Adobe® InDesign® 2 Programming Guide

Adobe Systems' documentation on how to use the Application Programming Interfaces for our next generation publishing product.

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Adobe InDesign Programming Guide

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1. Overview

1.0. Introduction

This chapter introduces you to the application program interface (API) plug-ins (source code) furnished with the SDK and the InDesign plug-in environment. It also describes the basic operations of the application, presented as programming considerations. If you understand the application, which itself consists of plug-ins, it will be easier for you to write plug-ins using or enhancing InDesign's functionalities.

At the end of the chapter, loading instructions and brief descriptions for the example plug-ins included in the SDK are provided. After you've read about the InDesign environment and operational information in this chapter, it is suggested you load the plug-ins and experiment.

1.1. Goals

The goals of this chapter are to:

- Acquaint you with the plug-in environment furnished by InDesign.
- Briefly describe the SDK-furnished API plug-ins.
- Provide programming considerations describing the basic InDesign operations.
- Provide loading instructions and brief descriptions for the example plug-ins.

1.2. Chapter-at-a-glance

"1.3. API Plug-ins Furnished by the SDK" on page 25 lists the plug-in code installed in the **Adobe InDesign 2.0 SDK/Api/Implementation/** directory. This code is useful when writing a plug-in.

"1.4. Plug-in Environment" on page 25 introduces the development environment supported by InDesign and the SDK.

"1.5. Programming Considerations" on page 29 provides InDesign details to be aware of when developing plug-ins.

"1.6. Summary" on page 56 recaps the material presented in this chapter.

"1.7. Review" on page 57 presents some review questions you can answer to check your knowledge before proceeding on to the next chapter.

"1.8. References" on page 57 lists reference material supporting the information in this chapter.

table 1.2.a. version history

Rev	Date	Author	Notes
2.0	23-Oct-02	Lee Huang	Update content for InDesgn 2.x API
0.1	2000		First Draft

1.3. API Plug-ins Furnished by the SDK

The following table summarizes the API plug-ins provided by the SDK. These are found in **Adobe InDesign 2.0 SDK/Api/Implementation/**, with associated interfaces defined in **Adobe InDesign 2.0 SDK/Api/Interfaces/**.

table 1.3.a. sdk-supplied plug-ins

Plug-In Set	Description
Commands	Code supporting the development of commands. See "1.5.2. Commands" on page 32.
Common Data	Code supporting object persistence. See "1.5.5. Common Data (Persistence)" on page 35.
Data Exchange	Code supporting data transfer using the operating system clipboard. See "1.5.12. Data Exchange" on page 43.
Document	Code supporting documents. See "1.5.6. Documents" on page 36.
Events	Code supporting event handling. See "1.5.18. Events" on page 49.
Graphics	Code supporting graphics and images. See "1.5.8. Graphics and Images" on page 39.
Localization	Code supporting customization for various locales. See "1.5.14. Text" on page 44.
Measurement Systems	Code supporting measurement systems.
Menus	Code supporting menus and menu components. See "1.5.1.3. Menus" on page 32.
Messaging	Code supporting messaging. See "1.5.3. Messaging" on page 33.
Page Items	Code for preparation of document page items. See "1.5.7. Page Items" on page 38.
Strings	Code supporting string handling. See "1.5.21. Strings" on page 49.
Trackers	Code to allow development of trackers for tools. See "1.5.4. Tools" on page 34.
Utilities	Code supporting various utilities that apply to plug-in development.
Widgets	Code assisting in development of plug-ins that implement widgets. See "1.5.1.1. Widgets" on page 29.

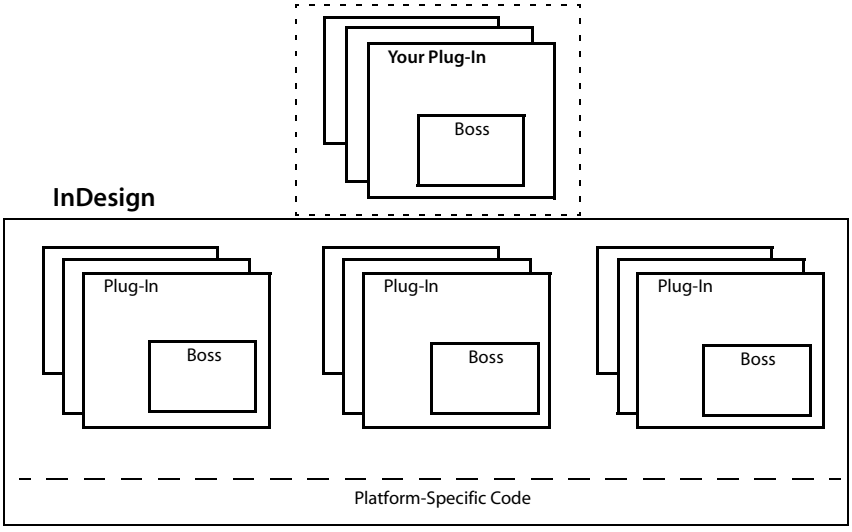
1.4. Plug-in Environment

When writing a plug-in to use or extend the functionality of InDesign, you are building on the basic features of the application itself. InDesign is packaged as a small core executable with the bulk of the feature set implemented as required plug-ins, a number of interfaces, helper classes, and commands. There is also a set of plug-ins that are not required, but it is part of the application. All the

application modules are hierarchically represented by an **object model** having its own interface.

Each plug-in can support a number of classes, either new ones or classes inheriting from the application-provided interfaces and helper classes. To support the distributed objects (class instantiations) associated with it's plug-ins, InDesign introduces the concept of a **boss**, with a **boss object** being an instantiation of a boss. The boss (for example, `kDocumentBoss`) is essentially a class providing a mapping between interfaces and implementation classes for a particular functional area of a plug-in. Each plug-in can support one or more bosses, depending on the functionality it provides.

figure 1.4.a. operating environment



Your plug-in will consist of new functionality you write, inheriting from the applicable classes within the application. Of course, you can also create implementations of the InDesign interfaces to use the internal application classes as they are. For example, you can add to InDesign menu components,

palettes, commands, and document-persistent data. All these elements will be available to other plug-ins at application run time.

1.4.1. Object Model

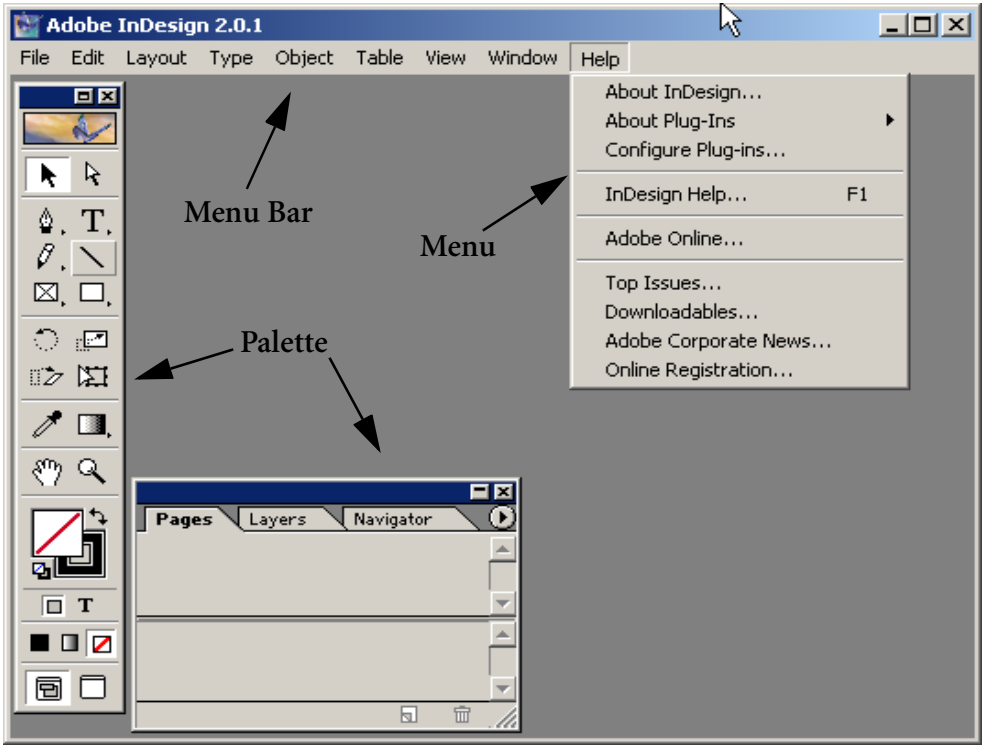
As mentioned above, InDesign uses an object model to control classes and implementations for all plug-ins. The interface for the object model is `IObjectModel`. For details, see the chapter "Architecture."

1.4.2. Base Class for All Interfaces (IPMUnknown)

InDesign provides a base class called `IPMUnknown`. It is inherited by all class objects exporting functionality to the object model. `IPMUnknown` supports methods allowing for querying interfaces and maintaining reference counts for pointers handed out to interfaces.

1.4.3. InDesign Session and Workspace

An InDesign **session** is considered the period between application startup and application shutdown. Its environment is set up by an `IEnvironment` interface that initializes and shuts down system software, accesses system settings, and



accesses version numbers. The session itself (`ISession` interface) supplies plug-ins with key resources of the InDesign environment. These resources include the active context, the application itself, the work area for the application, and the application's command processor.

InDesign creates a work area (**application workspace**) for the session. The basic interface for this workspace is `IWorkspace`, which provides startup and shutdown methods. It also keeps track of plug-ins implementing workspaces (for example, a **document workspace**). The application workspace presents general information for the application, and data pertaining to entire workspace, but not specific to a particular document.

figure 1.4.3.a. application workspace

Be aware the application workspace is a container with several main elements, including a menu bar, menus, and palettes. The **menu bar** at the top of the area presents **menus** for each of the main functions of the application, including one for the example plug-ins furnished with the SDK. The controlling interface for menus is `IMenuManager`. For more about menus, see "1.5.1.3. Menus" on page 32.

InDesign offers a number of **palettes**, with a controlling interface called `IPaletteMgr`. Each palette is a window that presents information arranged in icons or panels. The **toolbox** is an example of a palette presenting it's information in icons, each of which activates a particular **tool** ("1.5.4. Tools" on page 34). Palettes are accessible from the application's **Window** menu. Some palettes come up by default when the application starts.

Other main InDesign operations associated with the session and workspace include those in the list below. Each operation is associated with one or more controlling interfaces.

- Management of clipboard, dialogs, cursors, plug-ins, keyboard, mouse, color, measurement systems, and memory

- Command processing
- Maintenance of preferences and defaults
- Document open, close, save, and recovery
- Maintenance of views
- Event handling
- Exception handling
- Provision of a service registry, used at startup to automatically locate all service provider plug-ins and find out what services they support
- Localization

1.5. Programming Considerations

This section briefly discusses programming considerations for developing plug-ins to operate with InDesign. If you have questions about the referenced user interface (UI) components, refer to the *InDesign 2.0 User Guide*.

Remember from the previous section that API source code furnished with the SDK is located in **Adobe InDesign 2.0 SDK/Api/** in the **Implementation** and **Includes** directories. Interfaces are defined in header files in **Adobe InDesign 2.0 SDK/Api/Interfaces/**. You can find detailed interface, helper class, and command references in **Adobe InDesign 2.0 SDK/Documentation/**. See "1.8. References" on page 57. A lot of the headers are also available in the html format. To get started, go to the index.html in the SDK. You will see a list of browseable documents.

