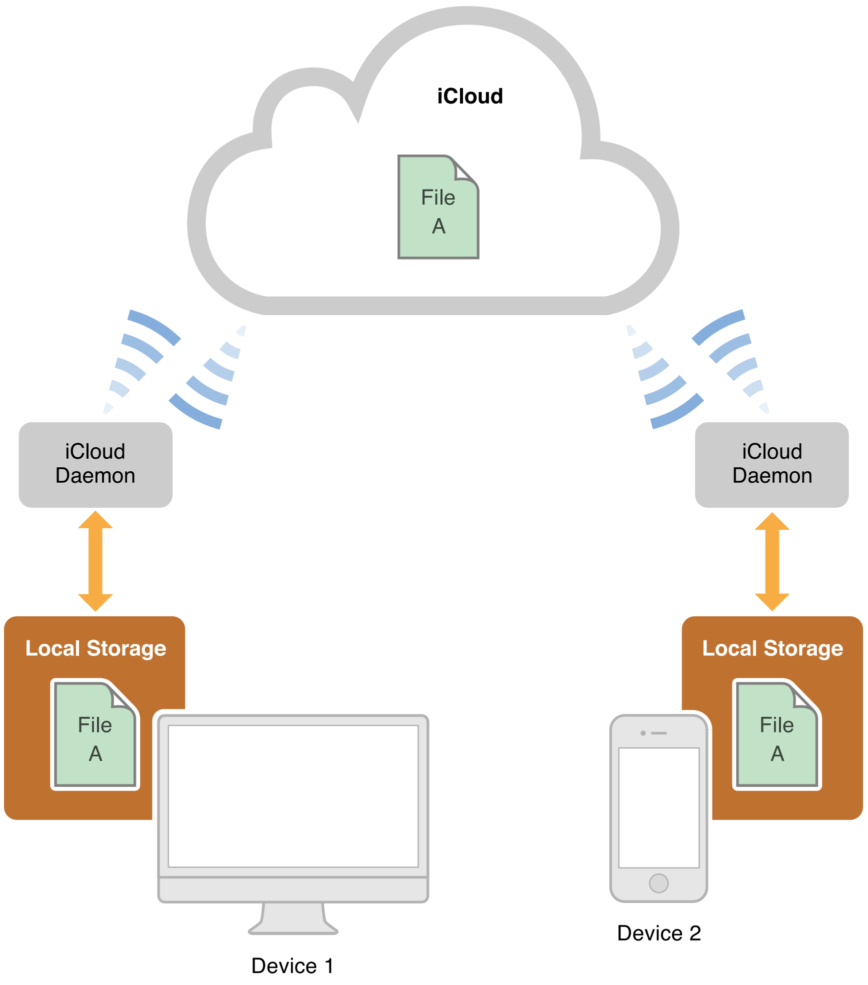
> **Note:** If you don't want to open an untitled document when the app is launched or activated, implement the app delegate method `applicationShouldOpenUntitledFile:` to return `NO`. If you do want to open an untitled document when launched, but don't want to open an untitled document when the app is already running and activated from the dock, you can instead implement the delegate's `applicationShouldHandleReopen:hasVisibleWindows:` method to return `NO`.

Implement `awakeFromNib` to initialize objects unarchived from the document's window nib files (but not the document itself).

Moving Document Data to and from iCloud

The iCloud storage technology enables you to share documents and other app data among multiple computers that run your document-based app. If you have an iOS version of your document-based app that shares the same document data formats, documents can be shared among iOS devices as well, as shown in Figure 4-1. Changes made to the file or directory on one device are stored locally and then pushed to iCloud using a local daemon. The transfer of files to and from each device is transparent to your app.

Figure 4-1 Sharing document data via iCloud



Access to iCloud is controlled using entitlements, which your app configures through Xcode. If these entitlements are not present, your app is prevented from accessing files and other data in iCloud. In particular, the container identifiers for your app must be declared in the `com.apple.developer.ubiquity-container-identifiers` entitlement. For information about how to configure your app's entitlements, see *Developing for the App Store* and *Tools Workflow Guide for Mac*.

All files and directories stored in iCloud must be managed by an object that adopts the `NSFilePresenter` protocol, and all changes you make to those files and directories must occur through an `NSFileCoordinator` object. The file presenter and file coordinator prevent external sources from modifying the file at the same time and deliver relevant notifications to other file presenters. `NSDocument` implements the methods of the `NSFilePresenter` protocol and handles all of the file-related management for you. All your app must do is read and write the document data when told to do so. Be sure you override `autosavesInPlace` to return `YES` to enable file coordination in your `NSDocument` object.

Determining Whether iCloud Is Enabled

Early in the execution of your app, before you try to use any other iCloud interfaces, you must call the `NSFileManager` method `URLForUbiquityContainerIdentifier:` to determine whether iCloud storage is enabled. This method returns a valid URL when iCloud is enabled (and the specified container directory is available) or `nil` when iCloud is disabled. `URLForUbiquityContainerIdentifier:` also returns `nil` if you specify a container ID that the app isn't allowed to access or that doesn't exist. In that case, the `NSFileManager` object logs a message to the console to help diagnose the error.

Listing 4-3 illustrates how to determine whether iCloud is enabled for the document's file URL, presenting an error message to the user if not, and setting the value of the document's destination URL to that of its iCloud container otherwise (in preparation for moving the document to iCloud using the `setUbiquitous:itemAtURL:destinationURL:error:` method).

Listing 4-3 Determining whether iCloud is enabled

```
NSURL *src = [self fileURL];
NSURL *dest = NULL;
NSURL *ubiquityContainerURL = [[[NSFileManager defaultManager]
                                URLForUbiquityContainerIdentifier:nil]
                                URLByAppendingPathComponent:@"Documents"];
    if (ubiquityContainerURL == nil) {
        NSDictionary *dict = [NSDictionary dictionaryWithObjectsAndKeys:
             NSLocalizedString(@"iCloud does not appear to be configured.", @""),
                              NSLocalizedFailureReasonErrorKey, nil];
        NSError *error = [NSError errorWithDomain:@"Application" code:404
                                         userInfo:dict];
        [self presentError:error modalForWindow:[self windowForSheet] delegate:nil
                         didPresentSelector:NULL contextInfo:NULL];
        return;
        }
        dest = [ubiquityContainerURL URLByAppendingPathComponent:
                                                     [src lastPathComponent]];
```

Because the message specifies `nil` for the container identifier parameter, `URLForUbiquityContainerIdentifier:` returns the first container listed in the `com.apple.developer.ubiquity-container-identifiers` entitlement and creates the corresponding directory if it does not yet exist. Alternatively, you could specify your app's container identifier—a concatenation of team ID and app bundle ID, separated by a period for the app's primary container identifier, or a different container directory. For example, you could declare a string constant for the container identifier, as in the following example, and pass the constant name with the message.

```
static NSString *UbiquityContainerIdentifier = @"A1B2C3D4E5.com.domainname.appname";
```

The method also appends the document's filename to the destination URL.

Searching for Documents in iCloud

Apps should use `NSMetadataQuery` objects to search for items in iCloud container directories. Metadata queries return results only when iCloud storage is enabled and the corresponding container directories have been created. For information about how to create and configure metadata search queries, see *File Metadata Search Programming Guide*. For information about how to iterate directories using `NSFileManager`, see *File System Programming Guide*.

Moving a Document into iCloud Storage

To save a new document to the iCloud container directory, first save it locally and then call the `NSFileManager` method `setUbiquitous:itemAtURL:destinationURL:error:` to move the document file to iCloud.

Warning: Do not call `setUbiquitous:itemAtURL:destinationURL:error:` from your app's main thread. Doing so can trigger a deadlock with any file presenter monitoring the file, and it can take an indeterminate amount of time to complete. Instead, call the method in a block running in a dispatch queue other than the main-thread queue.

Listing 4-4 shows an example implementation of a method that moves a file to iCloud storage. It assumes the source and destination URLs from Listing 4-3 (page 41).

Listing 4-4 Moving a document to iCloud

```
dispatch_queue_t globalQueue =
        dispatch_get_global_queue(DISPATCH_QUEUE_PRIORITY_DEFAULT, 0);
dispatch_async(globalQueue, ^(void) {
    NSFileManager *fileManager = [[NSFileManager alloc] init];
    NSError *error = nil;
    // Move the file.
    BOOL success = [fileManager setUbiquitous:YES itemAtURL:src
                                destinationURL:dest error:&error];
    dispatch_async(dispatch_get_main_queue(), ^(void) {
        if (! success) {
            [self presentError:error modalForWindow:[self windowForSheet]
                  delegate:nil didPresentSelector:NULL contextInfo:NULL];
        }
    });
});
[self setFileURL:dest];
[self setFileModificationDate:nil];
```

After a document file has been moved to iCloud, as shown in Listing 4-4, reading and writing are performed by the normal `NSDocument` mechanisms, which automatically manage the file access coordination required by iCloud.

Removing a Document from iCloud Storage

To move a document file from an iCloud container directory, follow the same procedure described in Moving a Document into iCloud Storage (page 42), except switch the source URL (now the document file in the iCloud container directory) and the destination URL (the location of the document file in the local file system). In addition, the first parameter of the `setUbiquitous:itemAtURL:destinationURL:error:` method should now be `NO`.

