Error Handling Programming Guide For Cocoa

Cocoa > Design Guidelines

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Introduction to Error Handling Programming Guide For Cocoa

Every program must deal with errors as they occur at runtime. The program, for example, might not be able to open a file, or perhaps it cannot parse an XML document. Often errors such as these require the program to inform the user about them. And perhaps the program can attempt to get around the problem causing the error.

Cocoa offers developers programmatic tools for these tasks: the NSError class in Foundation and new methods and mechanisms in the Application Kit to support error handling in applications. An NSError object encapsulates information specific to an error, including the domain (subsystem) originating the error and the localized strings to present in an error alert. With an application there is also an architecture allowing the various objects in an application to refine the information in an error object and perhaps to recover from the error. This document describes this API and architecture and explains how to use them.

Important: Although the NSError class was introduced in Mac OS X v10.3, several methods have been added to the class and to the Application Kit in Mac OS X v10.4 to support error handling as described in this document.

Organization of This Document

Error Handling Programming Guide for Cocoa has the following articles:

- "Error Objects, Domains, and Codes" (page 9) describes the attributes of an NSError object, particularly its domain and error code, and discusses the possible contents of an error object's "user info" dictionary, including localized message strings and underlying errors.
- "Error Responders and Error Recovery" (page 15) describes the Application Kit architecture for passing error objects up a chain of objects in an application, giving each object a chance to customize the error before it is presented. It also discusses the role of the recovery attempter, an object designated to attempt a recovery from an error if the user requests it.
- "Using and Creating Error Objects" (page 21) explains how to evaluate an error, how to display an error message using an NSError object, and how to implement methods that return an NSError object by reference.
- "Handling Received Errors" (page 27) discusses how, in the chain of error-responder objects, you handle a received error and customize it.
- "Recovering From Errors" (page 31) explains the procedure for attempting a user-requested recovery from an error.

See Also

"Error Handling in the Document Architecture" in *Document-Based Applications Overview* offers valuable advice for subclasses that override methods with a by-reference `NSError` parameter.

"Types of Dialogs and When to Use Them" in *Apple Human Interface Guidelines* in the *Apple Human Interface Guidelines* offers advice on the form and content of alerts. You should consult these guidelines before composing your error messages. Also take a look at the following conceptual documents on areas of Cocoa programming related to error handling and the presentation of error messages:

- *Assertions and Logging*
- *Dialogs and Special Panels* (alerts)
- *Sheet Programming Topics for Cocoa*

Exception Programming Topics for Cocoa discusses how to raise and handle exceptions. Exception Handling in *The Objective-C 2.0 Programming Language* describes the compiler directives `@try`, `@catch`, `@throw`, and `@finally`, which are used in exception handling.

Error Objects, Domains, and Codes

Cocoa programs use NSError objects to convey information about runtime errors that users need to be informed about. In most cases, a program displays this error information in a dialog or sheet. But it may also interpret the information and either ask the user to attempt to recover from the error or attempt to correct the error on its own.

The core attributes of an NSError object—or, simply, an error object—are an error domain, a domain-specific error code, and a "user info" dictionary containing objects related to the error, most significantly description and recovery strings. This chapter explains the reason for error objects, describes their attributes, and discusses how you use them in Cocoa code.

Why Have Error Objects?

Because they are objects, instances of the NSError class have several advantages over simple error codes and error strings. They encapsulate several pieces of error information at once, including localized error strings of various kinds. NSError objects can also be archived and copied, and they can be passed around in an application and modified. And although NSError is not an abstract class (and thus can be used directly) you can extend the NSError class through subclassing.

Because of the notion of layered error domains, NSError objects can embed errors from underlying subsystems and thus provide more detailed and nuanced information about an error. Error objects also provide a mechanism for error recovery by holding a reference to an object designated as the recovery attempter for the error.

Error Domains

For largely historical reasons, errors codes in Mac OS X are segregated into domains. For example, Carbon error codes, which are typed as `OSStatus`, have their origin in versions of the Macintosh operating system predating Mac OS X. On the other hand, POSIX error codes derive from the various POSIX-conforming "flavors" of UNIX, such as BSD. The Foundation framework declares in `NSError.h` the following string constants for the four major error domains:

```
NSMachErrorDomain
NSPOSIXErrorDomain
NSOSStatusErrorDomain
NSCocoaErrorDomain
```

The above sequence of domain constants indicates the general layering of the domains, with the Mach error domain at the lowest layer. You get the domain of an error by sending an NSError object a `domain` message.

In addition to the four major domains, there are error domains that are specific to frameworks or even to groups of classes or individual classes. For example, the Web Kit framework has its own domain for errors in its Objective-C implementation, `WebKitErrorDomain`. Within the Foundation framework, the URL classes have their own error domain (`NSURLErrorDomain`) as do the XML classes (`NSXMLParserErrorDomain`). The NSStream class itself defines two error domains, one for SSL errors and the other for SOCKS errors.

The Cocoa error domain (`NSCocoaErrorDomain`) includes all error codes for the Cocoa frameworks—except, of course, for error codes in class-specific domains of those frameworks. These frameworks include not only Foundation and Application Kit, but Core Data and potentially other Objective-C frameworks. (Error domains within the Cocoa frameworks that are separate from the Cocoa error domain were defined before the latter was introduced.)

Domains serve several useful purposes. They give Cocoa programs a way to identify the Mac OS X subsystem that is detecting an error. They also help to prevent collisions between error codes from different subsystems with the same numeric value. In addition, domains allow for a causal relationship between error codes based on the layering of subsystems; for example, an error in the `NSOSStatusErrorDomain` may have an underlying error in the `NSMachErrorDomain`.

You can create your own error domains and error codes for use in your own frameworks, or even in your own applications. It is recommended that the string constant for the domain be of the form `com.`*company*`.`*framework_or_app*`.ErrorDomain`.

Error Codes

An error code identifies a particular error in a particular domain. It is a signed integer assigned as the value of a program symbol. You get the error code by sending an NSError object a `code` message. As listed in Table 1-1, error codes are declared and documented in one or more header files for each major domain.

Table 1-1 Header files for error codes in major domains

Domain	Header file
Mach	`/usr/include/mach/kern_return.h`
POSIX	`/usr/include/sys/errno.h`
Carbon (`OSStatus`)	`/System/Library/Frameworks/CoreServices.framework/Frameworks/CarbonCore.fram`
Cocoa	See Table 1-2.