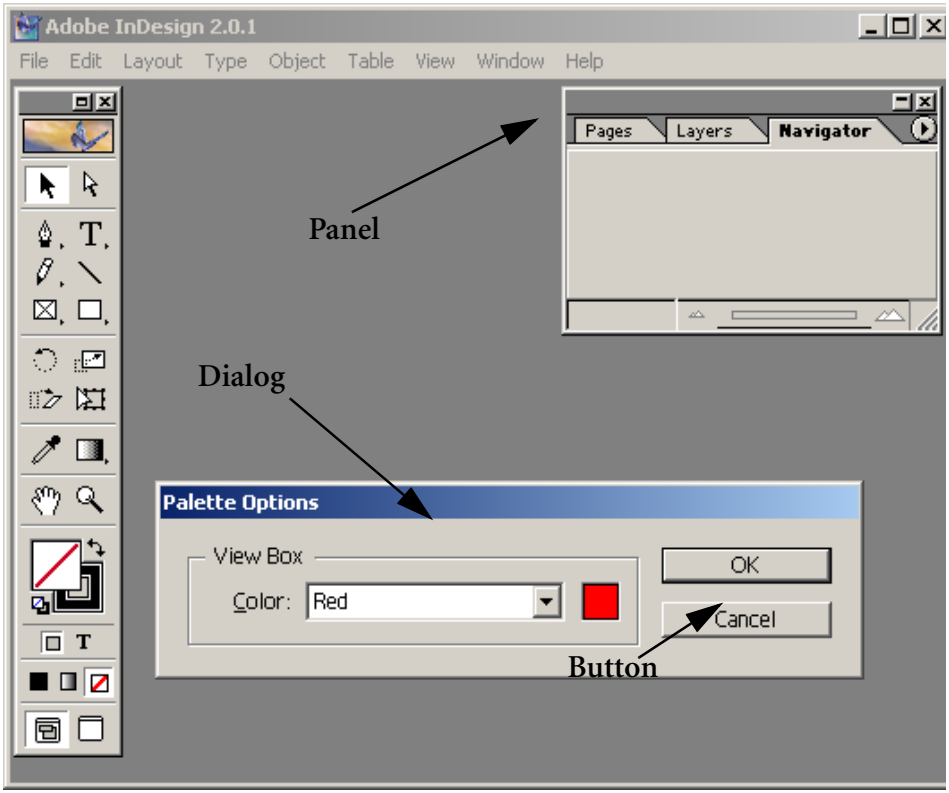
1.5.1. UI

This section discusses the main elements and operations of the application UI that you can affect through a plug-in.

1.5.1.1. Widgets

InDesign defines a basic UI control element called **widget**. Examples of widgets are dialogs, panels, and items these elements contain, such as buttons and checkboxes. The application implements each widget for a plug-in as a boss object useing a number of control interfaces.

figure 1.5.1.1.a. examples of widgets in indesign



Plug-ins use widgets for providing views on content (such as the clipboard) and text frames. As well as using the core set of widget interfaces, a widget can contain a number of other interfaces, depending on it's complexity.

Note: InDesign provides a set of interfaces allowing you to factor each widget. Factoring the widgets affords a number of advantages, including code reuse, smaller pieces to allow simpler development, etc.

In general, a widget does not have it's own coordinate system. All methods for specifying and retrieving the size and position of a widget are specified in window coordinates. This means all drawing and hit testing use window coordinates.

1.5.1.2. Dialogs

InDesign defines a **dialog** as a standard dialog window with sections indicating divisions in functionality, along with other widgets. The application supports the dialog types defined in the next table.

Table 1.5.1.a. indesign dialog types

Dialog Type	Description
Modal	Takes over from the application and must be exited using a button widget. A modal dialog can have a preview checkbox or button to allow the user to see the immediate effect on a document of modifying a document control.
Movable modal	Specifies a modal dialog that can be moved.
Modeless	Does not take over from the application; can have multiple windows up at one time within the application.
Selectable	Manages a group of panels. The user navigates the selectable dialog using a list pane or tabs.
Native platform-supplied	Specifies dialogs supplied by the platform. Examples are standard file dialogs, the page setup dialog, and the print dialog.

You can use any of the supported dialogs in your plug-in. It is possible to create new dialogs or add panels to existing selectable dialogs.

1.5.1.2. Panels

An InDesign **panel** is a functional division of a selectable palette or dialog. A panel can contain controls and widgets. Note: The InDesign architecture provides many panel implementation "freebies" for you. Some of these are: a tabbed panel dragged and dropped into any other panel; palette targeting to determine which dialog or palette the panel will appear in; and a placeholder panel menu.

When designing a plug-in, you can use any of the basic panels InDesign provides. You can also implement a panel creator. Your plug-in will implement a panel as a service provider (`IK2ServiceProvider` interface) returning a unique service ID to its containing dialog or palette. Usually you will attach an observer (`IObserver`) to each widget in the panel. When the user manipulates a

widget, the object must notify the observer, which fires off a command to bring about the desired change (see "1.5.3. Messaging" on page 33).

1.5.1.3. Menus

Adobe InDesign furnishes several interfaces to support menu development for your plug-ins. Using the basic interface `IMenuManager`, you can add and remove menus. Also there is an `IActionManager` that is responsible for enabling and disabling menu items, as well as executing them. You will use `MenuDef` and `ActionDef` framework resource to add menus and menu components at any time InDesign is running. You can find more information about menus in the MenuChanges.pdf (technote #10014) inside **Adobe InDesign 2.0 SDK/ Documentation/**.

The application allows menu components additions to the main menu, a popup menu, a right mouse menu, a pop-up panel, or a context-sensitive menu. Additionally, the architecture supports removal of menus and menu components you create.

1.5.2. Commands

For InDesign, a **command** (`ICommand` interface) is described as a set of changes to a document kept as a transaction in a database. This section introduces the command architecture used by the application. For details of developing a plug-in implementing commands, see the chapter "Commands." You can find detailed command references in the *InDesign Command Reference* described in "References" on page 57.

An InDesign document contains many items must be kept in sync with each other. The best way to do this is to use commands with execution controlled by a **command processor** (`ICommandProcessor`). The application maintains a command stack it uses in executing (doing), undoing, and redoing these commands. It also uses the standard **Model-View-Controller** (MVC) concept to connect changed items (model) with their views and controllers.

Every command has one **target**, which is a **command manager** object (`ICommandMgr`) executing the command inside a transaction on it's associated database (`IDataBase`). The default target of most commands is the command manager used by the active document (`IDocument`). The actual changes made by the command act on data in the targeted database (model). The data must support a **subject** (`ISubject` interface), to which **observers** (`IObserver` interface) attach so they can be notified of changes made by the command.

Your plug-in should use a command if any of the following is true:
- The action being performed changes any document page item.
- The plug-in needs to be able to undo the changes.
- There are observers needing to be informed of the changes.

If it is necessary to bundle more than one command together, InDesign supports command sequences. A sequence is a set of commands all done, undone, and redone together, as for a single command.

A special type of command is the **dynamic command**, which supports dynamic command execution, bypassing undo/redo stack. Trackers use dynamic command execution to provide visual feedback when in "patient user" mode. A typical dynamic command boss aggregates the interface `IDynamicUpdate`, it broadcasts the object being tracked has been modified and CmdUtils::ExecuteDynamicCommand is used to execute the command. Dynamic commands are used for interactive changes in a window. Such page item operations as resizing, rotating, and dragging use dynamic commands. For instance, the move tracker catches mouse moves and translates them into commands that move page items in the document. For more information on commands, see the "Commands" chapter.

1.5.3. Messaging

InDesign uses messages to provide **notification** to **observers** and **responders** for changes as they occur. In this section, the messaging architecture for the application will be summarized. See also the information about commands in the previous section.

The application issues notifications of changes concerning a particular **subject** (usually a data model, such as a document database). The observers and responders are the objects interested in changes information (receive notifications at methods in their interfaces). All page items and everything in a

document hierarchy are potential subjects because changes are always being made to them. For example, you would probably implement a panel containing a button as an observer, with the button as it's subject.

An observer (`IObserver`) can be tailored to recognize almost any type of change, after it has registered it's interest directly with the subject. It uses the notification to update its views. An observer can register its interest in an object in a data model or with an item in a view, such as a button on a panel. It can register and unregister interest at any point during run time.

Like an observer, a responder (`IResponder`) must register it's interest in a subject. However, the subject can only be a data model (for example, a new document or a new page item in a document). Another difference between observer and responder is the latter is tailored to a specific predefined set of changes, instead of just any change.

The responder registers it's interest in a change type during application startup, and remains in effect until the application shuts down. It is signaled during the change type for which it is registered (for example, creation of a new document).

1.5.4. Tools

InDesign defines a **tool** as an addition to it's **toolbox**, which contains several icons used to access individual tools. This section introduces the tool architecture for the application.

Most application tools create, select, edit, and transform document page items in a **layout view** ("1.5.6.2. Layout" on page 38). Tools are also provided to control the layout view itself. In summary, a tool does the following:

- Uses keyboard and mouse events to create and manipulate page items.
- Provides a visual cue of the selected tool (a **cursor**).
- Provides a **tool tip** to explain it's purpose.

- Uses a **tracker** to follow mouse movements and implement active tool operation. The tracker uses commands to apply changes to the items being manipulated.
- Provides an icon in the toolbox (and, optionally, a keyboard shortcut) to allow tool selection.
- Optionally provides other tools accessed through the tool icon.

1.5.5. Common Data (Persistence)

InDesign objects exist at run time as data stored in memory. Application databases, described in the next table, are storage areas on disk. They are managed by a database engine runing in the application core.

Note: Objects can be either **persistent** (capable of being stored in a database to last beyond the end of a session) or nonpersistent (lasting only until memory is freed when the destructor for the object is invoked). However, only persistent objects are stored in databases.

Each record in a database is identified by a unique identifier (**UID**), which is a 32-bit integer. When it allocates a UID for a record, InDesign stores the corresponding **class ID** for the object in a table associating the two identifiers. This storage method allows the database to respond to a later request to instantiate the object.

Table 1.5.5.a. application databases

Database Type	Description
Saved data	Represents the application object model. This database contains data about the plug-ins, the objects that they define, interfaces, etc. The application uses this information for loading and keeping track of plug-ins.
InDesign defaults	Contains default settings for the application and all plug-ins. You can add defaults for your plug-in by setting preferences.
Document	Represents a document as data ("1.5.6. Documents" on page 36). The application creates one database per document. Each document database maintains a list of UIDs (**UIDList**) representing the items that make up the document. The first UID, pointing to the document itself, is the **root object** for the document.
Scrap	Supports the application interfaces dealing with the operating system **clipboard**.

Database Type	Description
Alternate scrap	Serves as a holding area for data being transferred to or from an external data store. Such a database can also be called an "additional third-party database."

For a document database, InDesign stores individual document items as variable length database records, each record having one segment per supported interface. The records exist initially in memory. Certain events, such as a user's request to save a document, trigger the writing of records to disk. Other events trigger the reading of records. This strategy is different from many other applications, which store or retrieve an entire document at one time, holding all the data in memory for as long as the document is open.

Your plug-in supports persistence by including InDesign's `IPMPersist` interface. The plug-in can obtain UID information about other objects through the object interfaces and the utilities for persistent objects (**Adobe InDesign 2.0 SDK/Api/Includes/PersistUtils.h**).

1.5.6. Documents

InDesign defines a **document** (`IDocument` interface) as a collection of related **page items** (text and graphics) that can be saved, opened, and deleted as a set. This section discusses basic document layout and the **document hierarchy** used for arrangement of items within the document (with the document itself as the root object).

InDesign accesses a document through its **File»New** or **File»Open** menu. A new document is opened as a blank **spread** on the workspace.

1.5.6.1. Document Hierarchy

An InDesign document has a logical structure called the **document hierarchy** (`IHierarchy` interface). If one document component contains another, the first

is said to be the **parent** of the second (the **child**). Except for layers, document elements are all page items.

Text and graphics are threaded throughout the document in **spreads** (`ISpread` interface), each consisting of **pages** automatically created as required. Alternatively, the user can use a manual threading technique to minutely control text placement in strands (`ITextStrand`). For any of the pages, the user can apply a **master page** to control formatting features, such as headers and footers. A document can also be divided into **sections** as needed.

The **spread** is the root of the page item structure within the document. For each document layer, there are two spread layers on each spread, one for content, one for guide. Each spread layer can contain other page items, either individual or grouped, in the corresponding document layer.

Note: The page items in the layer can also be parents, for instance, if they are groups or frames.

The basic document components are defined in the following table.

Table 1.5.6.a. basic document components

Component	Description
Document layer	A container for page items, maintained in a layer list. An empty document with one document layer will have a total of four spread layers. Your plug-in can add non-pages layers to the layer list as needed. These layers can be shown, hidden, locked, unlocked, and rearranged in their z order.
Guide layer	Layer for guides only. Each document layer has a corresponding guide layer.
Master page	Layout page that can be applied to one or more document pages.
Page	Division of a spread governed by page size settings.
Page item	Text or graphics placed in frames in the document. Different page items can be assigned to different document layers, so that your plug-in can work selectively on the different sets of items. See "1.5.7. Page Items" on page 38.
Spread	Grouping of pages that the user can view simultaneously. Each spread (`ISpread` interface) is unique (has its own UID) and supports an `IHierarchy` interface with its children being spread layers. A set of spread layers is used to represent each document layer in the document.

Component	Description
Spread layer	Child of a spread. One spread layer is used for the pages document layer that controls document pages. For each of the non-pages document layers, there are two spread layers: guides spread layer represents document layer guides; and content spread layer representing the content for the document layer.