For clarity in this example, the URL of the file in iCloud storage is named `cloudsrc` and the local URL to which the file is moved is named `localdest`.

```
dispatch_queue_t globalQueue =
        dispatch_get_global_queue(DISPATCH_QUEUE_PRIORITY_DEFAULT, 0);
dispatch_async(globalQueue, ^(void) {
    NSFileManager *fileManager = [[NSFileManager alloc] init];
    NSError *error = nil;
    // Move the file.
    BOOL success = [fileManager setUbiquitous:NO itemAtURL:cloudsrc
                                destinationURL:localdest error:&error];

    dispatch_async(dispatch_get_main_queue(), ^(void) {
        if (! success) {
            [self presentError:error modalForWindow:[self windowForSheet]
                   delegate:nil didPresentSelector:NULL contextInfo:NULL];
        }
    });
});
```

For more information about iCloud, see *iCloud Design Guide* .

NSDocument Handles Conflict Resolution Among Document Versions

`NSDocument` handles conflict resolution automatically, so you do not need to implement it yourself. If a conflict comes in while the document is open, `NSDocument` presents a sheet asking the user to resolve the conflict (or ignore, which marks it as resolved and accepts the automatic winner of the conflict, usually the one with the most recent modification date). Clicking Resolve invokes the Versions user interface (see Users Can Browse Document Versions (page 50)) with only the conflicting versions visible. The user can choose a particular version and click Restore to make it the winner of the conflict, or just select Done to accept the automatic winner.

Even after the conflict is resolved, `NSDocument` always keeps the conflicting versions, and they can be accessed normally through Versions.

Optional Method Overrides

The areas described by items in the following sections require method overrides in some situations. And, of course, you must implement any methods that are special to your `NSDocument` subclass. More options for your `NSDocument` subclass are described in Alternative Design Considerations (page 57).

Window Controller Creation

NSDocument subclasses must create their window controllers. They can do this indirectly or directly. If a document has only one nib file with one window in it, the subclass can override windowNibName to return the name of the window nib file. As a consequence, the document architecture creates a default NSWindowController instance for the document, with the document as the nib file's owner. If a document has multiple windows, or if an instance of a custom NSWindowController subclass is used, the NSDocument subclass must override makeWindowControllers to create these objects.

If your document has only one window, the project template provides a default implementation of the NSDocument method windowNibName:

```
- (NSString *)windowNibName {
    return @"MyDocument";
}
```

If your document has more than one window, or if you have a custom subclass of NSWindowController, override makeWindowControllers instead. Make sure you add each created window controller to the list of such objects managed by the document using addWindowController:.

Window Nib File Loading

You can implement windowControllerWillLoadNib: and windowControllerDidLoadNib: to perform any necessary tasks related to the window before and after it is loaded from the nib file. For example, you may need to perform setup operations on user interface objects, such as setting the content of a view, after the app's model data has been loaded. In this case, you must remember that the NSDocument data-reading methods, such as readFromData:ofType:error:, are called before the document's user interface objects contained in its nib file are loaded. Of course, you cannot send messages to user interface objects until after the nib file loads. So, you can do such operations in windowControllerDidLoadNib:.

Here is an example:

```
- (void)windowControllerDidLoadNib:(NSWindowController *)windowController {
    [super windowControllerDidLoadNib:windowController];
    [textView setAllowsUndo:YES];
    if (fileContents != nil) {
        [textView setString:fileContents];
        fileContents = nil;
    }
}
```

Printing and Page Layout

A document-based app can change the information it uses to define how document data is printed. This information is encapsulated in an `NSPrintInfo` object. If you want users to be able to print a document, you must override `printOperationWithSettings:error:`, possibly providing a modified `NSPrintInfo` object.

Warning: If your app does not support printing, you must remove the printing-related menu items from the menu bar nib file (`MainMenu.nib`) provided when you create a document-based application using the Cocoa Application template in Xcode.

Modifying the Save Dialog Accessory View

By default, when `NSDocument` runs the Save dialog, and the document has multiple writable document types, it inserts an accessory view near the bottom of the dialog. This view contains a pop-up menu of the writable types. If you don't want this pop-up menu, override `shouldRunSavePanelWithAccessoryView` to return `NO`. You can also override `prepareSavePanel:` to do any further customization of the Save dialog.

Validating Menu Items

`NSDocument` implements `validateUserInterfaceItem:` to manage the enabled state of the Revert Document and Save menu items. If you want to validate other menu items, you can override this method, but be sure to invoke the superclass implementation. For more information on menu item validation, see *Application Menu and Pop-up List Programming Topics* .

Core App Behaviors

The Cocoa document architecture, and `NSDocument` in particular, provide support for many core behaviors of Mac apps.

Documents Are Automatically Saved

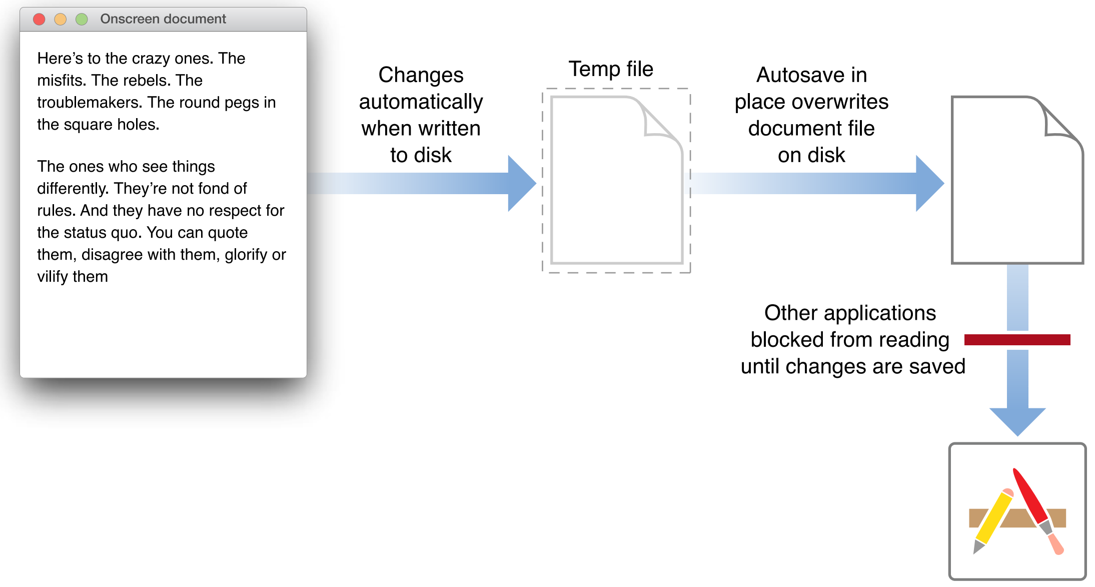
In OS X v10.7 and later, users don't need to save documents explicitly or be concerned about losing unsaved changes. Instead, the system automatically writes document data to disk as necessary. Your `NSDocument` subclass opts into this behavior by overriding the `autosavesInPlace` class method to return `YES`. The ideal baseline for save-less documents is this: The document data that users see in an app window is identical to the document data on disk at all times. For practical reasons, the system does not attempt to save every change immediately, but it saves documents often enough and at the correct times to ensure that the document in memory and the one on disk are *effectively* the same.

Part of the implementation of save-less documents is file coordination, a mechanism that serializes access to files among processes to prevent inconsistencies due to non-sequential reading and writing. Apps use file coordination so that users don't need to remember to save document changes before causing the document's file to be read by another app. Document-based Cocoa apps use file coordination automatically.

Autosaving in Place Differs From Autosaving Elsewhere

Automatic document saving is supported by the implementation of *autosaving in place*. Autosaving in place and autosaving elsewhere both protect against the user losing work due to app crashes, kernel panics, and power failures. However, autosaving in place differs from autosaving elsewhere in that it overwrites the actual document file rather than writing a new file next to it containing the autosaved document contents. (Autosaving in place performs a safe save by writing to a new file first, then moving it into the place of the document file when done.) Autosaving in place is illustrated in Figure 5-1.

Figure 5-1 Autosaving in place


Onscreen document
Here's to the crazy ones. The misfits. The rebels. The troublemakers. The round pegs in the square holes.
The ones who see things differently. They're not fond of rules. And they have no respect for the status quo. You can quote them, disagree with them, glorify or vilify them
Changes automatically when written to disk
Temp file
Autosave in place overwrites document file on disk
Other applications blocked from reading until changes are saved

The document architecture still uses autosaving elsewhere to save untitled documents that have content but have not been explicitly saved and named by the user. In this case, untitled documents are autosaved in `~/Library/Autosave Information`. In addition, `NSDocument` saves earlier revisions of documents elsewhere, giving the user access to previous versions.

The saveless-documents model automates crash protection but preserves the ability for users to save documents explicitly. It also automates maintenance of multiple older versions. Users can save immediately in the traditional way (by choosing File > Save a Version or pressing Command-S). For an untitled document, an explicit Save command presents a dialog enabling the user to name the document and specify the location where it is to be written to disk.