Table 1-2 lists the frameworks and header files where error codes in the Cocoa domain are currently declared.

Table 1-2

Framework/Header	Description
`<Foundation/FoundationErrors.h>`	Generic Foundation error codes
`<AppKit/AppKitErrors.h>`	Generic Application Kit error codes
`<CoreData/CoreDataErrors.h>`	Core Data error codes

To give an idea of how you might test for and act upon errors, let's say you want to test for underlying POSIX errors during an operation that writes to a file. (Underlying errors are explained in "Underlying Error" (page 14).) If you consulted the POSIX error codes declared in `/usr/include/sys/errno.h`, you would see a list similar to Listing 1-1.

Listing 1-1 Part of the POSIX error-code declarations (`errno.h`)

```
#define EPERM       1       /* Operation not permitted */
#define ENOENT      2       /* No such file or directory */
#define ESRCH       3       /* No such process */
#define EINTR       4       /* Interrupted system call */
#define EIO         5       /* Input/output error */
#define ENXIO       6       /* Device not configured */
#define E2BIG       7       /* Argument list too long */
#define ENOEXEC     8       /* Exec format error */
#define EBADF       9       /* Bad file descriptor */
#define ECHILD      10      /* No child processes */
#define EDEADLK     11      /* Resource deadlock avoided */
                            /* 11 was EAGAIN */
#define ENOMEM      12      /* Cannot allocate memory */
#define EACCES      13      /* Permission denied */
#define EFAULT      14      /* Bad address *#H
```

You could choose the error conditions you want to test for and use them in code similar to that in Listing 1-2.

Listing 1-2 Testing for particular error codes in a specific domain

```
// underError is underlying-error object of a Cocoa-domain error
if ( [[underError domain] isEqualToString:NSPOSIXErrorDomain] ) {
        switch([underError code]) {
            case EIO:
            {
                // handle POSIX I/O error
            }
            case EACCES:
            {
                // handle POSIX permissions error
            {
        // etc.
        }
}
```

You may declare you own error codes for use by your own applications or frameworks, but the error codes should belong to your own domain. You should never add error codes to an existing domain that you do not "own."

The User Info Dictionary

Every NSError object has a "user info" dictionary to hold error information beyond domain and code. You access this dictionary by sending a `userInfo` message to an NSError object. The advantage of a NSDictionary over another kind of container object is that it is flexible; it can even carry custom information about an error. But all user info dictionaries contain (or can contain) several predefined string and object values related to an error.

Localized Error Information

An important role for NSError objects is to contain error information that programs can display in an alert dialog or sheet. This information is usually stored in the user info dictionary as strings in several categories: description, failure reason, recovery suggestion, and recovery options. (See Figure 1-1 (page 13) for the placement of these strings on an alert.) When you create an NSError object, you should insert localized strings into the dictionary, unless you want to compute them lazily.

Note: Don't expect the user info dictionary of every error object to contain localized strings. A subclass of NSError, for example, could override `localizedDescription` to compose these strings on-the-fly from the error domain, code, and context instead of storing them.

You can usually access the localized information associated with an NSError object in one of two ways. You can send `objectForKey:` to the user info dictionary, specifying the appropriate key. Or you can send a equivalent message to the NSError object. However, you should send the message rather than use the dictionary key to access a localized string. The error object might not store the string in the dictionary, instead choosing to compose it dynamically. The dictionary is designed to be a fallback mechanism, not the sole repository of error strings. Use the dictionary keys instead to store your own strings in the user info dictionary.

The following summaries include both the dictionary key and the method used to access the localized string:

Error description

The main description of the error, appearing in a larger, bold type face. It often includes the failure reason. If no error description is present in the user info dictionary, NSError either constructs one from the error domain and code or (when the domain is well-known , such as `NSCocoaErrorDomain`), attempts to fetch a suitable string from a function or method within that domain. .

User info key: `NSLocalizedDescriptionKey`

Method: `localizedDescription` (never returns `nil`)

Failure reason

A brief sentence that explains the reason why the error occurred. It is typically part of the error description. Methods such as `presentError:` do not automatically display the failure reason because it is already included in the error description. The failure reason is for clients that only want to display the reason for the failure.

User info key: `NSLocalizedFailureReasonErrorKey`

Method: `localizedFailureReason` (can return `nil`)

Note: An example can help to clarify the relationship between error description and failure reason. An error object has an error description of "File could not be saved because the disk is full." The accompanying failure reason is "The disk is full."

Recovery suggestion

A secondary sentence that ideally tells users what they can do to recover from the error. It appears beneath the error description in a lighter type face. If the recovery suggestion refers to the buttons of the error alert, it should use the same titles as specified for recovery options (`NSLocalizedRecoveryOptionsErrorKey`). You may use this string as a purely informative message, supplementing the error description and failure reason.

User info key: `NSLocalizedRecoverySuggestionErrorKey`

Method: `localizedRecoverySuggestion` (can return `nil`)

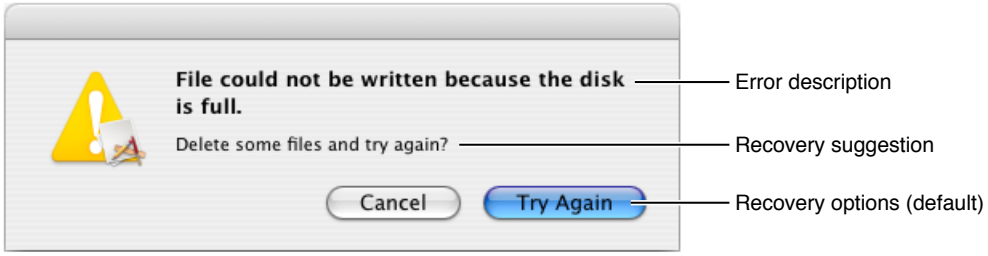
Recovery options

An array of titles (as strings) for the buttons of the error alert. By default, alert sheets and dialogs for error messages have only the "OK" button for dismissing the alert. The first string in the array is the title of the rightmost button, the next string is the title of the button just to the left of the first, and so on. Note that if a recovery attempter is specified for the error object, the recovery-options array should contain more than one string. The recovery attempter accesses the recovery options in order to interpret user choices.