1.5.6.2. Layout

Layout refers to the arrangement of page items in a document. To assist in layout of text and graphics in the document, InDesign supports a **layout view** (`ILayoutControlData`, `IControlView` interfaces) that can be manipulated. You can use the toolbox tools to work with text and graphics in this view, and apply changes to the view itself.

Specific layout-related features of the application include:

- Grids and guides
- Data links ("1.5.13. Data Links" on page 43)
- Position locking
- Page markers
- Column setup and modification
- Automatic layout adjustment
- Coordinate systems

1.5.7. Page Items

As discussed in "1.5.6.1. Document Hierarchy" on page 36, page items are part of the document hierarchy. A **page item** is a spread or anything placed on a page of the spread. Each page item you define for a plug-in must aggregate a geometry interface (`IGeometry`) specifying the geometric points comprising the item. Most page items use further interfaces, such as a shape interface (`IShape`) for drawing the item and a shape handling interface (`IHandleShape`) for drawing and hit-testing the selection handles.

To provide page item access, a plug-in must also use the hierarchy interface (`IHierarchy`) to represent the document hierarchy for the particular page item. For example, use of the hierarchy allows a draw command to be targeted initially at the spread, and then filter from there to the actual page item affected. The plug-in must implement a command to join it's page item to the appropriate spread.

1.5.8. Graphics and Images

This section provides an overview of the graphics and image architecture of InDesign. Note: Computer graphics are classified as either **vector graphics** or **bitmap images** (also called **raster images**). Some of the many interfaces used for graphics and images are: `IGeometry` (used for all page items); `IGraphicStateDefinition` (defines the state of the graphic); `ITransform` (controls transformation, such as rotation); `IRenderingObject` (controls color, gradient, and color tint); `IGraphicsPort` (controls drawing to an output medium).

Note: Your plug-in calls the Adobe Graphics Manager (**AGM**) through the API methods defined in `IGraphicsPort` and **GraphicsExternal.h**. The FrameLabel example plug-in illustrates calls to AGM. The `IAdornmentShape` implementation defined by this plug-in uses AGM to draw text over the top of a page item.

Note: The application provides support for DCS 2.0 (except for in-rip separations). For example, a 6-color file can be created in PhotoShop, saved as a DCS 2.0 file, then placed (imported) in an InDesign document. In this case, the fifth and sixth colors will be ouptut in a separated workflow, resulting in CMYK and XY separations.

Note: The application can also place an indexed color image into the document, just place it like the regular image file.

1.5.8.1. Vector Graphics

Vector graphics are drawings composed of lines and curves defined by vectors. A vector graphic is not converted to pixels until it is displayed or printed. Thus, it is resolution-independent, because the resolution of the printer or monitor controls the number of pixels used in it's display. EPS format is widely used to store vector based graphic, although you can also embed bitmap image in a EPS file.

For composing and manipulating vector graphics, InDesign uses the tools in its toolbox to control shape, stroke (outline), and fill. You can draw a **path**, which is considered an independent graphic. You can also draw a **text frame** to contain text or a **graphic frame** for a graphic. The graphics tools apply to any path or frame you draw in the application. For particulars of drawing features in InDesign, see the *InDesign 2.0 User Guide* described in "References" on page 57.

1.5.8.2. Bitmap Images

In contrast to vector graphics, bitmap images are composed of pixels. These images serve as the most common electronic medium for continuous-tone pictures. A bitmap image is resolution-dependent, since it comprises a fixed number of pixels. Such an image can require a lot of storage and the associated file formats often use compression (in the originating application) to reduce bitmap file size. TIFF format is an example of bitmap image.

InDesign allows you to import, export, and manage a number of different types of bitmap images. It provides options for linking graphics, storing frequently used objects in libraries, and exporting pages as EPS graphics. To find out more about handling of bitmap images in InDesign, see the *InDesign 2.0 User Guide*.

1.5.9. Color

InDesign allows you to apply color (`IColorAttributes`, `IColorData`, `ISwatchList`, etc.) to the paths, frames, and types used in text and graphics. In summary, the application supports:

- LAB, RGB, and CMYK **color spaces**, corresponding to the standard L*a*b, RGB, and CMYK **color models** for describing and reproducing color.
- Treatment of all colors as global colors.
- Color application through tools in the toolbox.
- **Color** and **Swatches** panels to reflect chosen colors and allow color application and refinement.
- Application of gradients to strokes and to type.

- A **color management system** (CMS) to keep color consistent throughout a workflow (from scanning source images to creating final output).

For more about the way the application handles color, see the *InDesign 2.0 User Guide*.

Note: The application supports **spot colors** (also known as "**custom colors**"). The application can print **halftones** for spot colors at print time. You can specify halftones during a print job. For methods retrieving spot colors, take a look at the `IInkData` and `IInkMgrUtils` interface.

1.5.10. Service Providers

In InDesign, a **service provider** offers a particular service, such as import filtering. This section describes the basics of service provider architecture.

Each service provider plug-in must implement an `IK2ServiceProvider` interface, along with other interfaces supportive of the specific service being provided. The service provider interface implementation returns a specific service ID. When InDesign starts up, the service registry automatically finds all plug-ins with a service provider interface and uses their IDs to check for information, for example, what services they support.

Your plug-in can implement several boss objects all returning the same service ID. In this case, the plug-in must also use a service manager interface to iterate over all the boss objects and implement the services as needed. The implementation for this interface should utilizes `IK2ServiceRegistry` to get a list of service provider that support the service id, and the same interface also provides method to get to the service provider's `IK2ServiceProvider` interface. For more information on service providers, see the "Service Provider" chapter.

1.5.11. Import/Export

InDesign handles import and export (both text and graphics) by means of import and export providers aggregated by filter bosses and bosses providing other services. This section describes import and export architectures supported by the application. See the *InDesign Interfaces Reference* (described in "References" on page 57) for details of the import/export interfaces.

1.5.11.1. Import

InDesign allows you to write an import service (for example, a filter) for importing a particular text or image type. The service you design for import aggregates both the `IImportProvider` and `IK2ServiceProvider` interfaces, with `IImportProvider` supporting stream handling and the display of import preferences.

In its UI, the application uses **File»Place** for importing information. When the user selects this function, the application calls a method in each import provider to ascertain the types of importable files. The application lists the categories in the **Files of type** dropdown list in the **Place** dialog. Based on the category currently selected by the user, the application lists all the files in the directory targeted by the dialog and have one of the extensions belonging to the category. The default category is **Importable Files**.

Note: Macintosh file types and Windows NT/98 extensions are not used later in the import process.

1.5.11.2. Export

InDesign also provides a UI for export of text and graphics. Thus it can support an export service (for example, an export filter) for a certain data type. The service aggregates both the `IExportProvider` and `IK2ServiceProvider` interfaces. It is `IExportProvider` that supports stream handling and the display of export preferences.

For exporting files, the InDesign UI uses **File»Export**. The application lists the export categories in the **Save as type** drop down list in the **Export** dialog. Based on the category currently selected by the user, the application lists all the files in the directory targeted by the dialog and have one of the extensions that belong to the category. The default category is **Adobe PDF**.

1.5.12. Data Exchange

In InDesign, **data exchange** refers to the movement of information into and out of the application. To share information with other applications, InDesign uses the clipboard, drag and drop, and a special library. Additionally, it uses a particular manager object for each type of data to copy.

The application allows the user to drag a text file to a document page, which essentially imports the file. You can use the drag and drop functionality to enable drag and drop capability on both Macintosh and Windows (OLE drag and drop). The functionality allows your plug-in to perform a variety of tasks, including tracking drags, supporting feedback, accepting drops, etc. If your plug-in puts up a window, palette, or view, the application allows it to be either a drag source (`IDragDropSource`), a drop target (`IDragDropTarget`), or both, monitored by a controller deriving from `IDragDropController`.

1.5.13. Data Links

InDesign provides **data links** (`IDataLink`) allowing the user to identify and monitor document page items originating with external files or data. The links feature helps the user avoid the redundant storage of large amounts of data in a document. This section provides an overview of data links.

Links store image-related information, OLE-specific data, filter hints, and file system flags. The links feature is accessible through **File**»**Links**. It does the following:

- Lists links.
- Identifies missing and modified links.
- Enables the user to find missing links.
- Lets the user reimport the data to update a modified link.
- Provides information about each link, such as format type, size, date, full path name, etc.
- Allows the user to replace a low-resolution placeholder image with a high-resolution version through the Display Performance Dialog from the Preferences.
- Provides link options storing an internal copy (always done for text), update automatically, and alert before updating.
- Manages files using WebDAV, it lets you check-in/out files on the WebDAV server and manage the links.

1.5.14. Text

In InDesign, all **text** (characters and paragraphs) is placed in a **text frame** in a document or graphic. Adobe InDesign renders text through lists of **stories** and **frames** (`IFrameList`) included in the document. Once text is placed as required in a document, the application allows the user to manipulate it in many ways, such as selection, adjustment of text frames, preference selection, application of character and paragraph styles, etc.

1.5.14.1. Text Attributes and Styles

InDesign applies attributes (for example, `kTextAttrPointSizeBoss`) to both characters and paragraphs. The application defines each attribute as a persistent boss object (not UID-based). An attribute for a character or a paragraph implements a particular text attribute interface describing it's data type (for example, `ITextAttrRealNumber`) and an attribute report (`IAttrReport`) to provide a designator.

The application applies text styles through the session workspace (`kWorkspaceBoss`) or the document workspace (`kDocWorkspaceBoss`). The workspace maintains one table of character styles and another of paragraph styles. Each style is represented as a boss (`kStyleBoss`) implementing `IStyleInfo`, `ITextAttributes`, and `IPMPersist`.

Note: InDesign maintains separate name spaces for character and paragraph styles. It might be possible to derive character styles from paragraph styles, or vice versa. However, you should not do it.

1.5.14.2. Text Story

The application maintains a list of text stories (`IStoryList`) for each document. For each story, a strand list (`IStrandList`) is used to represent associated text strands (`ITextStrand`), with a strand treated as a separate class with its own ID. Individual strands defined for text are:

- Text data strand: Stores characters.

- Character attribute strand: Provides character formatting information.
- Paragraph attribute strand: Provides paragraph formatting information.
- Owned item strand: Stores information about inline graphics.
- Wax strand: Describes composed/rendered text.
- Story thread strand: Describes a range of text in the text model that represents a flow of text content.

The strand list is rendered as a wax strand (`IWaxStrand`) and applied to the particular story flow. One strand is accessible by strand list index or unique class ID through calls to ITextStrand.

For strand and text frame management, a text story uses a **text model** (`ITextModel`) as the data repository. It implements various interfaces for view and control functions.

Note: Another interface required by a text story is `IComposeScanner`, an extensible interface querying data and attributes.

1.5.14.3. Text Storage

The **Virtual Object Store** (VOS) is the low-level storage mechanism the application uses for text. This includes Unicode code points, character attributes, paragraph attributes, and composition data. **VOS** is only used for storing text-related data.

An `IVOSDiskPage` interface manages the virtual memory paging InDesign uses for text storage. The application stores a text story in a list of **VOS disk page objects**, each representing a document page. Each page stores a list of **VOS objects**, which are instantiations of abstract VOS classes (for example, `VOSAllSavedData`) representing data blocks. If enough VOS objects are added to a single page, the page splits in two.

A VOS object has a **virtual length** indicating the number of characters the object represents. This is not a key, but rather a length of text with which the object is associated. The sum of the virtual lengths of all the VOS objects is the **text index** of the VOS object in a story. Each page is aware of the virtual lengths of its VOS objects. It applies these lengths in setting and getting data strands, finding text, and setting next and previous pages.

Note: Access to VOS objects should be at a higher level of abstraction, either through the `IFocusCache` interface of a **text focus** (`kTextFocusBoss`), the `IComposeScanner` interface of a story (`kTextStoryBoss`), or the `IxxxStrand` interface of a particular text strand.

1.5.14.4. Localization

Localization capabilities included in InDesign allow you to create localizable plug-ins. The main interface associated with a particular language is `ILanguage`. The application furnishes a locale ID class (`PMLocaleId`) you can use to specify a locale ID. In InDesign 2.0, localization can be classified into 2 different categories, one is user interface localization, the other is the locale specific feature set. `PMLocaleId` has methods to set and get both IDs. The class implements two simple, abstract long integer data type that represent these IDs and are defined in `PMLocaleTypes.h`.

`ILocaleSetting` is an interface used by the application workspace to store the current locale setting. A plug-in can change the global setting by implementing a change locale command. Plug-ins observing the change observers to receive a message when the locale changes. For example, the application's palette manager watches for a change of locale. In response to a locale change message, it closes the current palette set and opens a new one for the indicated locale.