You should not invoke the `autosavesInPlace` method to find out whether autosaving is being done. Instead, the document architecture passes one of two new autosaving-related enumerators as an `NSSaveOperationType` parameter to your overrides of the `NSDocument` methods beginning with `save...` and `write...`, and you can examine those values. The autosave enumerators are `NSAutosaveInPlaceOperation` and `NSAutosaveElsewhereOperation`. The old `NSAutosaveOperation` enumerator is equivalent to `NSAutosaveElsewhereOperation` and is deprecated in OS X v10.7.

Consider Autosaving Performance

Before you enable autosaving, consider the saving performance of your app. If your app saves quickly, there is little reason not to enable it. But if your app saves slowly, enabling autosaving could cause periodic blocking of your user interface while saving is happening. So, for example, if you have already implemented the autosaving behavior introduced in OS X v10.4 (sending `setAutosavingDelay:` to the `NSDocumentController` object with a nonzero value), then your app's saving performance is probably acceptable, and opting into autosaving in place is as simple as overriding `autosavesInPlace` to return `YES`. Otherwise, you may first need to address any issues with your document model or saving logic that could hinder saving performance.

Safety Checking Prevents Unintentional Edits

When saving happens without user knowledge, it becomes easier for unintentional edits to get saved to disk, resulting in potential data loss. To help prevent autosaving unintentional edits, `NSDocument` performs safety checking to determine when a user has opened a document to read it, but not edit it. For example, if the document has not been edited for some period of time, it is locked for editing and opened only for reading. (The period after editing when the document is locked is an option in the Time Machine system preference.) `NSDocument` also checks for documents that are in folders where the user typically does not edit documents, such as the `~/Downloads` folder.

When an edit is made to the document, `NSDocument` offers the user the choice of canceling the change, creating a new document with the change, or allowing editing. A document that is preventing edits displays Locked in the title bar. The user can explicitly enable editing of the document by clicking on the Locked label and choosing Unlock in the pop-up menu. A document that has been changed since it was last opened and is therefore being actively autosaved in place displays Edited in the titlebar instead of Locked.

An app can programmatically determine when a document is locked in read-only "viewing mode" by sending it the `isInViewingMode` message. You can use this information to prevent certain kinds of user actions or changes when the user is viewing an old document revision. Another useful feature for managing locked documents is `NSChangeDiscardable`. You can use this constant to specify that a particular editing change is non-critical and can be thrown away instead of prompting the user. For example, changing the slide in a Keynote document would normally cause some data to be saved in the document, but Keynote declares that change to be discardable, so the user viewing a locked document can change slides without being prompted to unlock it.

Document Saving Can Be Asynchronous

In OS X v10.7 and later, `NSDocument` can save asynchronously, so that document data is written to a file on a background thread. In this way, even if writing is slow, the app's user interface remains responsive. You can override the method `canAsynchronouslyWriteToURL:ofType:forSaveOperation:` to return `YES` to enable asynchronous saving. In this case, `NSDocument` creates a separate writing thread and invokes `writeSafelyToURL:ofType:forSaveOperation:error:` on it. However, the main thread remains blocked until an object on the writing thread invokes the `unblockUserInteraction` method.

When `unblockUserInteraction` is invoked, the app resumes dequeueing user interface events and the user is able to continue editing the document, even if the writing of document data takes some time. The right moment to invoke `unblockUserInteraction` is when an immutable snapshot of the document's contents has been taken, so that writing out the snapshot of the document's contents can continue safely on the writing thread while the user continues to edit the document on the main thread.

Some Autosaves Can Be Cancelled

For various reasons, an app may not be able to implement asynchronous autosaving, or it may be unable to take a snapshot of the document's contents quickly enough to avoid interrupting the user's workflow with autosaves. In that case, the app needs to use a different strategy to remain responsive. The document architecture supports the concept of cancellable autosaves for this purpose, which the app can implement instead of asynchronous saving. At various times during an autosave operation, the app can check to see if the user is trying to edit the document, usually by checking the event queue. If an event is detected, and if the actual write to file has not yet begun, the app can cancel the save operation and simply return an `NSUserCancelledError` error.

Some types of autosaves can be safely cancelled to unblock user interaction, while some should be allowed to continue, even though they cause a noticeable delay. You can determine whether a given autosave can be safely cancelled by sending the document an `autosavingIsImplicitlyCancellable` message. This method returns `YES` when periodic autosaving is being done for crash protection, for example, in which case you can safely cancel the save operation. It returns `NO` when you should not cancel the save, as when the document is being closed, for example.

Users Can Browse Document Versions

The document architecture implements the Versions feature of OS X v10.7 in the behavior of `NSDocument`. An `NSDocument` subclass adopts autosaving in place by returning `YES` from `autosavesInPlace`, as described in Documents Are Automatically Saved (page 47), and adopting autosaving in turn enables version browsing.

After a document has been named and saved, the Save menu item is replaced by the "Save a Version" menu item. This command saves a version of the document identified by date and time. And `NSDocument` sometimes creates a version automatically during autosaving. The user can choose File > Revert Document, or choose

Browse All Revisions from the pop-up menu at the right of the title bar, to display a dialog enabling the user to choose between the last saved version or an older version. Choosing an older version displays a Time Machine–like user interface that selects among all of the document's versions.

If the user chooses to restore a previous version, the current document contents are preserved on disk, if necessary, and the file's contents are replaced with those of the selected version. Holding down the Option key while browsing versions gives the user the option to restore a copy of a previous version, which does not affect the current document contents. The user can also select and copy contents from a version and paste them into the current document.

Windows Are Restored Automatically

The document architecture implements the Resume feature of OS X v10.7, so that individual apps need to encode only information that is peculiar to them and necessary to restore the state of their windows.

The document architecture implements the following steps in the window restoration process; the steps correlate to the numbers shown in Figure 5-2 (page 52):

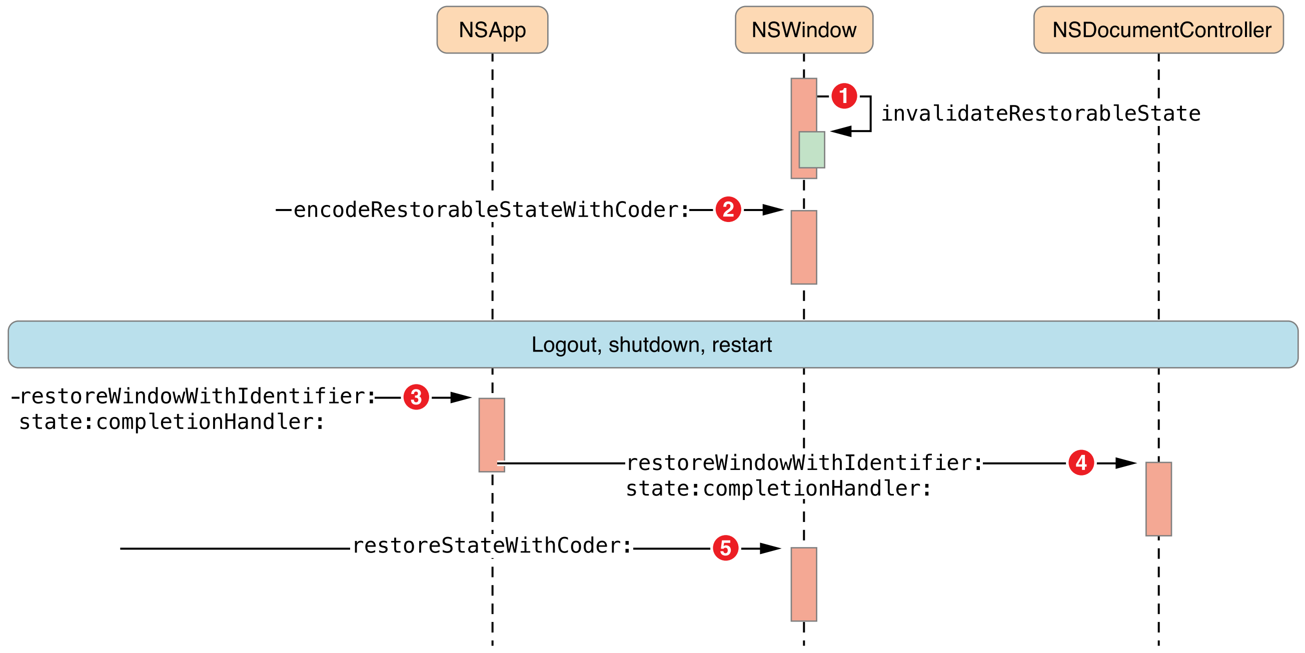
1. The `NSWindowController` method `setDocument:` sets the restoration class of document windows to the class of the shared `NSDocumentController` object. The `NSWindow` object invalidates its restorable state whenever its state changes by sending `invalidateRestorableState` to itself.
2. At the next appropriate time, Cocoa sends the window an `encodeRestorableStateWithCoder:` message, and the window encodes identification and status information into the passed-in encoder.
3. When the system restarts, Cocoa relaunches the app and sends the `restoreWindowWithIdentifier:state:completionHandler:` message to the `NSApp` object.

   Apps can override this method to do any general work needed for window restoration, such as substituting a new restoration class or loading it from a separate bundle.