User info key: `NSLocalizedRecoveryOptionsErrorKey`

Method: `localizedRecoveryOptions` (if returns `nil`, implies a single "OK button)

Figure 1-1 The localized strings of an NSError object



Note: Beginning with Mac OS X version 10.4, you can use the `alertWithError:` class method of NSAlert as a convenience for creating NSAlert objects to use when displaying alert dialogs or sheets. The method extracts the localized information from the passed-in NSError object for its message text, informative text, and button titles. You may also use the `presentError:` message to display error alerts.

To internationalize your error strings, create a `.strings` file for each localization and place the file in an appropriately named `.lproj` subdirectory of your bundle's `Resources` directory. Then use one of the `NSLocalizedString` macros to add localized strings to the user info dictionary of an NSError object. For more on internationalization and string localization, see *Internationalization Programming Topics*.

Note: For many error objects in the Cocoa error domain, the localization is performed on demand; in these cases, the localized values are not stored in the user info dictionary.

The Recovery Attempter

An NSError object's user info dictionary can also contain a recovery attempter. A recovery attempter is an object that implements one or more methods of the NSErrorRecoveryAttempting informal protocol. In many cases, this is the same object that creates the NSError object, but it can be any other object that may know how to recover from a particular error.

If a recovery attempter has been specified for an NSError object, and multiple recovery options have also been specified, when the error alert is displayed and the user selects a recovery option, the recovery attempter is given a chance to recover from the error. You access the recovery attempter by sending `recoveryAttempter` to the NSError object. You can add an recovery attempter to the user info dictionary using the key `NSRecoveryAttempterErrorKey`.

For more on the recovery-attempter object and its role in error handling, see "Error Responders and Error Recovery" (page 15).

Underlying Error

The user info dictionary can sometimes include another NSError object that represents an error in a subsystem underlying the error represented by the containing NSError. You can query this underlying error object to obtain more specific information about the cause of the error.

You access the underlying error object by using the `NSUnderlyingErrorKey` dictionary key.

Domain-Specific Keys

Many of the various error domains specify keys for accessing particular items of information from the user info dictionary. This information supplements the other information in the error object. For example, the Cocoa domain defines the keys `NSStringEncodingErrorKey`, `NSURLErrorKey`, and `NSFilePathErrorKey`.

Check the header files or documentation of error domains to find out what domain-specific keys they declare.

Error Responders and Error Recovery

As "Why Have Error Objects?" (page 9) points out, NSError objects bring considerable advantages to Cocoa programming. But the Cocoa frameworks also give NSError objects a prominent role to play in architectures for error presentation and error recovery. These architectures enhance the usefulness of error objects. They make it possible for Cocoa applications to present users with a richer and more customizable range of messages, and to attempt recovery from errors as well as informing users of them.

Note: The error-presentation and error-recovery architectures described in this chapter are new with Mac OS X v10.4. Earlier versions of the operating system do not have these architectures.

The Error-Responder Chain

The Application Kit, largely through the NSResponder class, defines a mechanism known as the responder chain by which events and action messages in an application are passed up the view hierarchy to windows and eventually to the application object. The Application Kit defines a similar chain of objects for error handling and presentation.

To initiate the journey of an NSError object up the error-responder chain, you can send one of two messages to any object in the chain:

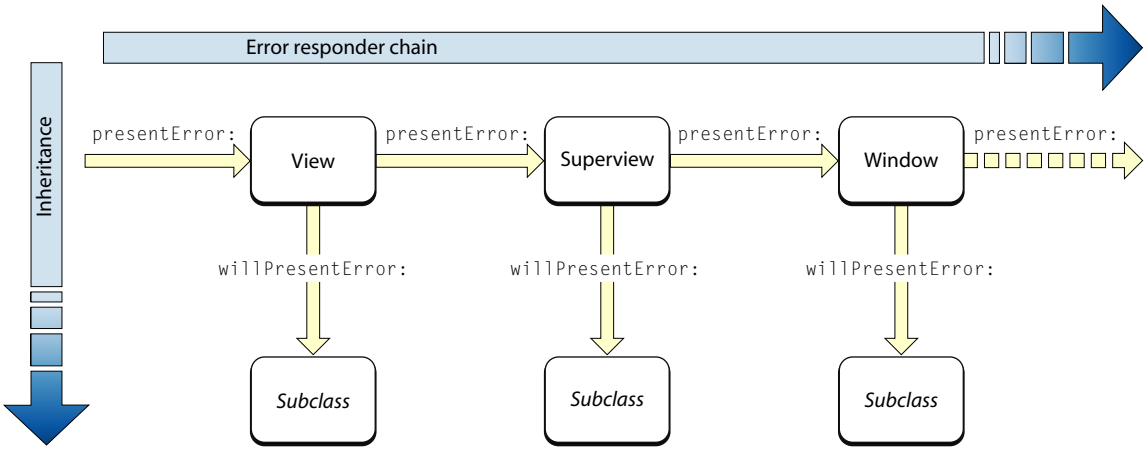
- `presentError:` — for error messages displayed in application-modal alert dialogs
- `presentError:modalForWindow:delegate:didPresentSelector:contextInfo:` — for error messages displayed in document-modal alert sheets

Although these methods are declared by the NSResponder class, you may also send them to objects of the NSDocument and NSDocumentController classes. (The NSResponder class is the superclass, of course, of the NSView, NSWindow, NSApplication, and NSWindowController classes.)

The default behavior of both the `presentError:...` methods—except for the NSApplication implementation—is to send `willPresentError:` to `self` before forwarding the `presentError:..` message to the next object in the chain. Subclasses can implement the `willPresentError:` method to inspect the passed-in NSError object and return a customized object. Subclasses might want to do this if they know more than their superclass about the conditions giving rise to the error or if they know best how to recover from it.