Your localizable plug-in needs to use a `LocaleIndex` resource to index a resource based on locale ID. The resource shell in InDesign uses the `LocaleIndex` resource when reading resources. Then, when an indexed resource is requested, the shell can retrieve the resource for the current locale, as specified in the locale index resource.

Another part of the application related to localization is the workspace interface `IStringDataBase`. This interface provides access to a database of all strings used by application plug-ins. The database stores string-locale ID pairs

for the various supported locales. These are used in the actual translations necessary for localization.

Your plug-in can add entries to the string database programmatically, but will typically load them using a `StringTable` resource. The first time InDesign executes, it will load the string database from resources. Subsequently the string data is stored in and loaded from the saved data database.

Note: A plug-in adding strings to the string database must implement the `IStringRegister` interface. The first time InDesign switches to a locale, it looks for plug-ins implementing this interface. When it finds one, it instantiates the associated implementation class and calls its `RegisterStrings()` method, passing the locale ID. The plug-in is then responsible for registering translations for the specified locale for all strings it uses.

1.5.14.5. Font Handling

Text fonts are stored in a **Font** folder. The application uses this folder to store any font supported by CoolType.

`IUsedFontList` constructs a used font list of the fonts used in the text of a document. This list includes fonts for imported PDF images, but does not collect the fonts used in graphic frames, EPS images, etc.

Note: The only bitmap fonts supported by the application are OCF fonts.

1.5.15. PDF

This section provides a brief summary of InDesign's portable document format (PDF) architecture, with text using the default source profile specified in **File**»**Preferences**.

InDesign provides support for PDF import into a document. Using this feature, you can convert a selected PDF file into the native document objects of the application. This results in a new, untitled document you can edit as needed. The PDF import feature is accessed through the **File**»**Place** menu.

Note: InDesign lists PDF documents on Windows NT/2000 with a .pdf extension. On Macintosh, these documents have a file type of PDF or TEXT.

The application also supports PDF export, allowing you to save one or more pages of a document as a PDF file. This export feature is available through **File»Export** for an open document (saved or unsaved).

1.5.16. Printing

This section discusses the way InDesign handles printing. InDesign prints by initializing and drawing pages, using the methods for drawing to the screen. The actual printing is done by means of calls to internal API functions furnished by another provider. These API functions generate all print UIs and the Postscript output.

The application implements several printing commands. You can use some or all of these commands to implement printing in your plug-ins.

Note: InDesign supports Postscript level 3, but not n-color. However, the application has the ability to pass through EPS files supporting n-color.

1.5.17. Scripting

InDesign employs a scripting architecture with three main divisions:

- Interface with the operating system (Macintosh or Windows NT/98/2000).
- Code to execute in response to a method call or property request.
- Interface with the script for error handling.

Every **scripting language** supported by the application implements the `IScriptManager` interface. An `IScript` interface must be aggregated by a scriptable **application object**, while the actual services between the **script** itself and the **script object** (IScript) are furnished by a **script provider** (IScriptProvider).

See the chapter "Scripting Architecture" for an introduction to the application scripting architecture. The *Adobe InDesign Scripting Guide* provides detailed development steps to use in extending this architecture. See "References" on page 57.

1.5.18. Events

InDesign maintains events in an internal event loop, with an event dispatcher interface controling the circulation of events among its plug-ins. Each plug-in wanting to send and receive events must implement the `IEventHandler` interface.

1.5.19. Exceptions

The application does not use exceptions. Your plug-in must provide its own exception handling mechanisms.

1.5.20. Streams

InDesign handles streams using the `IPMStream` class, defined in **IPMStream.h**. To help you handle streams in your plug-ins, you can use the static methods of the helper class `StreamUtil`.

1.5.21. Strings

InDesign provides platform-independent support for string handling. The application designates strings through string tables using the `PMString` class (**PMString.h**). You can incorporate strings into a resource script identifying the strings by keys that are the English versions of the strings.

Note: Your plug-in must register the strings so the platform resource manager can search the resources for your plug-in instead of the application-specific resources.

The application uses Unicode internally, but the data that `PMString` holds in RAM is in platform encoding, not Unicode. When the application reads or writes a string, it converts the string to or from Unicode. There is no way to get access to the Unicode character codes for a `PMString` without first converting to platform encoding.

Note: Although the application supports Unicode internally, it does not use the UNICODE preprocessor symbol for strings.

1.5.22. Measurement Systems

InDesign currently supports the following **measurement systems** (for both application and document workspaces). In addition, it provides a custom system you can modify for a plug-in and install in the application.

- Points

- Picas
- Inches
- Inches decimal
- Millimeters
- Centimeters
- Ciceros
- HA (Japanese feature set)
- Q (Japanese feature set)
- American Points (Japanese feature set)

The `IMeasurementSystem` interface is used to represent a measurement system. `IMeasurementType` defines the measurement unit to use, and preference panel settings are made using `IUnitOfMeasureSettings`. Since both the application workspace boss and the document workspace boss aggregate `IUnitOfMeasureSettings`, your plug-in can set the unit of measure preference for the application in general (applies to all documents) or for the current document only.

Note: Measurement systems are commonly used for widgets. For more about measurement system implementations, see the EditBox and ComboBoxWidget specifics in the *Adobe InDesign UI Reference* described in "References" on page 57.

1.5.23. Main Data Types

This section describes a number of the main data types used by the application.

1.5.23.1. ANSI-Based Types

This section defines simple ANSI C built-in data types used by the application. These data types are somewhat machine and compiler-neutral. See **AnsiBasedTypes.h**.

Table 1.5.23.a. ansi-based data types

Data Type	Description
bool8	uint8; explicit Boolean type
bool16	int16; explicit Boolean type
bool32	uint32; explicit Boolean type
Bool8	uint8; provided for Adobe Graphics Manager (AGM) compatibility
Bool16	int16; provided for AGM compatibility
Bool32	uint32; provided for AGM compatibility
int8	Signed character
int16	16-bit signed short integer
int32	32-bit signed long integer
int64	64-bit integer for Windows NT/98; 64-bit long long integer for Macintosh (Metrowerks)
uchar	Unsigned character
uchar16	16-bit unsigned character
uint8	Unsigned character
uint16	16-bit unsigned short integer
uint32	32-bit unsigned long integer
uint64	64-bit unsigned integer for Windows NT/98; 64-bit unsigned long long integer for Macintosh (Metrowerks)

1.5.23.2. Real Data Types

InDesign represents real numbers as defined in the **PMReal.h** file. It uses a `PMReal` type defined as either as a double or a class with several constructors. You will want to use the class if it is necessary to hide the epsilon comparisons behind operator definitions.

1.5.23.3. String Data Types

The application defines a `PMString` class to use as a string data type. This class has several constructors to use for various sorts of strings. The definitions are provided in **PMString.h**.

InDesign also defines a `WideString` class to represent a 16-bit character string. See **WideString.h**.

1.5.23.4. RECT Data Types

The application uses a `PMRect` class as a RECT data type, used primarily in parameter lists to aid in determining coordinate space. The definitions are provided in **PMRect.h**.

Other RECT data types (such as `SysRect`) that the application defines can be found in WSysType.h (Windows NT/98) and MSysType.h (Macintosh). See "1.5.23.9. Operating System Types" on page 53.

1.5.23.5. Point Data Types

InDesign uses a `PMPoint` class as a POINT data type to designate point coordinates. The definitions are provided in **PMPoint.h**.

Other POINT data types (such as `SysPoint`) the application defines can be found in WSysType.h (Windows NT/98) and MSysType.h (Macintosh). See "1.5.23.9. Operating System Types" on page 53.

1.5.23.6. Object Model Types (IDs)

InDesign 2.0 defined a template class IDType; all the object model types listed below are different types of IDType. Instead of defining them as simple data types, we can now prevent unintended typecast. This design gives you code that is maximally type safe. See **OMTypes.h**.

Table 1.5.23.g. om data types

Data Type	Description
ClassID	used as the class ID for the class related to a persistent object record in a database
ImplementationID	used as the ID for an implementation of an interface
PluginID	used as the ID for a plug-in
PMIID	used to identify an interface ID
ServiceID	used to identify a service
UID	used as a unique ID for a persistent object record in a database

Data Type	Description
WidgetID	used to identify a widget
ActionID	used to identify an action
KitViewID	used to identify a KitViewID
FileTypeInfoID	used to identify a FileTypeInfoID

1.5.23.8. Base Types (BaseType.h, PMTypes.h)

In **BaseType.h**, you will find a set of base data types for use by all InDesign-based applications. Examples of simple data types described in this file are `PString`, `ConstWString`, and `TextIndex`.

PMTypes.h is also provided to define a full set of InDesign application types. This file includes BaseType.h and other system files as applicable for the operating environments.

1.5.23.9. Operating System Types

Operating system data types are largely platform-specific. Types for Windows NT/98/2000 are placed in **WSysType.h**, and the comparable types for Macintosh in **MSysType.h**. The table below explains a few of the simple data types used frequently, indicating platform-specific differences as necessary. The files also define some useful complex data types, such as the `FileInfo` structure.

Table 1.5.23.j. selected operating system data types

Data Type	Description
FileInfo	Structure including creator and type information for a system file; structure is defined differently for the two platforms; see "1.5.23.12.3. FileInfo" on page 55
GSysPoint	POINT structure describing global cursor position; see "1.5.23.5. Point Data Types" on page 52
GSysRect	RECT structure describing global screen or device coordinates for the platform; see "1.5.23.4. RECT Data Types" on page 52
OSType	32-bit unsigned long integer that defines the operating system (defined in WSysType.h)
RsrcID	A uint32 resource ID
RsrcName	Pointer to the resource name (Macintosh only)
RsrcType	A uint32 resource type on Windows NT98; a ResType value on Macintosh

Data Type	Description
SysConnection	Type defining connection information for loading and unloading DLLs; instance handle (HINSTANCE) on Windows NT/98; CFragConnectionID class on Macintosh
SysFile	Type defining a system file for a database; a string class on Windows NT/98; an FSSpec type on Macintosh
SysFileInfo	FileInfo structure
SysFileRef	16-bit signed short integer identifying an open file reference (Macintosh only)
SysPoint	POINT structure describing cursor location; see "1.5.23.5. Point Data Types" on page 52
SysRect	RECT structure describing rectangular coordinates for the platform; see "1.5.23.4. RECT Data Types" on page 52.
WSysPoint	POINT structure describing "window" global cursor position; see "1.5.23.5. Point Data Types" on page 52
WSysRect	RECT structure describing "window" screen or device coordinates for the platform; see "1.5.23.4. RECT Data Types" on page 52

1.5.23.11. Cross-Platform Data Types

For help with defining resources for your plug-in, you will find **CrossPlatformTypes.h** useful. This file defines data types used with the C++ compiler and ODFRC. An example is `RezLong`, which generates a macro when you invoke ODFRC. For more about resource generation, see the chapter "Plug-Ins."

1.5.23.12. Complex Data Types

This section defines some of the global structures, enumerations, and other complex data types supplied by InDesign.

1.5.23.12.1. UIFlags

The UIFlags enumeration defines flags indicating how much UI to show during an operation. See "1.5.23.8. Base Types (BaseType.h, PMTypes.h)" on page 53.

```
typedef enum
{
  kSuppressUI,
  kMinimalUI,
  kFullUI
} UIFlags;
```

1.5.23.12.2. ErrorCode

The ErrorCode enumeration defines basic error codes used by the application. See "1.5.23.8. Base Types (BaseType.h, PMTypes.h)" on page 53.

```
typedef int32 ErrorCode;
enum { kSuccess = 0, kFailure = 1, kCancel = 2 };
```

1.5.23.12.3. FileInfo

FileInfo is an operating system-specific structure defining a file. For Windows NT/98, in WSysType.h, it is defined as follows:

```
struct FileInfo
{
  OSType creator;
  OSType type;
};
```

For Macintosh, in MSysType.h, FileInfo is defined this way:

```
struct FileInfo
{
  ScriptCode script;
  OSType creator;
  OSType type;
};
```

script	An int16 value representing a Macintosh script or a Windows language ID; see SString.h
creator	File creator; see OSType in "1.5.23.9. Operating System Types" on page 53
type	File type; see OSType in "1.5.23.9. Operating System Types" on page 53

1.5.23.13. Errors

InDesign uses two error handling techniques, as demonstrated in the SDK sample code.