   `NSApp` decodes the restoration class for the window, sends the `restoreWindowWithIdentifier:state:completionHandler:` message to the restoration class object, and returns `YES`.
4. The restoration class reopens the document and locates its window. Then it invokes the passed-in completion handler with the window as a parameter.

5. Cocoa sends the `restoreStateWithCoder:` message to the window, which decodes its restorable state from the passed-in `NSCoder` object and restores the details of its content.

Figure 5-2 Window restoration


NSApp
NSWindow
NSDocumentController
1
invalidateRestorableState
encodeRestorableStateWithCoder:
2
Logout, shutdown, restart
-restoreWindowWithIdentifier:
state:completionHandler:
3
restoreWindowWithIdentifier:
state:completionHandler:
4
restoreStateWithCoder:
5

Although the preceding steps describe only window restoration, in fact every object inheriting from `NSResponder` has its own restorable state. For example, an `NSTextView` object stores the selected range (or ranges) of text in its restorable state. Likewise, an `NSTabView` object records its selected tab, an `NSSearchField` object records the search term, an `NSScrollView` object records its scroll position, and an `NSApplication` object records the z-order of its windows. An `NSDocument` object has state as well. Although `NSDocument` does not inherit from `NSResponder`, it implements many `NSResponder` methods, including the restoration methods shown in Figure 5-2.

When the app is relaunched, Cocoa sends the `restoreStateWithCoder:` message to the relevant objects in turn: first to the `NSApplication` object, then to each `NSWindow` object, then to the `NSWindowController` object, then to the `NSDocument` object, and then to each view that has saved state.

The Document Architecture Provides Undo Support for Free

Undo support in the document architecture is built-in and straightforward to implement. By default, an `NSDocument` object has its own `NSUndoManager` object. The `NSUndoManager` class enables you to construct invocations that do the opposite of a previous action.

Important: Your document subclass should disable undo registration during document reading using the `[[self undoManager] disableUndoRegistration]` message.

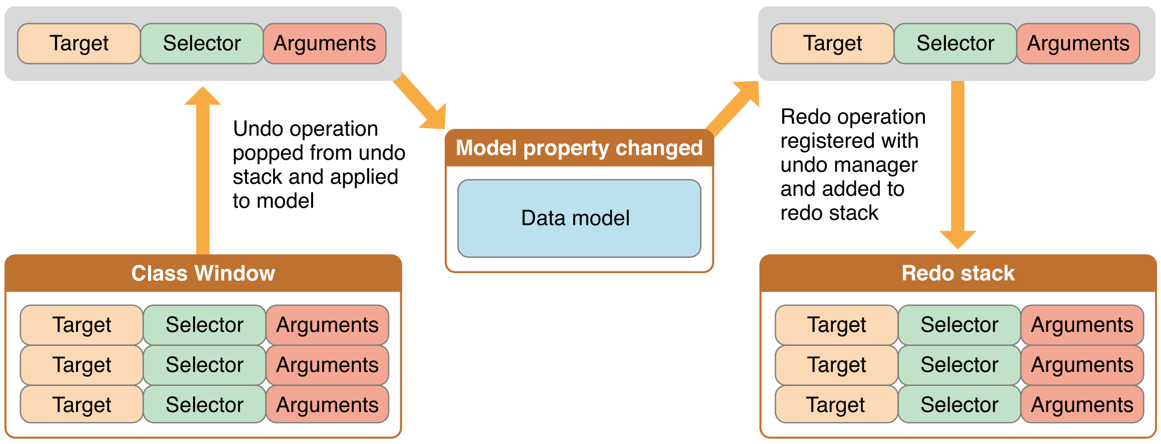
Implementing Undo

The key to implementing undo properly is to have well-defined primitives for changing your document. Each model object, plus the `NSDocument` subclass itself, should define the set of primitive methods that can change it. Each primitive method is then responsible for using the undo manager to enqueue invocations that undo the action of the primitive method. For example, if you decide that `setColor:` is a primitive method for one of your model objects, then inside of `setColor:` your object would do something like the following:

```
[[[myDocument undoManager] prepareWithInvocationTarget:self] setColor:oldColor]
```

This message causes the undo manager to construct and save an invocation. If the user later chooses Undo, the saved invocation is invoked and your model object receives another `setColor:` message, this time with the old color. You don't have to keep track of whether commands are being undone to support redo. In fact, the way redo works is by watching what invocations get registered as the undo is happening and recording them on the redo stack.

Figure 5-3 Undo and redo stacks



You can use the `setUndoManager:` method if you need to use a subclass or otherwise need to change the undo manager used by the document.

Because many discrete changes might be involved in a user-level action, all the undo registrations that happen during a single cycle of the event loop are usually grouped together and are undone all at once. `NSUndoManager` has methods that allow you to control the grouping behavior further if you need to.

Another aspect of good undo implementation is to provide action names so that the Undo and Redo menu items can have more descriptive titles. Undo action names are best set in action methods instead of the change primitives in your model objects because many primitive changes might go into one user action, or different user actions might result in the same primitives being called in different ways. The Sketch example app implements undo in action methods.

Implementing Partial Undo

Because the undo manager does multiple-level undo, do not implement undo for only a subset of the possible changes to your document. The undo manager relies on being able to reliably take the document back through history with repeated undos. If some changes get skipped, the undo stack state is no longer synchronized with the contents of the document. Depending on your architecture, that situation can cause problems that range from merely annoying to fatal.

For example, imagine that you have a drawing program that is able to undo a resize, but not a delete operation. If the user selects a graphic and resizes it, the undo manager gets an invocation that can undo that resize operation. Now the user deletes that graphic (which is not recorded for undo). If the user now tries to undo, nothing happens (at the very least), because the graphic that was resized is no longer there and undoing the resize can't have any visual effect. At worst, the app might crash trying to send a message to a freed object. So when you implement undo, remember that everything that causes a change to the document should be undoable.

If there are some changes that you cannot undo, there are two ways to handle the situation when a user makes such a change. If you can be absolutely sure that the change has no relationship to any other changes that can happen to the document (that is, something totally independent of all the rest of the contents of the document has changed), then you do not register any undo action for that change. On the other hand, if the change does have some relationship to the rest of the document contents, remove all actions from the undo manager when such a change takes place. Such changes then mark points of no return in your user experience. When designing your app and document format, you should strive to avoid the need for these "point of no return" operations.

Managing the Change Count

Because of undo support, the document must keep more information than just whether the document is dirty or clean. If a user opens a file, makes five changes, and then chooses Undo five times, the document should once again be clean. But if the user chooses Undo only four times, the document is still dirty.

The `NSDocument` object keeps a change count to deal with this. The change count can be modified by sending an `updateChangeCount:` message with one of the supported change types. The supported change types are `NSChangeDone`, `NSChangeUndone`, and `NSChangeCleared`. The `NSDocument` object itself clears the change count whenever the user saves or reverts the document. If the document has an undo manager, it observes the undo manager and automatically updates the change count when changes are done, undone, or redone.

Not Supporting Undo

If you don't want to support undo at all, first send the `setHasUndoManager:` message with a parameter value of `NO` to your document. This message causes the document never to get an undo manager.

Without an undo manager (and without undo support from your model objects), the document cannot automatically track its dirty state. So, if you aren't implementing undo, you need to send an `updateChangeCount:` message explicitly whenever your document is edited.

The Document Architecture Supports Robust Error Handling

Many `NSDocument` and `NSDocumentController` methods include as their last parameter an indirect reference to an `NSError` object. These are methods that create a document, write a file, access a resource, or perform a similar operation.

An example of an `NSDocumentController` method that takes an error parameter is `openUntitledDocumentAndDisplay:error:`, which creates a new untitled document. In case of failure, this method directly returns `nil` and, in the last parameter, indirectly returns an `NSError` object that describes the error. Before calling such a method, client code that is interested in a possible error declares an `NSError` object variable and passes the address of the variable in the error parameter. If the clients are not interested in the error, they pass `NULL` in the error parameter.

Using `NSError` objects gives Cocoa apps the capability to present much more useful error messages to the user, including detailed reasons for the error condition, suggestions for recovery, and even a mechanism for attempting programmatic recovery. In addition, AppKit handles presenting the error to the user.

Important: Cocoa methods that take error parameters in the Cocoa error domain are guaranteed to return `NSError` objects. So, if you override such a method, you must adhere to the following rule: A method that takes an `error:(NSError **)outError` parameter must set the value of `*outError` to point to an `NSError` object whenever the method returns a value that signals failure (typically `nil` or `NO`) and `outError != NULL`.

If you override a method that takes an error parameter and you call the superclass implementation, you don't need to set `outError` yourself. Pass it the error argument that your override received when invoked.

If you override such a method to prevent some action but you don't want an error alert to be presented to the user, return an error object whose domain is `NSCocoaErrorDomain` and whose code is `NSUserCancelledError`. The AppKit framework presents errors through the `NSApplication` implementations of the `presentError:` and `presentError:modalForWindow:delegate:didPresentSelector:contextInfo:` methods declared by `NSResponder`. Those implementations silently ignore errors whose domain is `NSCocoaErrorDomain` and whose code is `NSUserCancelledError`. So, for example, if your override wanted to avoid presenting an error to the user, it could set an error object as shown in the following fragment:

```
if (outError) {
    *outError = [NSError errorWithDomain:NSCocoaErrorDomain
                                   code:NSUserCancelledError userInfo:nil];
}
```

For detailed information about `NSError` handling see *Error Handling Programming Guide* .