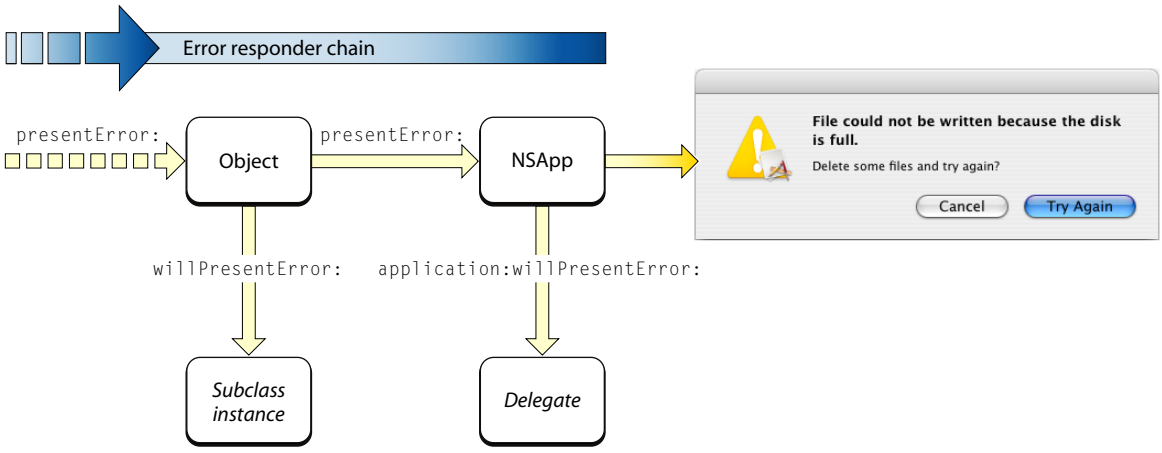
For the purposes of illustration, assume that a view object well down the view hierarchy receives the `presentError:` message. As Figure 2-1 shows, it sends `willPresentError:` to `self` and then sends `presentError:` to its superview, passing it any modified NSError object. The superviews of the originating view do the same thing until finally the window's content view sends the `presentError:` message to its window object.

Figure 2-1 The error-responder chain—part one



The `presentError:` message proceeds up the chain of error responders in this fashion until it reaches the global application object, NSApp. As Figure 2-2 depicts, NSApp sends the `application:willPresentError:` message to its delegate, giving it the same opportunity as the subclass objects in the chain to inspect the error object and possibly modify it—but without the need for a custom subclass. When the delegate returns, NSApp displays the error as (in this case) an alert dialog.

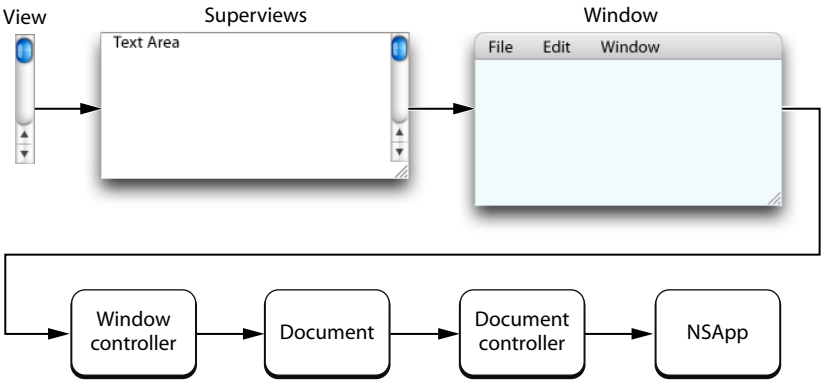
Figure 2-2 The error-responder chain — part two



Important: Overriding the `presentError:modalForWindow:delegate:didPresentSelector:contextInfo:` method or `presentError:` method is not recommended.

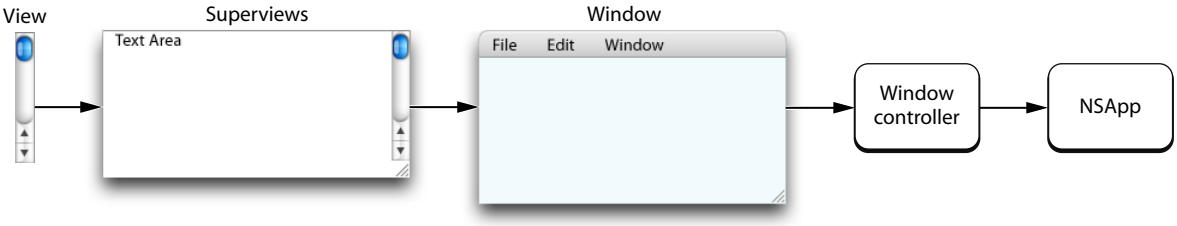
The exact sequence of objects in the error-responder chain varies according to the type of application. For document-based applications, the error-responder chain includes document objects, window controllers, and document controllers as well as views, windows, and NSApp (Figure 2-3).

Figure 2-3 Error-responder chain for document-based applications



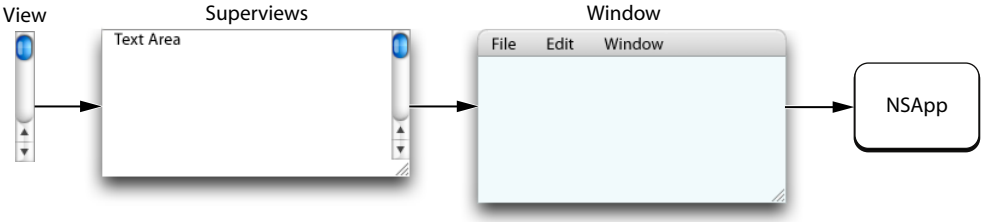
Some Cocoa applications are not document-based but still use one or more window controllers. Figure 2-4 shows the sequence of objects in this error-responder chain.

Figure 2-4 Error-responder chain for non-document applications with window controllers



Finally, simple Cocoa applications—those that are not document-based and that don't use window controllers—have an error-responder sequence as depicted in Figure 2-5.

Figure 2-5 Error-responder chain for simple (non-document) applications



Error Customization

As described in the preceding section, all along the error-responder chain custom subclasses of objects in the chain are given the opportunity to inspect and customize an NSError object if they implement the `willPresentError:` method. Near the end of the chain the application delegate has the same opportunity in `application:willPresentError:`. What kind of tests and customizations can take place in these methods?

In either method, you probably first want to determine what the error is. When doing this, test the NSError object's domain and error code against the constants that are probably related to the error condition. Do not evaluate the description or recovery strings as these can vary, especially when they are localized. You might also narrow down the cause of the error by using domain-specific keys to extract various pieces of information from the user info dictionary.

Important: You should always special-case test for the `NSUserCancelledError` error code (in the `NSCocoaErrorDomain`). This code indicates that the user cancelled the operation (for example, by pressing Command-period). In this case, you should not display any error dialog.

You might also want to find out if the error object has an underlying error; you can access this object from the user info dictionary with the `NSUnderlyingErrorKey` key. If there is an underlying error, and this object has a failure reason in its user info dictonary, you can append this localized string to the error description to create a more informative description.