- Technique 1. Apply a local ErrorCode variable, a lof of API will return an ErrorCode as return value, you should always check that value before you proceed to next line of code.
- Technique 2. Get/Set global error state using PMGetGlobalErrorCode and PMSetGlobalErrorCode in ErrorUtils class. Please refer to ErrorUtils.h for more information

A plug-in localizes error strings through string tables defined in .fr files, one for each language the application supports. For example, in BasicDialog sample, BscDlg_jaJP.fr contains localized japanese strings, which are used when Japenese locale is in use, while BscDlg_enUS.fr is used when the roman locale is used. For each error message, your plug-in should provide a complete text string. It is recommended you don't build messages from substrings in the resource files.

1.5.23.14. Registers

InDesign uses registers to represent the following component types. Note: Each register must be a service provider.

- Panels. Each panel register boss (`IPanelRegister`) needs an `IK2ServiceProvider` interface supporting `kPanelRegisterService`.
- Strings. Each string register boss (`IStringRegister`) needs an `IK2ServiceProvider` interface supporting `kStringRegisterService`.
- Tools. Each tool register boss (`IToolRegister`) needs an `IK2ServiceProvider` interface supporting `kToolRegisterService`.
- Trackers. Each tracker register boss (`ITrackerRegister`) needs an `IK2ServiceProvider` interface supporting `kTrackerRegisterService`.

1.6. Summary

In this chapter, the InDesign plug-in environment and the API plug-ins provided for you in the SDK were described. The basics of InDesign components and operations were also discussed. The chapter has also introduced the various example plug-ins furnished with the SDK.

1.7. Review

You should be able to answer these questions:

1. How does InDesign define a plug-in? (2.4, page 35)
2. What is a boss? How many bosses can be associated with a plug-in? (2.4, page 35)
3. What is a widget? (2.5.1.1, page 39)
4. How does InDesign define a command? (2.5.2, page 41)
5. How do you load the example plug-ins into InDesign? (2.6.1, page 67)
6. What example plug-in provides code to help write a basic dialog? (2.6.12.3, page 91)

1.8. References

- Adobe User Education. *InDesign 2.0 User Guide*, 2001.
- Adobe InDesign SDK. *InDesign 2.0 Scripting Guide*, 2001. See **InDesign Scripting Guide.pdf** on your installation disk.
- Adobe InDesign SDK. *Technical Note #10070 Command Reference, 2002*.
- Adobe InDesign SDK. *Technical Note #10050 User Interface Programming Model, 2002*.
- Adobe InDesign SDK. *Technical Note #10056 User Interface Widgets, 2002*.

2. Architecture

2.0. Overview

Adobe InDesign is a small host application with features that are implemented through client plug-ins. The application defines an architecture that determines how a plug-in interacts with the host, and also provides the building blocks from which each plug-in is made.

This chapter will discuss the abstract ideas of InDesign's architecture, and then discuss the implementations of these ideas.

2.1. Goals

The goals of this chapter are to:

- Provide you with an overview of each abstract idea of the architecture.
- Show how each abstract idea is implemented in the architecture.
- Provide tables of implemented architectural components.

2.2. Chapter-at-a-glance

"2.3.Introduction" on page 60 introduces you to the sections in this chapter.

"2.4.Object Models" on page 60 is a high-level discussion of object models.

"2.5.Managers" on page 61 is another high-level discussion, but of managers this time.

table 2.1.a. version history

Rev	Date	Author	Notes
4.0	17-Sep-02	Paul Norton	Update for InDesign 2.01
3.0	29-Feb-00	Allison Feliciano	Edits and roll in of base camp materials
2.0	2-Jul-1999	Jeff Gehman	First draft.

"2.6.Model-View-Controller (MVC)" on page 61 is a final high-level discussion, about the Model-View-Controller (MVC) architecture.

"2.7.Adobe InDesign's Object Model Implementation" on page 62 gives the nuts and bolts information about InDesign's object model.

"2.8.InDesign Managers" on page 80 explains what InDesign managers are.

"2.9.MVC in InDesign" on page 81 is a discussion of how MVC maps onto InDesign.

"2.10.Summary" on page 88 wraps up the chapter for you.

"2.11.Review" on page 88 hits you with some review questions.

"2.12.Reference" on page 88 gives you some tips and pointers on where to look for additional information.

2.3. Introduction

This chapter is divided into two sections. The first section presents the theories and architectural concepts used in the InDesign application. The second section discusses the implementation of those theories. Each section covers Object Models, Managers, and Model-View-Controller (MVC).

The "InDesign's MVC Implementation" section describes how this concept is used to factor InDesign's user interface. "Managers" discusses how managers are implemented in InDesign, and also lists commonly used managers in a table. In the "InDesign's Object Model Implementation" section, the bedrock ideas of how InDesign describes and processes objects is explored in depth.

The "MVC" section gives a generic overview of this architecture. "Managers" discusses the theory behind application managers, and the "Object Models" section presents a high-level discussion of the parts and purpose of an object model.

2.4. Object Models

Conceptually, an object model is a set of rules or conventions that describe how objects will be created and handled within a system. The C++ language implements an object model, describing an object as a contiguous block of

memory (at its most basic level) and defining how that object will be instantiated, behave during its lifetime, and be destroyed.

Object models can be used to map out how large, complex systems will behave. Microsoft's COM (Component Object Model) defines objects with functionality that is accessible through interfaces, making it possible to have distributed components.

2.5. Managers

A Manager is responsible for a specific functionality in an application, and keeps track of that functionality's state. Managers have methods for getting and setting the state of that functionality.

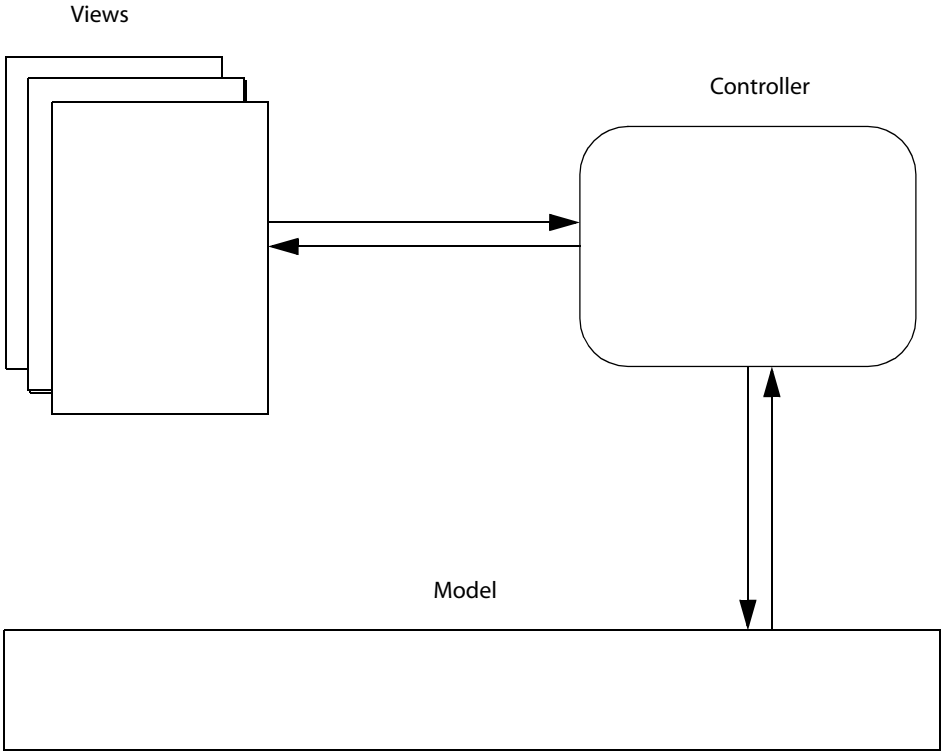
As an example, an application could have a Window Manager that is used to create and destroy windows, and keeps a list of the currently open windows. A client of this Manager could query it to find the window that is currently active, or to find a window with a specific name and bring it to the front.

2.6. Model-View-Controller (MVC)

MVC is a concept borrowed from SmallTalk, an object-oriented language quite different from C++. Using this architecture, an application is divided into a user interface and a data-and-processing module. The latter is the model. The former is subdivided into a part that handles input (the controller) and a part that handles output (the view). Note: "Application," with respect to MVC, is used in a very general sense; what in ordinary parlance is called a "software application" may consist of many smaller "applications."

One way of thinking about MVC is that it formalizes the relationships between input, output, and data processing. If you have constructed a view of your model (which could be a window displaying a document), it is a small step to realize that you can easily have multiple views of the same model.

figure 2.6.a. model-view-controller



2.7. Adobe InDesign's Object Model Implementation

The InDesign object model consists of two components: a description of objects, and a runtime manager of them. The object model describes an object as a "boss." Just as a C++ class encapsulates data and member functions that produces an object at runtime, a boss can be thought of as an InDesign class that produces a boss object. Access to bosses is provided through interfaces.

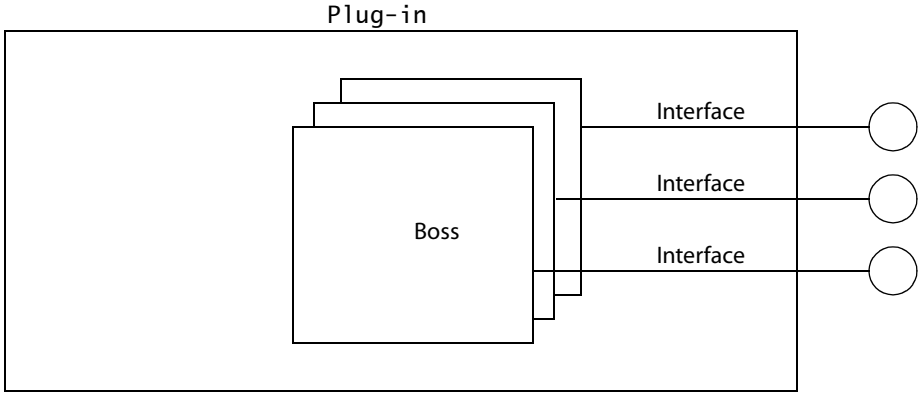
The InDesign application itself has a very small footprint. There is platform-centric code that executes on startup during launch, and the rest of the application is the implementation of the plug-in architecture. All of the application's features and functionality are implemented through plug-ins.

A plug-in defines bosses. Interfaces provide access to bosses. A plug-in can provide implementations for interfaces on a boss that perform some new

functionality. A plug-ins boss is available to the plug-in, or to any other plug-in that knows about the boss and its interfaces.

At runtime, plug-ins don't call other plug-ins, but they can gain access to bosses that other plug-ins define through interfaces. In fact, it's possible to access any boss that's known to the object through its interfaces. A list of API bosses and interfaces is available in InterfaceList.txt.

figure 2.7.a. plug-in



2.7.1. Bosses

Understanding what a boss is and how it behaves is key to programming InDesign plug-ins. Bosses are the fundamental building blocks of a plug-in. A **boss** is a class in the InDesign Object Model. It is not a C++ class, but is made up of a group of C++ classes. A **boss object** is the instantiation of a boss. Any boss that is defined will have a set of protocols or **interfaces** that establish how a user interacts with that boss. A boss also has, for each of it's interfaces, an **implementation** that defines the bosses behavior for a given interface. The interfaces are abstract C++ classes and implementations are concrete C++ classes. Boss objects are reference counted. Each reference to the boss increments the count when it's created, and decrements the count when it is released. The reference count controls the lifetime of the object. Any boss object with a reference count of zero is subject to destruction.

A table could be used to represent the document boss

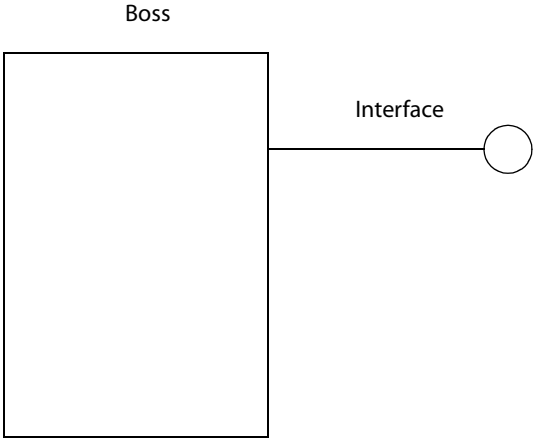
figure 2.7.a. kDocBoss represented as a table

kDocBoss (kDocBoss has no parent boss)	
Interface ID	**Associated Implementation ID**
IID_IDOCUMENT	kDocumentImpl
IID_IWINDOWLIST	kDocWindowListImpl
IID_ICOMMANDMGR	kCommandMgrImpl
IID_ISUBJECT	kCSubjectImpl
...	...