Alternative Design Considerations

Most document-based apps can use the information presented in other chapters of this document. However, some apps have particular requirements necessitating alternate techniques, some of which are discussed in this chapter.

Overriding the URL and File Package Reading Methods

There are situations in which the simplest solution for document reading, overriding the data-based reading method, `readFromData:ofType:error:`, as described in Reading Document Data (page 35), is not sufficient. In such cases, you can override another `NSDocument` reading method instead, such as the URL-based and file package reading methods.

If your app needs access to the URL of a document file, you should override the `readFromURL:ofType:error:` method instead of `readFromData:ofType:error:`, as in the example implementation shown in Listing 6-1.

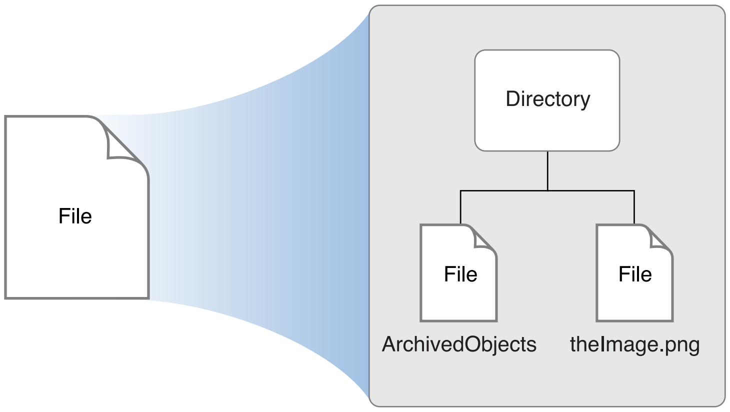
This example assumes that the app has an `NSTextView` object configured with an `NSTextStorage` object to display the document's data. The `NSDocument` object has `text` and `setText:` accessors for the document's `NSAttributedString` data model.

Listing 6-1 URL-based document-reading method implementation

```
- (BOOL)readFromURL:(NSURL *)inAbsoluteURL ofType:(NSString *)inTypeName
                                             error:(NSError **)outError {
    BOOL readSuccess = NO;
    NSAttributedString *fileContents = [[NSAttributedString alloc]
                                initWithURL:inAbsoluteURL options:nil
                                documentAttributes:NULL error:outError];
    if (fileContents) {
        readSuccess = YES;
        [self setText:fileContents];
    }
    return readSuccess;
}
```

If your app needs to manipulate directly a document file that is a file package, you should override the `readFromFileWrapper:ofType:error:` method instead of `readFromData:ofType:error:`. For example, if your document contains an image file and a text file, you can store both in a file package. A major advantage of this arrangement is that if only one of those objects changes during an editing session, you don't need to save both objects to disk but can save just the changed one. Figure 6-1 shows a file package containing an image file and an object archive.

Figure 6-1 File package containing an image



When opening a document, the method looks for the image and text file wrappers. For each wrapper, the method extracts the data from it and keeps the file wrapper itself. The file wrappers are kept so that, if the corresponding data hasn't been changed, they can be reused during a save and thus the source file itself can be reused rather than rewritten. Keeping the file wrapper avoids the overhead of syncing data unnecessarily. Listing 6-3 shows an override of the `NSDocument` file wrapper reading method `readFromFileWrapper:ofType:error:`.

The example code in Listing 6-3 (and its corresponding file wrapper writing override shown in Listing 6-5 (page 61)) assume the existence of some auto-synthesized properties and constants, such as those shown in Listing 6-2; of course, a complete `NSDocument` implementation also requires some additional program logic.

Listing 6-2 File wrapper example properties and constants

```
@property (assign) IBOutlet NSTextView *textView;
@property (nonatomic, strong) NSImage *image;
@property (strong) NSString *notes;
@property (strong) NSFileWrapper *documentFileWrapper;

NSString *ImageFileName = @"Image.png";
NSString *TextFileName = @"Text.txt";
```

```
NSStringEncoding TextFileEncoding = NSUTF8StringEncoding;
```

Listing 6-3 File wrapper document-reading method implementation

```
- (BOOL)readFromFileWrapper:(NSFileWrapper *)fileWrapper
                     ofType:(NSString *)typeName
                      error:(NSError **)outError {

    NSDictionary *fileWrappers = [fileWrapper fileWrappers];
    NSFileWrapper *imageFileWrapper = [fileWrappers objectForKey:ImageFileName];
    if (imageFileWrapper != nil) {

        NSData *imageData = [imageFileWrapper regularFileContents];
        NSImage *image = [[NSImage alloc] initWithData:imageData];
        [self setImage:image];
    }

    NSFileWrapper *textFileWrapper = [fileWrappers objectForKey:TextFileName];
    if (textFileWrapper != nil) {

       NSData *textData = [textFileWrapper regularFileContents];
       NSString *notes = [[NSString alloc] initWithData:textData
                                               encoding:TextFileEncoding];
       [self setNotes:notes];
    }

    [self setDocumentFileWrapper:fileWrapper];

    return YES;
}
```

If the data related to a file wrapper changes (a new image is added or the text is edited), the corresponding file wrapper object is disposed of and a new file wrapper created on save. See Listing 6-5 (page 61) which shows an override of the corresponding file writing method, `fileWrapperOfType:error:`.

Overriding the URL and File Package Writing Methods

As with document reading, there are situations in which the simplest solution for document writing, overriding the data-based writing method, `dataOfType:error:`, as described in Writing Document Data (page 37), is not sufficient. In such cases, you can override another `NSDocument` writing method instead, such as the URL-based and file package writing methods.

If your app needs access to the URL of a document file, you should override the `NSDocument` URL-based writing method, `writeToURL:ofType:error:`, as shown in Listing 6-4. This example has the same assumptions as Listing 6-1 (page 57).

Listing 6-4 URL-based document-writing method implementation

```
- (BOOL)writeToURL:(NSURL *)inAbsoluteURL ofType:(NSString *)inTypeName
                                          error:(NSError **)outError {
    NSData *data = [[self text] RTFFromRange:NSMakeRange(0,
                    [[self text] length]) documentAttributes:nil];
    BOOL writeSuccess = [data writeToURL:inAbsoluteURL
                                 options:NSAtomicWrite error:outError];
    return writeSuccess;
}
```

If your override cannot determine all of the information it needs from the passed-in parameters, consider overriding another method. For example, if you see the need to invoke `fileURL` from within an override of `writeToURL:ofType:error:`, you should instead override `writeToURL:ofType:forSaveOperation:originalContentsURL:error:`. Override this method if your document writing machinery needs access to the on-disk representation of the document revision that is about to be overwritten. This method is responsible for doing document writing in a way that minimizes the danger of leaving the disk to which writing is being done in an inconsistent state in the event of a software crash, hardware failure, or power outage.

If your app needs to directly manipulate a document file that is a file package, you should override the `fileWrapperOfType:error:` method instead of `dataOfType:error:`. An example file wrapper writing method implementation is shown in Listing 6-5. In this implementation, if the document was not read from a file or was not previously saved, it doesn't have a file wrapper, so the method creates one. Likewise, if the document file wrapper doesn’t contain a file wrapper for an image and the image is not `nil`, the method creates a file wrapper for the image and adds it to the document file wrapper. And if there isn’t a wrapper for the text file, the method creates one.

Listing 6-5 File wrapper document-writing method override

```
- (NSFileWrapper *)fileWrapperOfType:(NSString *)typeName
                              error:(NSError **)outError {

    if ([self documentFileWrapper] == nil) {
        NSFileWrapper * documentFileWrapper = [[NSFileWrapper alloc]
                                             initDirectoryWithFileWrappers:nil];
        [self setDocumentFileWrapper:documentFileWrapper];
    }

    NSDictionary *fileWrappers = [[self documentFileWrapper] fileWrappers];

    if (([fileWrappers objectForKey:ImageFileName] == nil) &&
        ([self image] != nil)) {

         NSArray *imageRepresentations = [self.image representations];
        NSData *imageData = [NSBitmapImageRep
                            representationOfImageRepsInArray:imageRepresentations
                                                  usingType:NSPNGFileType
                                                 properties:nil];
        if (imageData == nil) {
            NSBitmapImageRep *imageRep = nil;
            @autoreleasepool {
                imageData = [self.image TIFFRepresentation];
                imageRep = [[NSBitmapImageRep alloc] initWithData:imageData];
            }
            imageData = [imageRep representationUsingType:NSPNGFileType
                                              properties:nil];
        }

        NSFileWrapper *imageFileWrapper = [[NSFileWrapper alloc]
                                         initRegularFileWithContents:imageData];
        [imageFileWrapper setPreferredFilename:ImageFileName];

        [[self documentFileWrapper] addFileWrapper:imageFileWrapper];
    }

    if ([fileWrappers objectForKey:TextFileName] == nil) {
        NSData *textData = [[[self textView] string]
                                    dataUsingEncoding:TextFileEncoding];
        NSFileWrapper *textFileWrapper = [[NSFileWrapper alloc]
                                  initRegularFileWithContents:textData];
        [textFileWrapper setPreferredFilename:TextFileName];
        [[self documentFileWrapper] addFileWrapper:textFileWrapper];
    }
    return [self documentFileWrapper];
}
```

Incremental Data Reading and Writing

If your app has a large data set, you may want to read and write increments of your files as needed to ensure a good user experience. Consider the following strategies:

- **Use file packages.** If your app supports document files that are file packages, then you can override the file-wrapper reading and writing methods. File wrapper (`NSFileWrapper`) objects that represent file packages support incremental saving. For example, if you have a file package containing text objects and graphic objects, and only one of them changes, you can write the changed object to disk but not the unchanged ones.
- **Use Core Data.** You can subclass `NSPersistentDocument`, which uses Core Data to store your document data in a managed object context. Core Data automatically supports incremental reading and writing of only changed objects to disk.