If you decide that you know how to recover from the error, you can add an object to the user info dictionary as the recovery attempter. For a recovery attempter to be effective, it must satisfy the requirements summarized in "Error Recovery" (page 18).

If you are customizing a received NSError object to have a custom error domain and error code, you may choose to store the original error in the user info dictonary as an underlying error. Use the key `NSUnderlyingErrorKey` for this purpose (or override the `recoveryAttempter` method).

You cannot modify a received NSError object because the class provides no setter methods and the user info dictionary is immutable. When customizing an error, you must create a new NSError object, initializing with new data plus data from the old error object that you want to carry over. See "Using and Creating Error Objects" (page 21) for explicit instructions and examples.

Error Recovery

A recovery attempter is an object designated to attempt, upon user request, a recovery from a specific error. For example, say that a program cannot save a file because it is locked. The recovery attempter could try to unlock it first before overwriting it.

The error recovery mechanism is similar to the delegate design pattern in that a designated object —the recovery attempter—is asked to respond to a user action. An NSError object can encapsulate a recovery attempter and recovery options, which is an array of button titles to display in the error alert. Among the button titles is one requesting error recovery. When an error alert is displayed and the user clicks a button, the application sends a message to the recovery attempter, passing it the index of the button that was clicked. If the the "recover" button was clicked, the recovery attempter tries to complete the operation in a way that avoids the error or fixes the condition that gives rise to it. Finally, the recovery attempter informs either the application object or the document-modal sheet delegate whether it was successful.

There are three requirements for error recovery to occur as a result of a user choice:

- The recovery-attempter object must implement one of the NSErrorRecoveryAttempting informal protocol methods:
  `attemptRecoveryFromError:optionIndex:delegate:didRecoverSelector:contextInfo:`
  or `attemptRecoveryFromError:optionIndex:`, depending on whether the error alert is document-modal (sheet) or application-modal (dialog), respectively.

- The `recoveryAttempter` method must return a suitable object. To ensure this, you can add the recovery attempter to the user info dictionary as the value of `NSRecoveryAttempterErrorKey` , or you can override the `recoveryAttempter` method.
- The the `localizedRecoveryOptions` must return an array of button titles (including the title of the button that requests error recovery). To ensure this, you can add the array to the user info dictionary as the value of `NSLoalizedRecoveryOptionsErrorKey` , or you can override the `localizedRecoveryOptions` method.

For the complete procedure for error recovery, including sample code, see "Recovering From Errors" (page 31).

Using and Creating Error Objects

The following sections describe how to deal with NSError objects returned from framework methods, how to display error messages using error objects, how to create error objects, and how to implement methods that return error objects by reference.

Handling Error Objects Returned From Methods

Beginning with Mac OS X v10.4, many methods in the Cocoa frameworks include as their last parameter an indirect reference to an NSError object. Typically these are methods that create a document, write a file, load a URL, access a resource, or perform a similar operation. For example, the following method declaration is from the NSDocument class header file:

```
- (BOOL)writeToURL:(NSURL *)absoluteURL
    ofType:(NSString *)typeName
    error:(NSError **)outError;
```

If this method encounters an error in its implementation, it directly returns `NO` to indicate failure and indirectly returns (if the client code requests it) an NSError object in the last parameter to describe the error. If you want to evaluate the error, declare an NSError object variable before calling a method such as `writeToURL:ofType:error:`. When you invoke the method, pass in a pointer to this variable. (If you are not interested in the error, just pass `NULL`.) If the method directly returns `nil` or `NO`, inspect the NSError object to determine the cause of the error or simply display an error alert. Listing 3-1 illustrates this approach.

Listing 3-1 Handling an NSError object returned from a Cocoa method

```
NSError *theError;
BOOL success = [myDoc writeToURL:[self docURL]
                    ofType:@"html"
                    error:&theError];
if (success == NO) {
    // maybe try to determine cause of error and recover first
    NSAlert *theAlert = [NSAlert alertWithError:theError];
    [theAlert runModal]; // ignore return value
}
```

Note: Cocoa methods that indirectly return error objects in the Cocoa error domain are guaranteed to return such objects if the method indicates failure by directly returning `nil` or `NO`.

This code fragment uses the returned NSError to display an error alert to the user immediately. Error objects in the Cocoa domain are always localized and ready to present to users, so they can often be presented without further evaluation. (The example in Listing 3-1 is just one of the several approaches you could take for displaying errors; see the following section, "Displaying Information From Error Objects" (page 23), for more on this topic).

Instead of merely displaying an error message returned from a framework call, you could examine the NSError object to determine if you can do something else:

- You might be able to perform the operation again in a slightly different way that circumvents the error—without notifying the user.
- If you know how to recover from the error, but require the user's approval, you could create a new version of the error object that adds a recovery attempter to it (see "Recovering From Errors" (page 31)).
- You might be able supplement the information in the error from the current programming context and then create a new error object that contains this enriched information.
- Send the error object up the error-responder chain so that other objects in the application can add to it or try to recover from the error.
- If you use the returned NSError as the basis of a new error object, either by adding a recovery attempter or supplementary information, you can either:
  - Display the message immediately.
  - Pass the error on to the next error responder.

  For more on customizing errors passed up the error-responder chain, see "Handling Received Errors" (page 27).

Important: You should always special-case test for the `NSUserCancelledError` error code (in the `NSCocoaErrorDomain`). This code indicates that the user cancelled the operation (for example, by pressing Command-period). In this case, you should not display any error dialog.

When evaluating an NSError object, always use the object's domain and error code as the bases of tests and not the strings describing the error or how to recover from it. Strings are typically localized and are thus likely to vary. With a few exceptions, pre-existing errors returned from Cocoa framework methods are always in the `NSCocoaErrorDomain` domain; however, because there are exceptions you might want to test whether the top-level error belongs to that domain. Error objects returned from Cocoa methods can often contain underlying error objects representing errors returned by lower subsystems, such as the BSD layer (`NSPOSXIErrorDomain`).

Of course, to make a successful evaluation of an error, you have to anticipate the errors that might be returned from a method invocation. And you should ensure that your code deals adequately with new errors that might be returned in the future.