The boss is kDocBoss, or the entire table. IID_IDOCUMENT is one of the interfaces on kDocBoss, and kDocumentImpl is an implementation of IID_IDOCUMENT.

At runtime, the object model adds your boss to a list of bosses that it keeps for all of the plug-ins. It also builds a table of interfaces that your boss **aggregates**. Both of these tables are lists of unique IDs. To access the functionality that your boss provides, you will query for an interface on your boss, and then call the methods of that interface.

figure 2.7.1.a. boss



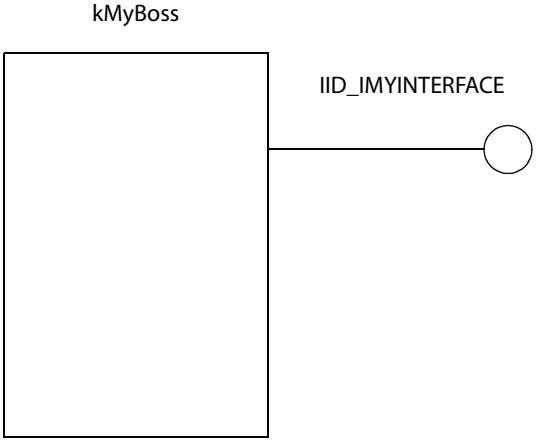
2.7.1.1. Unique IDs

The InDesign application keeps tables of the bosses, interfaces, and implementations made available by your plug-in. Each boss, interface, and implementation has an unique ID that identifies it within the space of all InDesign bosses, interfaces, or implementations. The boss, interface and implementation ID spaces are separate spaces, and so your plug-in may use the same number for an interface and a boss safely, but there should be no overlap of bosses with other bosses, or interfaces with other interfaces. The IDs are defined as 32 bit values, and so to ensure unique IDs are used in each plug-in you need to request a 24 bit prefix from InDesign Developer Support. There is a request form on http://partners.adobe.com. The 24 bit prefix that you recieve will be reserved for your use in your plug-in -- giving a maximum value of 256 values for boss, interface, or any other prefix based IDs. Typically this is more than enough for any single, or sometimes a set of plug-ins.

InterfaceList.txt is the current catalog of all of the public bosses and interfaces available to third-party developers. InterfaceList.txt contains the rest of the definition of kDocBoss. In InterfaceList.txt, you will see examples of naming conventions used for boss, interface, and implemntation constants. The convention for bosses is to prefix the name with "k" and suffix it with "Boss". Interface IDs are prefixed with "IID_" and implementation IDs are prefixed with "k" and suffixed with "Impl".

You can use the same naming conventions for the bosses and interfaces that make up your plug-in. This will help you to quickly differentiate between bosses and interfaces, and help you keep those separate from the other groups of unique IDs you will learn about in subsequent chapters.

figure 2.7.1.1.a. boss and interface ids



2.7.1.2. Resources

Bosses are defined in a plug-ins resource. For each plug-in project there are as set of resource files that are compiled by the ODFRC compiler. Within one of these files is a table of bosses. Since bosses are InDesign Classes they are called classes in this table. An entry from one of the sample plug-ins is below. This file is where your boss is given a name, unique ID, and where the interfaces on the boss are listed. InDesign will look in your plug-in's resource to find this information as it builds the boss and interface tables.

```
Class{
  kDocBoss,
  kInvalidClass,{
    IID_IDOCUMENT, kDocumentImpl,
    IID_IWINDOWLIST, kDocWindowListImpl,
    IID_ICOMMANDMGR, kCommandMgrImpl,
    IID_ISUBJECT, kCSubjectImpl,
    ...
  }
}
```

As was noted before, kDocBoss doesn't inherit from another boss, the way this is shown in the resource is that it inherits from the invalid boss, "kInvalidClass". This boss has a list of interfaces, and the ID for each interface is given in the definition. IID_IDOCUMENT is an interface ID, or 32 bit value that is used to

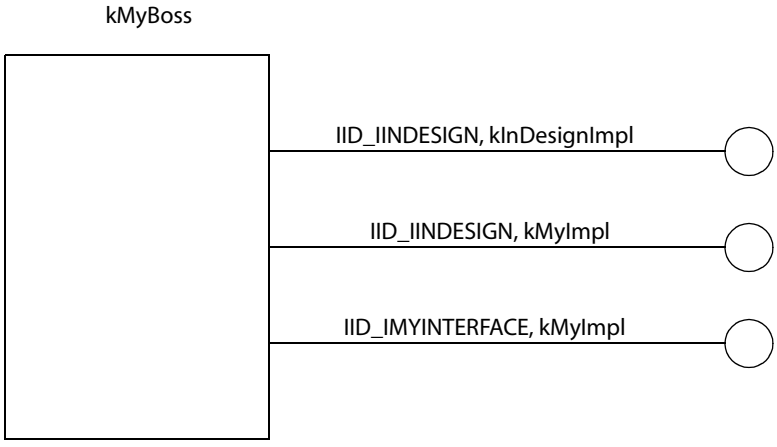
identify an abstract C++ class. Since the IDs are named after the classes, we can deduce that the interface that IID_IDOCUMENT represents is IDocument (found in IDocument.h). The implementation ID for each interface is listed after the interface ID. Remember, these interface IDs and implementation IDs are 32 bit values that are tied to the C++ classes they represent, not the actual names of the classes themselves. (However, the name of the class appears in the name of the ID in each case to make navigation easier.)

In a boss definition, interfaces are listed by their interface ID (e.g., IID_IMYINTERFACE), and an implementation ID (e.g., kMyImpl). The object model uses these IDs to identify the type of interface that you are aggregating, and also the specific implementation that is being provided for that interface.

Each boss and interface that you define must have a unique ID. There are three cases that apply to specifying interfaces on a boss in your plug-in:

- Use an existing interface and an existing implementation (e.g., IID_IINDESIGN, kInDesignImpl).
- Use an existing interface and define your own implementation (e.g., IID_IINDESIGN, kMyImpl).
- Define your own interface and implementation (e.g., IID_IMYINTERFACE, kMyImpl).

figure 2.7.1.2.a. boss definition

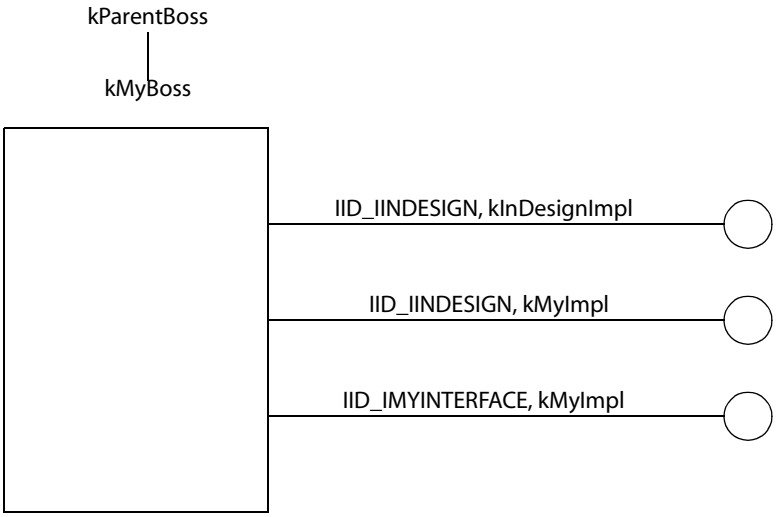


Bosses can inherit from other bosses. Boss inheritance is specified in the boss definition. As might be expected, if you inherit from a boss, you also inherit the interfaces that the parent boss aggregates. Inheritance is additive, and derived bosses may override base bosses.

The advantages to this approach are numerous. In the case of developing your own page item, you can inherit from an existing page item that knows how to draw itself, hold text frames, and be part of a group. You can add your own interfaces to this boss and provide implementations that customize the page item to behave as you want it to.

As you will see in the "Plug-ins" chapter, it is also possible to add interfaces to an existing InDesign boss in your boss definition file. This is a common practice, but as an external developer, you should only add interface IDs that are defined in the ID space for your plug-in. (In other words, only use IIDs that are based on your assigned prefix.) The InDesign team could add an interface of the same type in a future release.

figure 2.7.1.2.b. boss inheriting from parent



2.7.1.3. Interfaces

A boss is an InDesign class that is defined in a resource, has a unique ID, and is managed by the object model at runtime. An **interface** on a boss provides

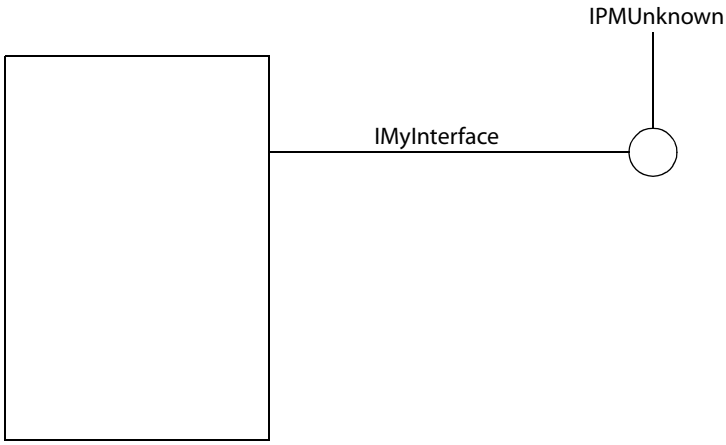
access to the boss, and it is the implementation of an interface's methods that provides the functionality of the boss.

You can gain access to a boss by querying for an interface on it. If your query is successful, you can use the interface in two ways: you can call the methods of the interface, and you can query for another interface on the same boss. Once you have an interface on a boss, you can query for any other interface on that boss.

Interfaces are defined as abstract C++ classes. In your implementation of an interface, you can specify additional member functions as part of the derived class, but you can only directly call the methods that have been exposed at the abstract level.

All but a few InDesign interfaces inherit from IPMUnknown, which has three methods: `QueryInterface()`, `AddRef()`, and `Release()`. Interfaces are bound to implementations at runtime through the `CREATE_PMINTERFACE` macro. InterfacePtr is a templated utility class that performs a `QueryInterface()` and returns an interface pointer.There are many default implementations for interfaces available to third-party developers.

figure 2.7.1.3.a. interface inheritance



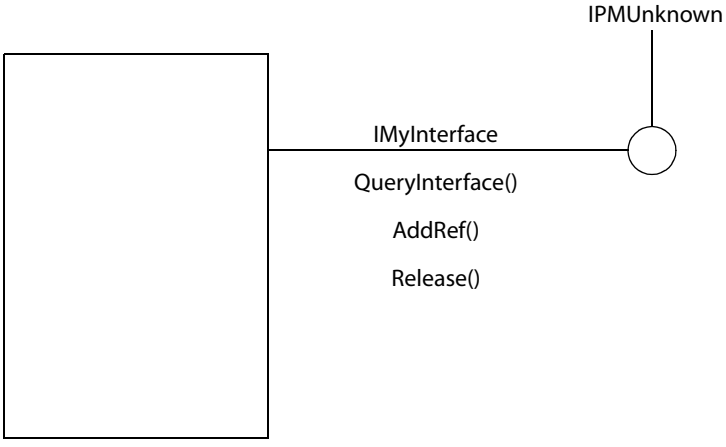
IPMUnknown. This is the parent interface for nearly all of InDesign's interfaces. In order for InDesign's object model to function correctly, interfaces must inherit from IPMUnknown, and support `QueryInterface()`, `AddRef()`, and `Release()`. You can query a boss for an interface pointer of type `IPMUnknown` and get back a valid interface pointer.

There are a few special cases where an interface does not subclass from IPMUnknown (e.g., IDatabase).

Querying for interfaces. `QueryInterace()` is used to query for an interface on a boss. This function returns a pointer to an interface, or nil if an instance of the interface is not available. `QueryInterface()` automatically performs an `AddRef()`, which increments the **refcount** on the interface. The object model keeps track of the refcount for interfaces on bosses. If all of the interfaces on a boss have a refcount of zero, the boss can be marked for deletion.

If you have used `QueryInterface()` to obtain an interface pointer, it is necessary to call the `Release()` method when you are through with the interface, so that the refcount for the interface is decremented correctly.