For more information about reading and writing files, see *File System Programming Guide* .

Multiple Document Types Use Multiple NSDocument Subclasses

The document architecture provides support for apps that handle multiple types of documents, each type using its own subclass of `NSDocument`. For example, you could have an app that enables users to create text documents, spreadsheets, and other types of documents, all in a single app. Such different document types each require a different user interface encapsulated in a unique `NSDocument` subclass.

If your multiple-document-type app opens only existing documents, you can use the default `NSDocumentController` instance, because the document type is determined from the file being opened. However, if your app creates new documents, it needs to choose the correct type.

The `NSDocumentController` action method `newDocument:` creates a new document of the first type listed in the app's array of document types configured in the `Info.plist` file. But automatically creating the first type does not work for apps that support several distinct types of document. If your app cannot determine which type to create depending on circumstances, you must provide a user interface allowing the user to choose which type of document to create.

You can create your own new actions, either in your app's delegate or in an `NSDocumentController` subclass. You could create several action methods and have several different New menu items, or you could have one action that asks the user to pick a document type before creating a new document.

Once the user selects a type, your action method can use the `NSDocumentController` method `makeUntitledDocumentOfType:error:` to create a document of the correct type. After creating the document, your method should add it to the document controller's list of documents, and it should send the document `makeWindowControllers` and `showWindows` messages.

Alternatively, if you subclass `NSDocumentController`, you can override the `defaultType` method to determine the document type and return it when the user chooses New from the File menu.

Additional Document Type Considerations

If your app has some document types that it can read but not write, you can declare this by setting the role for those types to `Viewer` instead of `Editor` in Xcode. If your app has some types that it can write but not read, you can declare this by using the `NSExportableTypes` key. You can include the `NSExportableTypes` key in the type dictionary for another type that your document class supports, usually the type dictionary for the most native type for your document class. Its value is an array of UTIs defining a supported file type to which this document can export its content.

The Sketch sample app uses this key to allow it to export TIFF and PDF images even though it cannot read those types. Write-only types can be chosen only when doing Save As operations. They are not allowed for Save operations.

Sometimes an app might understand how to read a type, but not how to write it, and when it reads documents of that type, it should automatically convert them to another type that you can write. An example would be an app that can read documents from an older version or from a competing product. It might want to read in the old documents and automatically convert them to the new native format. The first step is to add the old type as a read-only type. By doing this, your app is able to open the old files, but they come up as untitled files.

If you want to automatically convert them to be saved as your new type, you can override the `readFrom...` methods in your `NSDocument` subclass to call `super` and then reset the filename and type afterwards. You should use `setFileType:` and `setFileURL:` to set an appropriate type and name for the new document. When setting the filename, make sure to strip the filename extension of the old type from the original filename, if it is there, and add the extension for the new type.

Customizing the Save Dialog

By default, when `NSDocument` runs the Save dialog and the document has multiple writable document types, `NSDocument` inserts an accessory view near the bottom of the dialog. This view contains a pop-up menu of the writable types. If you don't want this pop-up menu, override `shouldRunSavePanelWithAccessoryView` to return `NO`. You can also override `prepareSavePanel:` to customize the Save dialog.

Customizing Document Window Titles

Subclasses of `NSDocument` sometimes override `displayName` to customize the titles of windows associated with the document. That is rarely the right thing to do because the document's display name is used in places other than the window title, and the custom value that an app might want to use as a window title is often not appropriate. For example, the document display name is used in the following places:

- Error alerts that may be presented during reverting, saving, or printing of the document
- Alerts presented during document saving if the document has been moved, renamed, or move to the Trash
- The alert presented when the user attempts to close the document with unsaved changes
- As the default value shown in the "Save As:" field of Save dialog

To customize a document's window title properly, subclass `NSWindowController` and override `windowTitleForDocumentDisplayName:`. If your app requires even deeper customization, override `synchronizeWindowTitleWithDocumentName`.

Customizing Document Closing

If a document has multiple windows, each window has its own window controller. For example, a document might have a main data-entry window and a window that lists records for selection; each window would have its own `NSWindowController` object.

If you have multiple window controllers for a single document, you may want to explicitly control document closing. By default, a document closes when its last remaining window controller closes. However, if you want the document to close when a particular window closes—the document's "main" window, for example—then you can send the main window controller a `setShouldCloseDocument:` message with a value of `YES`.

Message Flow in the Document Architecture

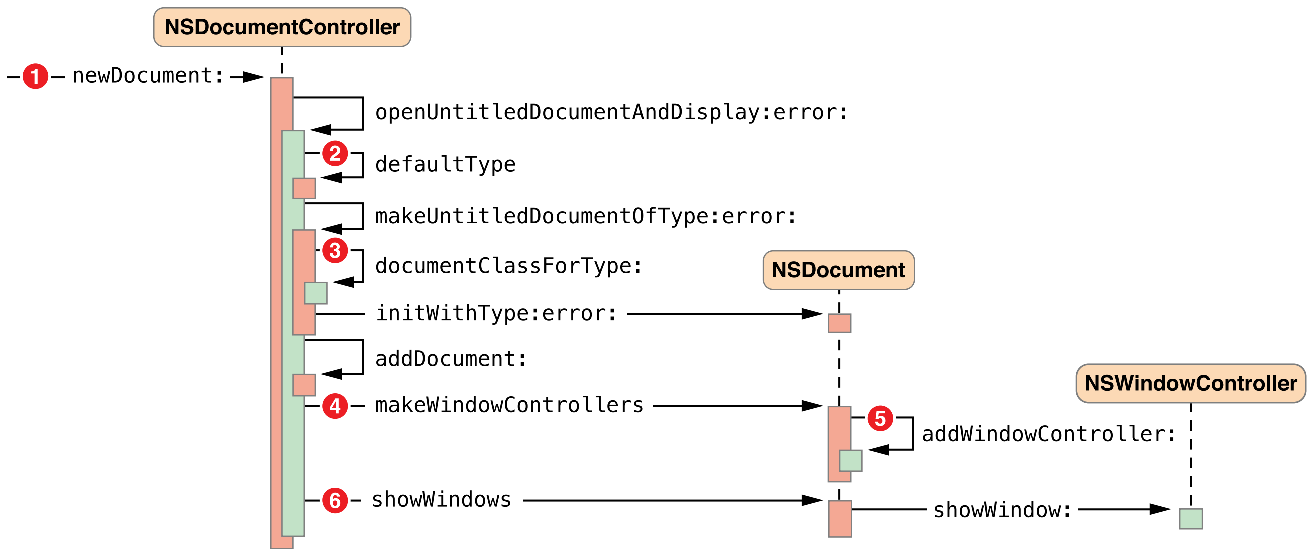
The objects that form the document architecture interact to perform the activities of document-based apps, and those interactions proceed primarily through messages sent among the objects via public APIs. This message flow provides many opportunities for you to customize the behavior of your app by overriding methods in your `NSDocument` subclass or other subclasses.

This section describes default message flow among major objects of the document architecture, including objects sending messages to themselves; it leaves out various objects and messages peripheral to the main mechanisms. Also, these messages are sent by the default implementations of the methods in question, and the behavior of subclasses may differ.

Creating a New Document

The document architecture creates a new document when the user chooses New from the File menu of a document-based app. This action begins a sequence of messages among the `NSDocumentController` object, the newly created `NSDocument` object, and the `NSWindowController` object, as shown in Figure 6-2.

Figure 6-2 Creating a new document



The sequence numbers in Figure 6-2 refer to the following steps in the document-creation process:

1. The user chooses New from the File menu, causing the `newDocument:` message to be sent to the document controller (or an Apple event, for example, sends an equivalent message).
2. The `openUntitledDocumentAndDisplay:error:` method determines the default document type (stored in the app's `Info.plist` file) and sends it with the `makeUntitledDocumentOfType:error:` message.
3. The `makeUntitledDocumentOfType:error:` method determines the `NSDocument` subclass corresponding to the document type, instantiates the document object, and sends it an initialization message.
4. The document controller adds the new document to its document list and, if the first parameter passed with `openUntitledDocumentAndDisplay:error:` is `YES`, sends the document a message to create a window controller for its window, which is stored in its nib file. The `NSDocument` subclass can override `makeWindowControllers` if it has more than one window.
5. The document adds the new window controller to its list of window controllers by sending itself an `addWindowController:` message.
6. The document controller sends the document a message to show its windows. In response, the document sends the window controller a `showWindow:` message, which makes the window main and key.