Note: Some methods of the Cocoa frameworks can give you error objects in ways other than indirection. For example, some methods of the NSXMLParser class, such as `parser:validationErrorOccurred:`, pass an NSError object to the delegate if an fatal error has occurred. Other methods, such as `streamError` of the NSStream class, return an NSError object directly. What you can do with the error object is the same in all cases.

Displaying Information From Error Objects

There are several different ways to display the information in NSError objects. You could extract the localized description (or failure reason), recovery suggestion, and the recovery options from the error object and use them to initialize an NSAlert object with message text, informative text, and button titles. Although this approach is the most painstaking, it does give you a large degree of control over the content and presentation of the error alert.

Fortunately, the Application Kit provides a few shortcuts for displaying error alerts. The `presentError:` and the `presentError:modalForWindow:delegate:didPresentSelector:contextInfo:` methods permit you to originate an error alert that is eventually displayed by the application object, NSApp; the former method requests an application-modal alert and the latter a document-modal alert. You must send either of these present-error messages to an objects in the error-responder chain (see "The Error-Responder Chain" (page 15)): a view object, a window object, an NSDocument object, an NSWindowController object, an NSDocumentController object, or NSApp. (If you send the message to a view, it should ideally be a view object associated in some way with the condition that produced the error.) Listing 3-2 illustrates how you might invoke the document-modal `presentError:modalForWindow:delegate:didPresentSelector:contextInfo:` method.

Listing 3-2 Displaying a document-modal error alert

```
NSError *theError;
NSData *theData = [doc dataOfType:@"xml" error:&theError];
if (!theData && theError)
    [anyView presentError:theError
            modalForWindow:[doc windowForSheet]
            delegate:self
            didPresentSelector:
                @selector(didPresentErrorWithRecovery:contextInfo:)
            contextInfo:nil];
```

After the user dismisses the alert, NSApp invokes a method (identified in the `didPresentSelector:` keyword) implemented by the modal delegate. As Listing 3-3 shows, the modal delegate in this method checks whether the recovery-attempter object (if any) managed to recover from the error and responds accordingly.

Listing 3-3 Modal delegate handling the user response

```
- (void)didPresentErrorWithRecovery:(BOOL)recover
            contextInfo:(void *)info {
    if (recover == NO) { // recovery did not succeed, or no recovery attempter
        // proceed accordingly
    }
}
```

For more on the recovery-attempter object, see "Recovering From Errors" (page 31).

Sometimes you might not want to send an error object up the error-responder chain to be displayed by NSApp. You would rather show an error alert to the user immediately, and not have to construct it yourself. The NSAlert class provides the `alertWithError:` method for this purpose.

Listing 3-4 Directly displaying an error alert dialog

```
NSAlert *theAlert = [NSAlert alertWithError:theError];
int button = [theAlert runModal];
if (button != NSAlertFirstButtonReturn) {
    // handle
}
```

Note: The `presentError:` and `presentError:modalForWindow:delegate:didPresentSelector:contextInfo:` methods silently ignore `NSUserCancelledError` errors in the `NSCocoaErrorDomain` domain.

Creating and Returning NSError Objects

You can declare and implement your own methods that indirectly return an NSError object. Methods that are good candidates for NSError parameters are those that open and read files, load resources, parse formatted text, and so on. In general, these methods should not indicate an error through the existence of an NSError object. Instead, they should return `NO` or `nil` from the method to indicate that an error occurred. Return the NSError object to describe the error.

If you are going to return an NSError object by reference in an implementation of such a method, you must create the NSError object. You create an error object either by allocating it and then initializing it with the `initWithDomain:code:userInfo:` method of NSError or by using the class factory method `errorWithDomain:code:userInfo:` . As the keywords of both methods indicate, you must supply the initializer with a domain (string constant), an error code (a signed integer), and a "user info" dictionary containing descriptive and supporting information. (See "Error Objects, Domains, and Codes" (page 9) for full descriptions of these data items.) You should ensure that all strings in the user info dictionary are localized. If you create an NSError object with `initWithDomain:code:userInfo:`, you should send `autorelease` to it before you return it to the caller.

Listing 3-5 is an example of a method that, for the purpose of illustration, calls the POSIX-layer `open` function to open a file. If this function returns an error, the method creates an NSError object of the `NSPOSIXErrorDomain` that is used as the underlying error of a custom error domain returned to the caller.

Listing 3-5 Implementing a method that returns an NSError object

```
- (NSString *)fooFromPath:(NSString *)path error:(NSError **)anError {
    const char  *fileRep = [path fileSystemRepresentation];
    int fd = open(fileRep, O_RDWR|O_NONBLOCK, 0);
    if (fd == -1) {
        NSString *descrip;
        NSDictionary *uDict;
        int errCode;
        if (errno == ENOENT) {
                descrip = NSLocalizedString(@"No such file or directory at
```

```
                requested location", @"");
            errCode = MyCustomNoFileError;
    } else if (errno == EIO) {
        // continues for each possible POSIX error...
    }

    // Make underlyining error
    NSError *undError = [[[NSError alloc] initWithDomain:NSPOSIXErrorDomain
        code:errno userInfo:nil] autorelease];
    // Make and return custom domain error
    NSArray *objArray = [NSArray arrayWithObjects:descrip, undError, path, nil];
    NSArray *keyArray = [NSArray arrayWithObjects:NSLocalizedDescriptionKey,
        NSUnderlyingErrorKey, NSFilePathErrorKey, nil];
    NSDictionary *eDict = [NSDictionary dictionaryWithObjects:objArray
        forKeys:keyArray];
    if (anError != NULL)
        *anError = [[[NSError alloc] initWithDomain:MyCustomErrorDomain
            code:errCode userInfo:eDict] autorelease];
    return nil;
}
// ...
```

In this example, the returned error object includes in its user info dictionary the path that caused the error.

As the example in Listing 3-5 shows, you can use errors that originate from underlying subsystems as the basis for error objects that you return to callers. You can use raised exceptions that your code handles in the same way. An NSException object is compatible with an NSError object in that its attributes are a name, a reason, and an user info dictionary. You can easily transfer information in the exception object over to the error object.

A Note on Errors and Exceptions

It is important to keep in mind the difference between NSError objects and NSException objects, and when to use one or the other in your code. They serve different purposes and should not be confused.

Exceptions (represented by NSException objects) are for programming errors, such as an array index that is out of bounds or an invalid method argument. User-level errors (represented by NSError objects) are for runtime errors, such as when a file cannot be found or a string in a certain encoding cannot be read. Conditions giving rise to exceptions are due to programming errors; you should deal with these errors before you ship a product. Runtime errors can always occur, and you should communicate these (via NSError objects) to the user in as much detail as they require.