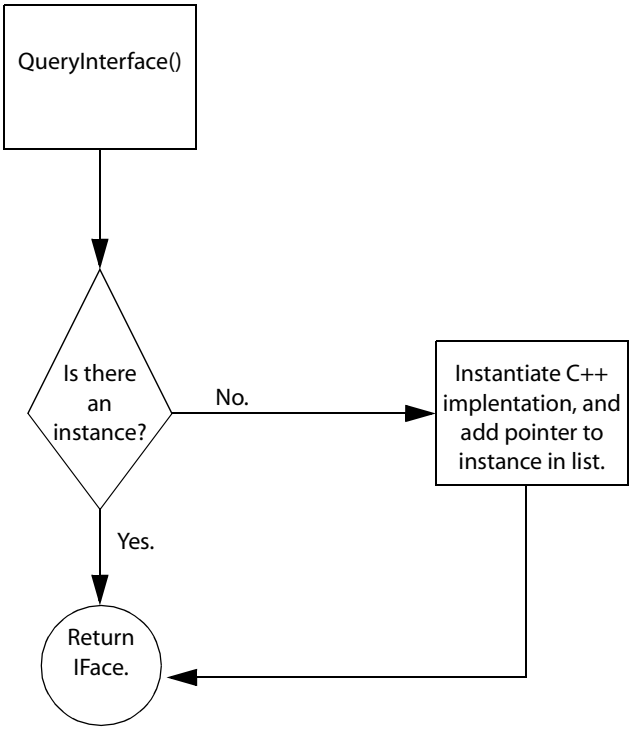
figure 2.7.1.3.b. refcounting interfaces



Interface instantiation. The object model keeps a table of interface instances. An instance in this table is a pointer to the instantiated C++ implementation of the interface. When QueryInterface() is called, it looks in the table to see if

there's an instance associated with the ID being passed in. If there is, a pointer to the interface is returned by QueryInterface(). If not, the object model tries to instantiate one.

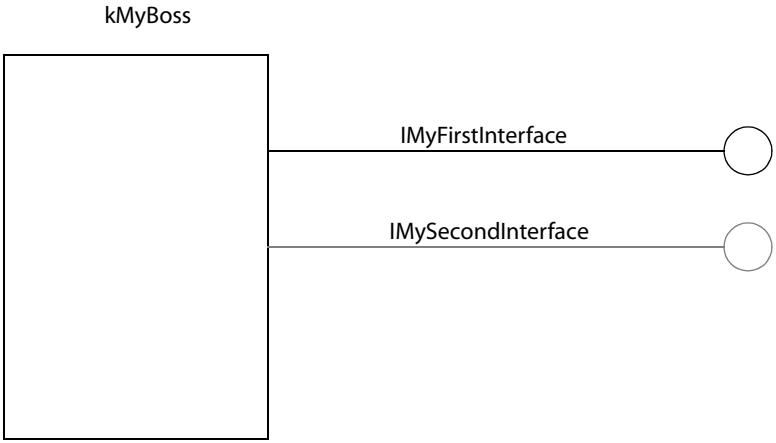
figure 2.7.1.3.c. queryinterface() flow



The object model will return a valid interface pointer, or nil. You should test for nil before you call the methods of the interface.

Interface implementations are created on the fly as they are needed. It is quite possible to have a boss object that has some interfaces that have been instantiated, and some that have not. If you are querying for an interface on a boss from another interface on the same boss, the above flow takes place, and the second interface's implementation is pulled into memory.

figure 2.7.1.3.d. interface implementation not in memory



Binding implementations to interfaces. In a plug-ins resource, a boss definition lists interfaces with the `Interface ID (PMIID)` and implementation ID of each interface aggregated by a boss (e.g., `IID_IMYINTERFACE`, `kMyInterfaceImpl`). As we've seen, interfaces and implementations can be from the API or ones that you design. An implementation is provided by a C++ class that derives from the abstract definition of that interface (e.g., IMyInterface.h).

The `CREATE_PMINTERFACE` macro is used to bind an implementation to an interface. This macro appears before the constructor of an interface implementation class, and passes the name of the implementation class with the implementation ID as parameters.

`CREATE_PMINTERFACE` creates an `InterfaceFactory` object that has methods for creating and destroying an instance of the interface implementation. These methods are called by the object model to create an instance of the interface. If `QueryInterface()` is called on an interface implementation that is not instantiated, the class factory object gets created, and its methods are available to the object model. The "Plug-ins" chapter will walk you through the `CREATE_PMINTERFACE` macro in depth.

HelperInterface. This class is used to map the `QueryInterface()`, `AddRef()`, and `Release()` methods of IPMUnknown to an interface implementation. There are three macros that are used to declare, define, and initialize these methods that perform substitution for the name of the interface implementation class. The "Plug-ins" chapter will give a detailed view of this class and how it's used for interfaces.

InterfacePtr. `InterfacePtr` (InterfacePtr.h) is a class that wraps `QueryInterface()`. In addition to the `AddRef()` that is automatically performed by `QueryInterface()`, `InterfacePtr` performs a `Release()` when the pointer goes out of scope. This ensures that `Release()` is called on an interface, and prevents memory leaks.

InterfacePtr is a templated class that calls `QueryInterface()` in its constructor, and `Release()` in its destructor. There are several different constructors you can use, depending on your situation:

- You have an interface on a boss, and want to get another on the same boss.
- You want to instantiate an interface from a database.
- You have an interface pointer that already has a refcount, and you want to make sure that `Release()` will be called for it.

To handle scoping issues, declare an `InterfacePtr` without initializing it:

```
InterfacePtr<IMyInterface> iMyInterface;
```

More typically, you will declare and initialize simultaneously:

```
InterfacePtr<IMyInterface> IMyInterface(kMyBoss, IID_IMYINTERFACE);
```

UseDefaultIID(). Many interfaces in the API support `UseDefaultIID`. This is a dummy class that is used only to drive the type system. You can pass `UseDefaultIID()` as the trailing parameter in one of the `InterfacePtr` constructors:

```
InterfacePtr<IMyInterface> iMyInterface(kMyBoss, UseDefaultIID());
```

This approach can lead to cleaner code, and fewer "copy paste" mistakes, but keep in mind that not every interface supports `UseDefaultIID`. Both `InterfacePtr` and `ConstInterfacePtr` support this class.

2.7.1.4. Boss instantiation

`CreateObject` (see CreateObject.h) is the class used to instantiate bosses. In general, a plug-in instantiates the bosses it defines. For example, if you defined a kMyBoss in your plug-in, you would use one of the `CreateObject` constructors, and pass in the class ID (kMyBoss) as one of the parameters.

`CreateObject` asks the object model to create a new boss object of the class that you specify. The object model returns an IPMUnknown interface pointer that you can cast to the type you have aggregated on the boss. You can wrap a call to CreateObject in an `InterfacePtr`:

```
InterfacePtr<IMyInterface>
IMyInterface((IMyInterface*)::CreateObject(kMyBoss,
IID_IMYINTERFACE));
```

figure 2.7.1.4.a. boss defined, but not instantiated

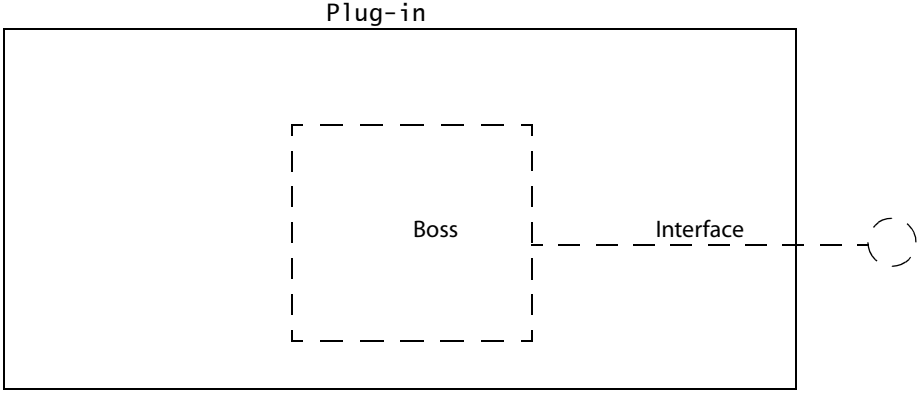
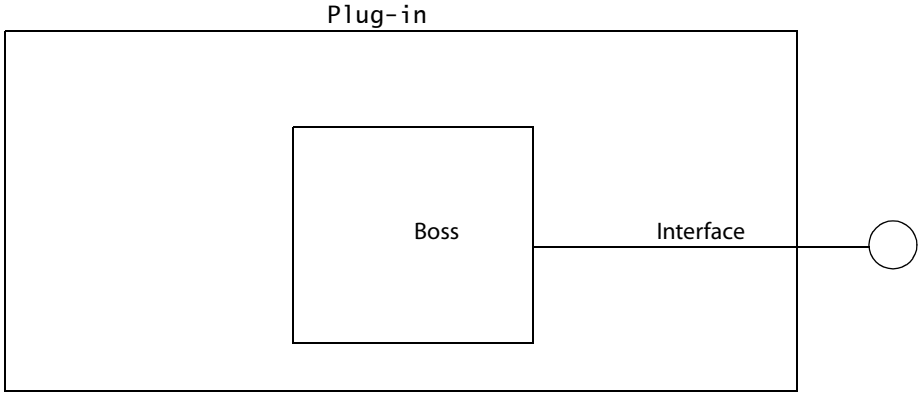


figure 2.7.1.4.b. boss after createobject called



In general, it is not necessary to create a new boss object of a type that is provided by the API. This is not always true (e.g., applying text attributes, see the Text chapter), but you can usually safely assume that there is an instance of an API boss that you are trying to access.

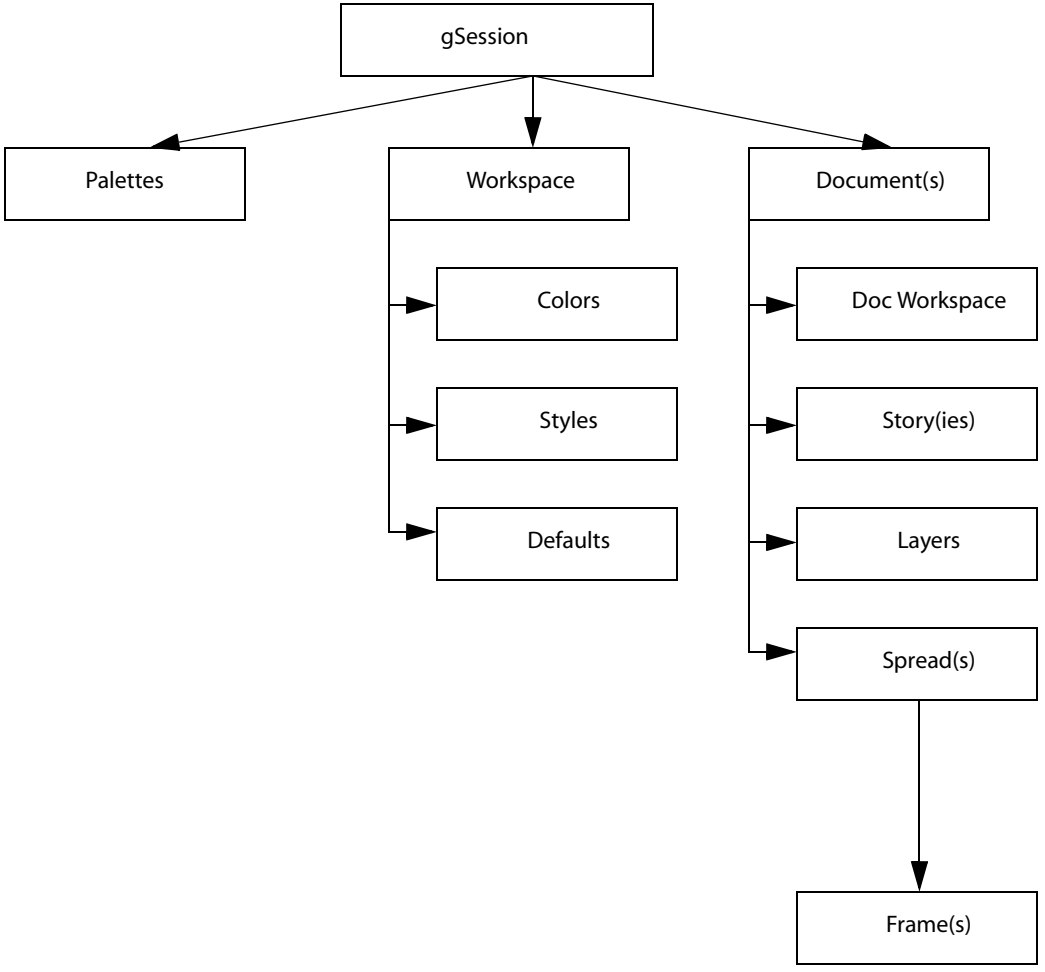
CreateObject creates both persistent and non-persistent boss objects (see the Persistence chapter). There are three constructors you can use, depending on the type of boss object you are trying to create:

- Create a new non-persistent boss object of the type specified by the class ID.
- Create either a persistent object if a valid database pointer is passed in, or a non-persistent object if the database pointer is nil.
- Create a persistent object from the resource boss definition, in the database passed in (the database pointer parameter must be valid).