If the first parameter passed with `openUntitledDocumentAndDisplay:error:` is `NO`, the document controller needs to explicitly send the document `makeWindowControllers` and `showWindows` messages to display the document window.

Opening a Document

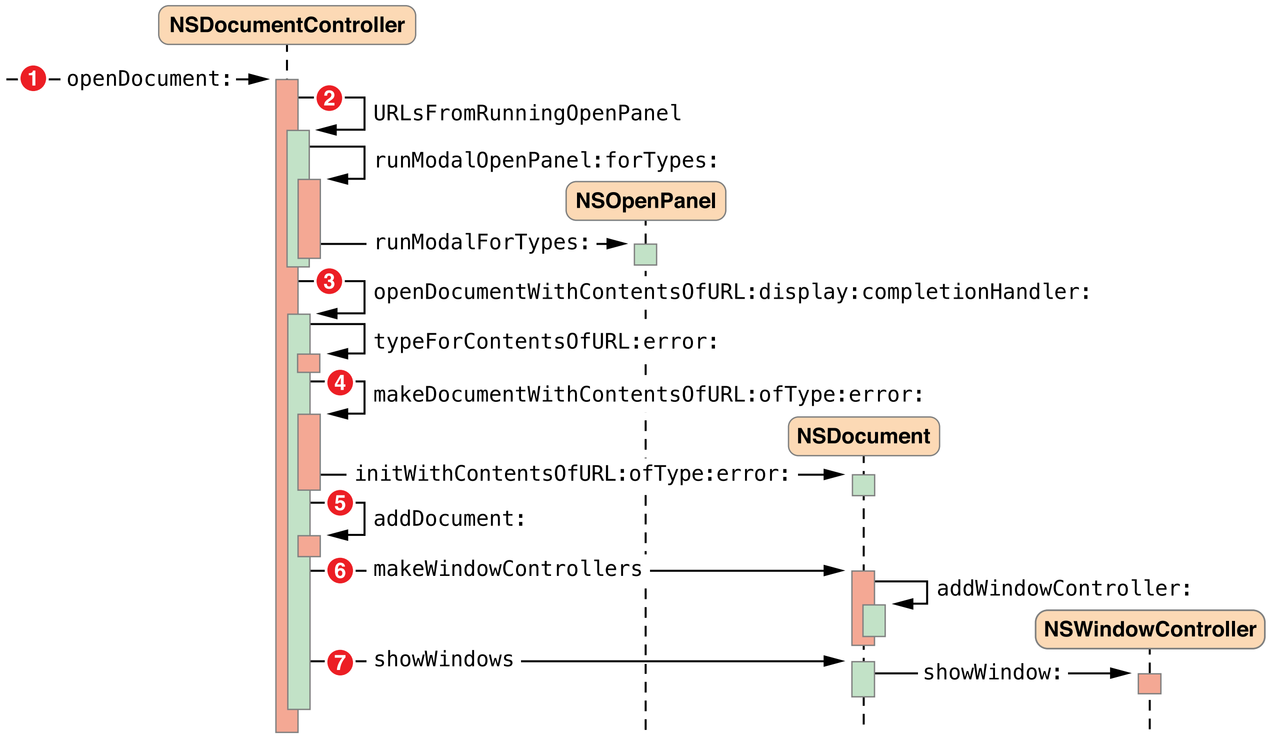
The document architecture opens a document, reading its contents from a file, when the user chooses Open from the File menu. This action begins a sequence of messages among the `NSDocumentController`, `NSOpenPanel`, `NSDocument`, and `NSWindowController` objects, as shown in Figure 6-3 (page 67).

There are many similarities between the mechanisms for opening a document and creating a new document. In both cases the document controller needs to create and initialize an `NSDocument` object, using the proper `NSDocument` subclass corresponding to the document type; the document controller needs to add the document to its document list; and the document needs to create a window controller and tell it to show its window.

Document Opening Message Flow

Opening a document differs from creating a new document in several ways. If document opening was invoked by the user choosing Open from the File menu, the document controller must run an Open dialog to allow the user to select a file to provide the contents of the document. An Apple event can invoke a different message sequence. In either case, the document must read its content data from a file and keep track of the file's meta-information, such as its URL, type, and modification date.

Figure 6-3 Opening a document



The sequence numbers in Figure 6-3 refer to the following steps in the document-opening process:

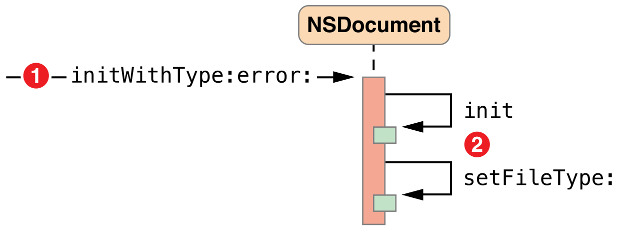
1. The user chooses Open from the File menu, causing the `openDocument:` message to be sent to the document controller.
2. The URL locating the document file must be retrieved from the user, so the `NSDocumentController` object sends itself the `URLsFromRunningOpenPanel` message. After this method creates the Open dialog and sets it up appropriately, the document controller sends itself the `runModalOpenPanel:forTypes:` message to present the Open dialog to the user. The `NSDocumentController` object sends the `runModalForTypes:` message to the `NSOpenPanel` object.
3. With the resulting URL, the `NSDocumentController` object sends itself the `openDocumentWithContentsOfURL:display:completionHandler:` message.

4. The `NSDocumentController` object sends itself the `makeDocumentWithContentsOfURL:ofType:error:` message and sends the `initWithContentsOfURL:ofType:error:` message to the newly created `NSDocument` object. This method initializes the document and reads in its contents from the file located at the specified URL. Document Initialization Message Flow (page 68) describes document initialization in this context.
5. When `makeDocumentWithContentsOfURL:ofType:error:` returns an initialized `NSDocument` object, the `NSDocumentController` object adds the document to its document list by sending the `addDocument:` message to itself.
6. To display the document's user interface, the document controller sends the `makeWindowControllers` message to the `NSDocument` object, which creates an `NSWindowController` instance and adds it to its list using the `addWindowController:` message.
7. Finally, the document controller sends the `showWindows` message to the `NSDocument` object, which, in turn, sends the `showWindow:` message to the `NSWindowController` object, making the window main and key.
8. If the `URLsFromRunningOpenPanel` method returned an array with more than one URL, steps 3 through 7 repeat for each URL returned.

Document Initialization Message Flow

Steps in the document-initialization process for document creation are shown in Figure 6-4. Document initialization in the context of document opening is noteworthy because it invokes the document's location-based or data-based reading and writing methods, and you must override one of them. Steps in the document-initialization process for document opening are shown in Figure 6-5 (page 69).

Figure 6-4 Document initialization for document creation

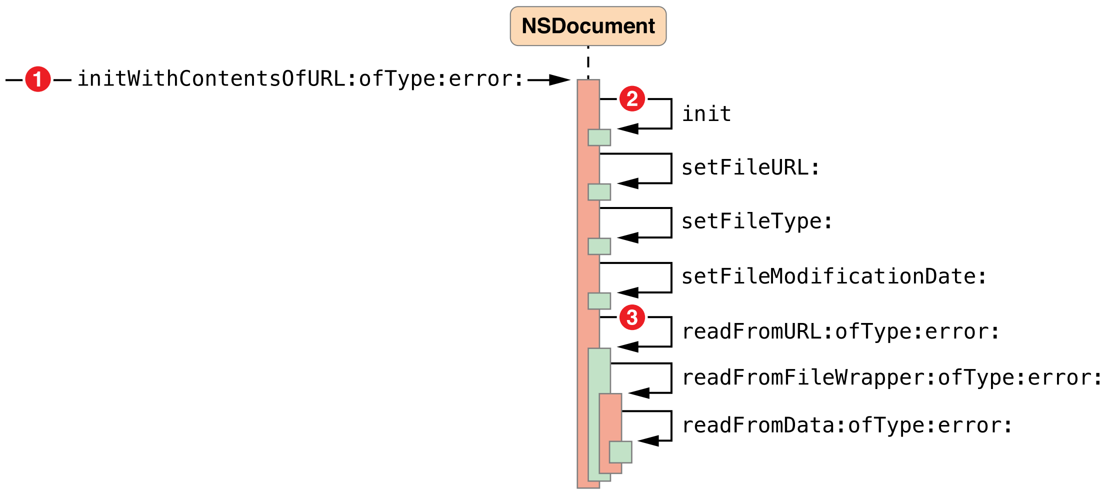


The sequence numbers in Figure 6-4 refer to the following steps in the document-initialization process:

1. The `NSDocumentController` object begins document initialization by sending the `initWithType:error:` message to the newly created `NSDocument` object.

2. The `NSDocument` object sends the `init` message to itself, invoking its designated initializer, then sets its filetype by sending itself the message `setFileType:`.