Although exceptions should ideally be taken care of before deployment, a shipped application can still experience exceptions as a result of some truly exceptional situation such as “out of memory” or “boot volume not available.” It is best to allow the highest level of the application—NSApp itself—to deal with these situations.

Handling Received Errors

When you send a `presentError:` or `presentError:modalForWindow:delegate:didPresentSelector:contextInfo:` message to certain eligible objects, the message travels up a sequence of objects in an application called the error-responder chain (see "The Error-Responder Chain" (page 15)). The default implementation for most objects in this chain is to send the `willPresentError:` method to `self` before sending the `presentError:` message to the next object. The `willPresentError:` message gives instances of custom subclasses an opportunity to look at the error object being passed up the chain and possibly customize it. When the error object reaches the end of the chain, the global application object, NSApp, displays an error alert to users; but before NSApp displays the error alert, it invokes the method `application:willPresentError:`, giving its delegate the same opportunity.

The following sections discuss strategies for implementing the `willPresentError:` and `application:willPresentError:` methods.

Passing Errors Up the Error-Responder Chain

If you have a subclass of NSDocument, NSDocumentController, NSWindowController, NSWindow, NSPanel, or any view class, you can override the `willPresentError:` method to customize the presentation of errors. This might be something you want an instance of your subclass to do if it knows more about the context of a particular error than other objects in the application. Generally, an implementation of `willPresentError:` examines the passed-in NSError object and if, for example, its localized description is insufficient, or if the subclass knows how to recover from the error, it creates a new NSError object and returns it. In most cases, the customized error object retains some information from the passed-in object.

An implementation of the `willPresentError:` method should always use the error domain and error code as the basis for deciding whether to return a customized error object. Do not base the decision on the strings in the user info dictionary for these can be localized and may vary between invocations. If your implementation decides not to customize the error, don't return the passed-in object directly; instead, send the `willPresentError:` message to `super`. Listing 4-1 illustrates some of these strategies.

Listing 4-1 Handling an error passed up the error-responder chain

```
- (NSError *)willPresentError:(NSError *)error {
    if ([[error domain] isEqualToString:NSCocoaErrorDomain]) {

        switch([error code]) {
            case NSFileLockingError:
            case NSFileReadNoSuchFileError:
            { // private method of custom subclass
                return [self customizeError:error];
            }
            default:
                return [super willPresentError:error];
        }
```

```
    }
}
```

You don't have to make a subclass in order to customize an NSError object for presentation. Instead, your application delegate can implement the `application:willPresentError:` method. The same observations and guidelines given for `willPresentError:` above apply to the implementation of `application:willPresentError:`, except that you can return the original error object directly if you decide not to customize it.

Customizing an Error Object

In the `willPresentError:` example in Listing 4-1 (page 27), a private method is invoked to customize the error object. This is done to clarify the structure of the implementation. But if the customizing code was in-line, it might look some like the `willPresentError:` implementation in Listing 4-2. This code checks if the passed-in object has a failure reason and, if it does, it creates a more application-specific error description, appending the failure reason. Then it creates a new NSError object with this different description.

Listing 4-2 Customizing an NSError object

```
- (NSError *)willPresentError:(NSError *)error {
    if ([[error domain] isEqualToString:NSCocoaErrorDomain]) {

        switch([error code]) {
            case NSFileLockingError:
            case NSFileReadNoSuchFileError:
            {
                NSString *locFailure = [error localizedFailureReason];
                if (locFailure) {
                    NSMutableDictionary *newUserInfo = [NSMutableDictionary
                        dictionaryWithCapacity:[[[error userInfo] allKeys] count]];
                    [newUserInfo setDictionary:[error userInfo]];
                    NSString *errorDesc = [NSString stringWithFormat:
                        NSLocalizedString(@"MyGreatApp cannot open the file. %@", @""),
                        locFailure];
                    [newUserInfo setObject:errorDesc
                        forKey:NSLocalizedDescriptionKey];
                    NSError *newError = [NSError errorWithDomain:[error domain]
                        code:[error code] userInfo:newUserInfo];
                    return newError;
                } else {
                    return [super willPresentError:error];
                }
            }
            default:
                return [super willPresentError:error];
        }
    }
}
```

In this example, the original error object is essentially cloned to make the new one. The new error object contains a more specific error description and appends the failure reason to it.

As noted in "Passing Errors Up the Error-Responder Chain" (page 27), there is no difference in implementing `willPresentError:` and the delegate method `application:willPresentError:`, except that in the latter method you can return the passed-in error object directly if you do not customize it.

Note: For another example of error-object customization, see Listing 5-1 (page 31) in "Recovering From Errors" (page 31). In this case, the original object is changed to include recovery options, a recovery suggestion, and a recovery-attempter object.

Recovering From Errors

As described in "The Recovery Attempter" (page 14), an `NSError` object can have a designated recovery attempter, an object that attempts to recover from the error if the user requests it. The error object holds a reference to the recovery attempter in its user info dictionary, so if the error object is passed around within an application, the recovery attempter stays with it. The user info dictionary must also contain recovery options, an array of localized strings for button titles, one or more of which requests recovery. When the error is presented in an alert and the user selects the recovery option, a message is sent to the recovery attempter, requesting it to do its job.

Ideally, the recovery attempter should be an independent object that knows something about the conditions of an error and how best to circumvent those conditions. An application could even have an object whose role is to recover from errors of various kinds. A recovery attempter must implement at least one of the two methods of the NSErrorRecoveryAttempting informal protocol: `attemptRecoveryFromError:optionIndex:delegate:didRecoverSelector:contextInfo:` or `attemptRecoveryFromError:optionIndex:`. It implements the former method for error alerts presented document-modally, and the latter method for application-modal alerts.

You must also prepare an error object so that error recovery can take place. To do this, add three items to the user info dictionary of the error object:

- The recovery-attempter object under the key `NSRecoveryAttempterErrorKey`
- The recovery options, an array of localized strings, under the key `NSLocalizedRecoveryOptionsErrorKey`
- A recovery-suggestion string, also localized, under the key `NSLocalizedRecoverySuggestionErrorKey`. Although this property is not strictly required, an error alert that offers recovery as an option should display this string. And if the string refers to particular button titles, it should use the same titles in the recovery-options array.

  For guidelines about error alerts, see *Apple Human Interface Guidelines* (section on dialogs in "Windows").

Listing 5-1 illustrates a case involving the NSXMLDocument class. In this example, an NSDocument object attempts to create an internal tree representing an XML document using the `initWithContentsOfURL:options:error:` method of NSXMLDocument. If the attempt fails, the usual cause is that the source XML is malformed—for example, there is a missing end tag for an element, or an attribute value is not quoted. If the source XML is "tidied" first to fix the structural problems, it may be possible to create the XML tree.

In the example in Listing 5-1 if the invocation of `initWithContentsOfURL:options:error:` returns an error object by reference, the document object customizes the error object, adding (among other things) a recovery-attempter object, localized recovery options, and a localized recovery suggestion to its user info dictionary. Then it sends `presentError:modalForWindow:delegate:didPresentSelector:contextInfo:` to `self`.

Listing 5-1 Preparing for error recovery

```
- (BOOL)readFromURL:(NSURL *)furl ofType:(NSString *)type error:(NSError **)anError {
    NSError *err=nil;
```

```
    if (xmlDoc) {
        [xmlDoc release];
        xmlDoc = nil;
    }
    // xmlDoc is an NSXMLDocument instance variable
    xmlDoc = [[NSXMLDocument alloc] initWithContentsOfURL:furl
            options:NSXMLNodeOptionsNone error:&err];
    if (xmlDoc == nil && err) {
        NSString *newDesc = [[err localizedDescription] stringByAppendingString:
            ([err localizedFailureReason] ? [err localizedFailureReason] : @"")];
        NSMutableDictionary *newDict = [NSMutableDictionary dictionaryWithCapacity:4];
        [newDict setObject:newDesc forKey:NSLocalizedDescriptionKey];
        [newDict setObject:
            NSLocalizedString(@"Would you like to tidy the XML and try again?", @"")
            forKey:NSLocalizedRecoverySuggestionErrorKey];
        [newDict setObject:self forKey:NSRecoveryAttempterErrorKey];
        [newDict setObject:[NSArray arrayWithObjects:
            NSLocalizedString(@"Try Again", @""), NSLocalizedString(@"Cancel", @""),
            nil] forKey:NSLocalizedRecoveryOptionsErrorKey];
        [newDict setObject:furl forKey:NSURLErrorKey];
        NSError *newError = [[NSError alloc] initWithDomain:[err domain]
            code:[err code] userInfo:newDict];
        [self presentError:newError modalForWindow:[self windowForSheet]
            delegate:self
            didPresentSelector:@selector(didPresentErrorWithRecovery:contextInfo:)
            contextInfo:nil];
    }
// ...
```

Note that the document object also adds to the user info dictionary the URL identifying the source of XML. The recovery attempter will use this URL when it attempts to create a tree representing the XML.

The error object is passed up the error-responder chain and NSApp displays it. When the user clicks any button of the error alert, NSApp checks to see if the error object has both a recovery attempter and recovery options. If both of these conditions are true, it invokes the method implemented by the recovery attempter that corresponds to the mode of the alert (that is, document-modal or application-modal).

Listing 5-2 shows how the recovery attempter for the XML document implements the `attemptRecoveryFromError:optionIndex:delegate:didRecoverSelector:contextInfo:` method.

Listing 5-2 Recovering from the error and informing the modal delegate

```
- (void)attemptRecoveryFromError:(NSError *)error
                     optionIndex:(unsigned int)recoveryOptionIndex
                        delegate:(id)delegate
              didRecoverSelector:(SEL)didRecoverSelector
                     contextInfo:(void *)contextInfo {

    BOOL success=NO;
    NSError *err=nil;
    NSInvocation *invoke = [NSInvocation invocationWithMethodSignature:[delegate
methodSignatureForSelector:didRecoverSelector]];
    [invoke setSelector:didRecoverSelector];

    if (recoveryOptionIndex == 0) { // recovery requested
        xmlDoc = [[NSXMLDocument alloc] initWithContentsOfURL:[[error userInfo]
                objectForKey:NSURLErrorKey] options:NSXMLDocumentTidyXML error:&err];
```

```
        if (xmlDoc != nil) {
            success = YES;
        }
    }
    [invoke setArgument:(void *)&success atIndex:2];
    if (err)
        [invoke setArgument:&err atIndex:3];
    [invoke invokeWithTarget:delegate];
}
```

The key part of the above example is the test the recovery attempter makes to determine if the user clicked the "Try Again" button: it checks the value of `recoveryOptionIndex`. If the user did click this button, the recovery attempter invokes the `initWithContentsOfURL:options:error:` method again, this time with the `NSXMLDocumentTidyXML` option. Then it creates and invokes an NSInvocation object, thereby sending the required message to the modal delegate of the error alert. The invocation object includes the two parameters required by the delegate's selector: a Boolean indicating whether the recovery attempt succeeded and a "context info" parameter which, in this case, contains any error object returned from the recovery attempt.

Note: The example in Listing 5-2 shows the use of NSInvocation to send a message. However, if you have a reference to the modal delegate and know the name of the method it implements, you can send the message directly.

When the modal delegate receives the message from the recovery attempter, as in Listing 5-3, it can respond appropriately.

Listing 5-3 Modal delegate responding to recovery attempter

```
- (void)didPresentErrorWithRecovery:(BOOL)didRecover
            contextInfo:(void *)contextInfo {
NSError *theError = (NSError *)contextInfo;
    if (didRecover) {
        [tableView reloadData];
    } else if (theError && [theError isKindOfClass:[NSError class]]) {
        [NSAlert alertWithError:theError];
    }
}
```

Document Revision History

This table describes the changes to *Error Handling Programming Guide For Cocoa*.

Date	Notes
2009-03-04	Corrected a link error.
2009-01-06	Added link to "Error Handling in the Document Architecture" in Document-Based Application Overview. Mentioned default behavior of presentError: with NSCocoaErrorDomain/NSUserCancelledError errors. Provided related reference, sample code, and documents.
2006-10-03	Corrected code in Listing 5-2 showing creation of NSInvocation object.
2006-04-04	Corrected code listing illustrating error recovery and discussed NSUserCancelledError code.
2005-04-29	New document that describes how to use NSError objects and related Application Kit support when handling user-level errors.

Document Revision History

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