Figure 6-5 Document initialization for document opening


NSDocument
1
initWithContentsOfURL:ofType:error:
2
init
setFileURL:
setFileType:
setFileModificationDate:
3
readFromURL:ofType:error:
readFromFileWrapper:ofType:error:
readFromData:ofType:error:

The sequence numbers in Figure 6-5 refer to the following steps in the document-opening process:

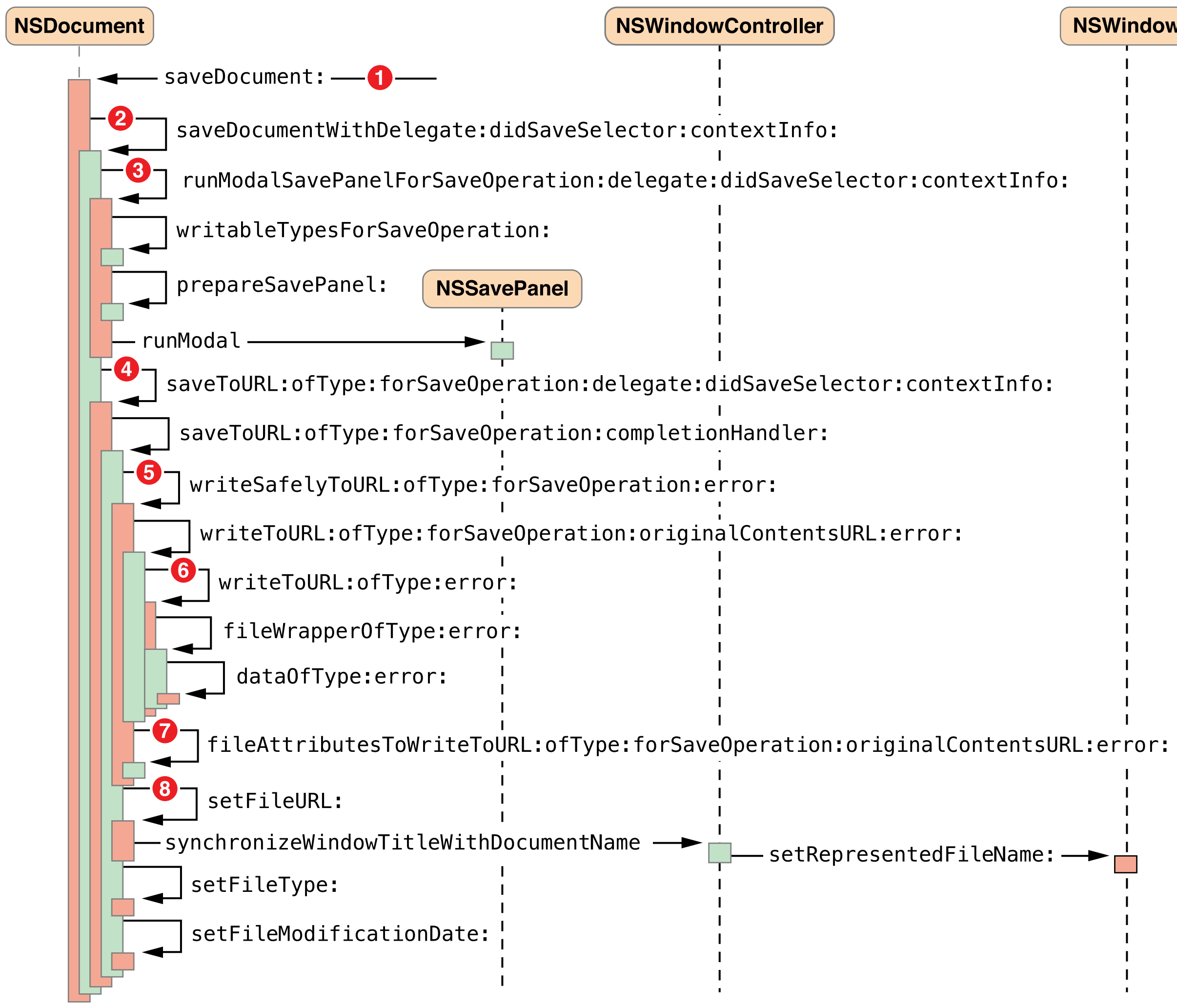
1. The `NSDocumentController` object begins document initialization by sending the `initWithContentsOfURL:ofType:error:` message to the newly created `NSDocument` object.
2. The `NSDocument` object sends the `init` message to itself, invoking its designated initializer, then sets its metadata about the file it is about to open by sending itself the messages `setFileURL:`, `setFileType:`, and `setFileModificationDate:`.
3. The `NSDocument` object reads the contents of the file by sending the `readFromURL:ofType:error:` message to itself. That method gets a file wrapper from disk and reads it by sending the `readFromFileWrapper:ofType:error:` message to itself. Finally, the `NSDocument` object puts the file contents into an `NSData` object and sends the `readFromData:ofType:error:` message to itself.

   Your `NSDocument` subclass *must* override one of the three document-reading methods (`readFromURL:ofType:error:`, `readFromData:ofType:error:`, or `readFromFileWrapper:ofType:error:`) or every method that may invoke `readFromURL:ofType:error:`.

Saving a Document

The document architecture saves a document—writes its contents to a file—when the user chooses one of the Save commands or Export from the File menu. Saving is handled primarily by the document object itself. Steps in the document-saving process are shown in Figure 6-6.

Figure 6-6 Saving a document


NSDocument
NSWindowController
NSWindow
saveDocument:
1
2
saveDocumentWithDelegate:didSaveSelector:contextInfo:
3
runModalSavePanelForSaveOperation:delegate:didSaveSelector:contextInfo:
writableTypesForSaveOperation:
prepareSavePanel:
NSSavePanel
runModal
4
saveToURL:ofType:forSaveOperation:delegate:didSaveSelector:contextInfo:
saveToURL:ofType:forSaveOperation:completionHandler:
5
writeSafelyToURL:ofType:forSaveOperation:error:
writeToURL:ofType:forSaveOperation:originalContentsURL:error:
6
writeToURL:ofType:error:
fileWrapperOfType:error:
dataOfType:error:
7
fileAttributesToWriteToURL:ofType:forSaveOperation:originalContentsURL:error:
8
setFileURL:
synchronizeWindowTitleWithDocumentName
setRepresentedFileName:
setFileType:
setFileModificationDate:

The sequence numbers in Figure 6-6 refer to the following steps in the document-saving process:

1. The user chooses Save As (document has never been saved) or Save a Version (document has been saved before) from the File menu, causing the `saveDocument:` message to be sent to the `NSDocument` object.
2. The `NSDocument` object sends the `saveDocumentWithDelegate:didSaveSelector:contextInfo:` message to itself.

If the document has never been saved, or if the user has moved or renamed the document file, then the `NSDocument` object runs a modal Save dialog to get the file location under which to save the document.

3. To run the Save dialog, the `NSDocument` object sends the `runModalSavePanelForSaveOperation:delegate:didSaveSelector:contextInfo:` message to itself. The document sends `prepareSavePanel:` to itself to give subclasses an opportunity to customize the Save dialog, then sends `runModal` to the NSSavePanel object.
4. The `NSDocument` object sends the `saveToURL:ofType:forSaveOperation:delegate:didSaveSelector:contextInfo:` and, in turn, `saveToURL:ofType:forSaveOperation:error:` to itself.
5. The `NSDocument` object sends the `writeSafelyToURL:ofType:forSaveOperation:error:` message to itself. The default implementation either creates a temporary directory in which the document writing should be done, or renames the old on-disk revision of the document, depending on what sort of save operation is being done, whether or not there's already a copy of the document on disk, and the capabilities of the file system to which writing is being done. Then it sends the `writeToURL:ofType:forSaveOperation:originalContentsURL:error:` message to the document.
6. To write the document contents to the file, the `NSDocument` object sends itself the `writeToURL:ofType:error:` message, which by default sends the document the `fileWrapperOfType:error:` message. That method, in turn, sends the document the `dataOfType:error:` message to create an `NSData` object containing the contents of the document. (For backward compatibility, if the deprecated `dataRepresentationOfType:` is overridden, the document sends itself that message instead.)

   The `NSDocument` subclass *must* override one of its document-writing methods (`dataOfType:error:`, `writeToURL:ofType:error:`, `fileWrapperOfType:error:`, or `writeToURL:ofType:forSaveOperation:originalContentsURL:error:`).
7. The `NSDocument` object sends the `fileAttributesToWriteToURL:ofType:forSaveOperation:originalContentsURL:error:` message to itself to get the file attributes, if any, which it writes to the file. The method then moves the just-written file to its final location, or deletes the old on-disk revision of the document, and deletes any temporary directories.
8. The `NSDocument` object updates its location, file type, and modification date by sending itself the messages `setFileURL:`, `setFileType:`, and `setFileModificationDate:` if appropriate.

Document Revision History

This table describes the changes to *Document-Based App Programming Guide for Mac* .

Date	Notes
2012-12-13	Added cross-references to iCloud Design Guide. Clarified example implementations of fileWrapperOfType:error: and readFromFileWrapper:ofType:error:.
2012-07-23	Rewrote the implementations of document-reading and writing methods. Removed references to manual memory management in favor of ARC.
2012-01-09	New document that explains how to create document-based applications using the Cocoa document architecture on OS X.