2.7.1.5. Boss object hierarchy

InDesign's boss objects are arranged in a hierarchy. The gSession object is the root of the application boss tree, and you can navigate to any boss object in the hierarchy.

figure 2.7.1.5.a. conceptual view of boss object hierarchy



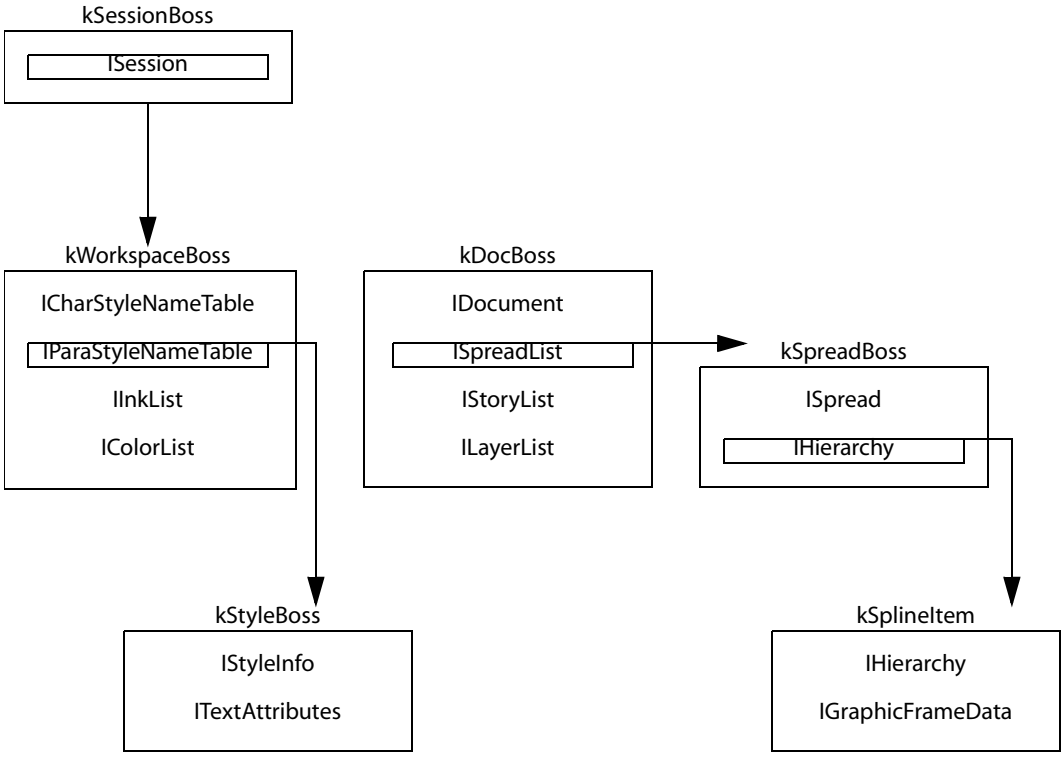
The relationships between parent and child in the boss object tree is established by interfaces on a boss that have methods for obtaining an interface on another boss. ISession, for example, has a method, `QueryApplication()`, that returns an IApplication interface pointer:

```
InterfacePtr<IApplication> theApp(ISession->QueryApplication());
```

ISession (see ISession.h) has several query methods that you should be aware of to help you traverse the object tree:

- `IActiveContext* GetActiveContext()` - This object holds the active selection, active view, active doc, etc.
- `IChangeManager* GetChangeManager()` - Return the global change manager.
- `IWorkspace* QueryWorkspace()` - Return a reference to the global workspace.
- `ICommandProcessor* QueryCommandProcessor()` - Return a reference to the global command processor.

figure 2.7.1.5.b. boss object hierarchy



As a plug-in developer, you can create boss object hierarchies for the bosses in your plug-ins. This provides a consistent, documented way to access a boss, helps eliminate multiple instantiations of the same boss, and helps you refcount your bosses correctly. Boss hierarchies are not required for every plug-in, but an obvious opportunity for this approach is the case of implementing plug-ins with functionality that will be accessed by other plug-ins.

To create a boss hierarchy where `kMyFirstBoss` is the parent of `kMySecondBoss`, you can use the following recipe (we will assume that `kMyFirstBoss` aggregates `IMyFirstInterface`, and `kMySecondBoss` aggregates `IMySecondInterface`):

- Define a method in `IMyFirstInterface`, "`QuerySecondBoss()`".
- Create an implementation class for IMyFirstInterface. This is a C++ class that inherits from IMyFirstInterface. We'll call it, "`ImplementedFirst`."

- Add a private interface pointer data member to your implementation of IMyFirstInterface, fMySecondInterface.
- In ImplementedFirst::QuerySecondBoss(), test fMySecondInterface for nil.
- If fMySecondInterface is nil, use CreateObject to create an instance of kMySecondBoss, and fMySecondInterface gets the IPMUnkown cast as IMySecondInterface.
- Call AddRef() on fMySecondInterface, and return fMySecondInterface.
- In the destructor for ImplementedFirst, call Release().

Note the use of AddRef() and Release(). Any method starting with "Query" or "Create" is required to return a pointer to the interface with it's reference count already incremented -- but it is up to the client code to ensure that release is called. Using the outline above, the code calls CreateObject once, and therefore has ownership of a single interface pointer, and must release it. The QuerySecondBoss() method also does an AddRef(), but it is the responsibility of the client code to release those references.

Typically, management of references is delegated to InterfacePtr:

```
InterfacePtr<IMySecondInterface>
  second(first, IID_IMYSECONDINTERFACE);
```

2.7.1.6. InDesign's Object Model Implementation Summary

Bosses are classes in InDesign, that are defined in a resource, and produce a boss object at runtime. A boss aggregates interfaces. Both a boss and its interfaces have unique 32-bit IDs.

You can query for an interface on a boss, and receive back an interface pointer. QueryInterface() causes an interface to be instantiated, if an instance doesn't already exist. Querying for an interface causes the interface to increment the boss' refcount.

Interface implementations are C++ classes that derive from the pure virtual methods of an interface class. Interface implementations are instantiated as they are needed by QueryInterface(). Interface implementations are bound to interfaces by CREATE_PMINTERFACE.

You must call `Release()` before an interface pointer goes out of scope. The InterfacePtr class wraps `QueryInterface()` and automates decrementing the refcount on an interface when a pointer to it goes out of scope.

The `CreateObject` class is used to instantiate boss objects. It returns an `IPMUnknown` pointer that you cast to the interface you have queried for. Boss objects are arranged in a hierarchy, of which `gSession` is the root. To navigate the boss object hierarchy, you call accessor methods of interfaces that have knowledge of another boss.

2.8. InDesign Managers

As we've seen, a manager is a logical grouping of functionality. InDesign uses managers to keep track of the state of specific functionality, provide access to the functionality, and do any housekeeping that's required by the functionality. Managers are single points of control for their functional areas.

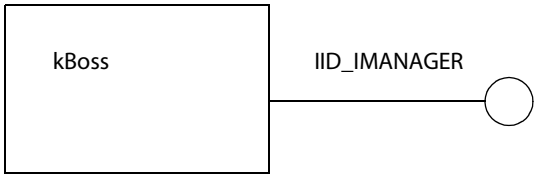
InDesign's API managers must be available to all other plug-ins that need access to their functionality. A manager must be instantiated before it is required, and deleted during shutdown.

2.8.1. Manager Implementation

A manager is an interface on a boss with public methods for providing access to the manager's functionality. Manager interfaces also have methods that are used privately to keep track of the state, or do other housekeeping tasks for their functional area. These methods are exposed because they are abstract, but should not be called by your plug-in.

Manager interfaces are aggregated by bosses that define managed functionality. Managers have accessor methods for obtaining an interface pointer to the manager so that you can use it's methods. The `IMenuManager` interface, for example, is aggregated by the `kMenuManagerBoss`, which defines InDesign's menu system. You can access it from the `IApplication` interface through `QueryMenuManager()`.

figure 2.8.a. manager interface



As an InDesign plug-in developer, you will commonly use several managers to perform certain tasks (adding and deleting menu items, drawing page items, etc.).

2.8.2. Commonly Used InDesign Managers

The following table displays commonly used managers, and has a brief description for each.

Figure 2.8.2.a.

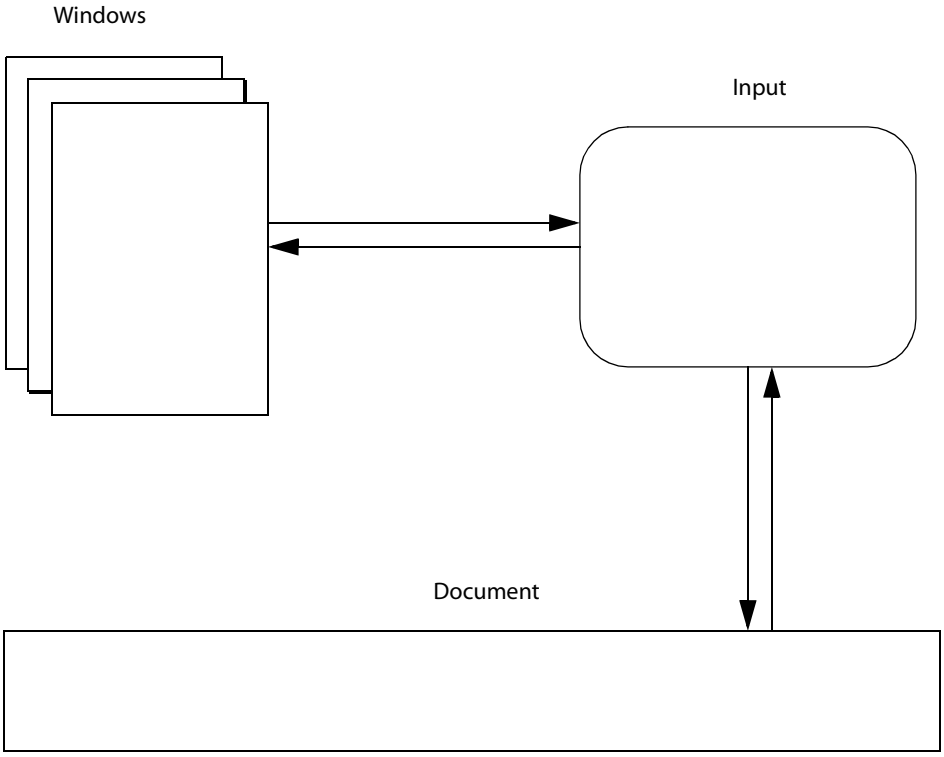
Manager	Description
IMenuManager	Provides access to InDesign's menu system.
ICommandMgr	Manages processing of commands.
IDialogMgr	Methods for creating and manipulating dialogs.
IPanelMgr	Methods for getting the state of a panel and changing it.
IDrawMgr	Used to draw page items.
ISignalMgr	Used by Responders as part of InDesign's messaging.

2.9. MVC in InDesign

InDesign uses the mode-view-controller (MVC) architecture from SmallTalk to factor its user interface.The model manages the behavior and data of the application domain, delivers information about its state to the view and makes changes to its state as directed by the controller. The view manages the GUI, including the onscreen representation of the model. The controller interprets the mouse gestures and keyboard input from the user, commanding the model and or view to change as appropriate. Mapped onto InDesign, a **model**,is a

document, the text on a page, an image, or any of the data that makes up InDesign documents, a **view** is a window opened on the document, and a **controller** is an object that facilitates communication between the model and the view (dialog controller, event handler, and others.)

figure 2.9.a. mvc in indesign



The model communicates with the view through **messages**. The view communicates with the model through **commands**.

2.9.2. MVC Process in InDesign

When a user of InDesign causes a change to occur using the user interface, it responds by creating command objects. Commands cause a change to occur in the document, and then send out a message notifying any interested parties (usually views) that the change has occurred. The views then update to reflect the change to the model.

This is different than non-MVC applications, in which the change to the model is made directly from the view, and the model makes changes directly to the view. For example, a user enters input into a dialog, the dialog code directly changes something in the document, and then the document directly updates the dialog with the change.

When you are developing your plug-ins, you should try to implement your user interface in one plug-in, and any model changes (commands) in another. This will allow you to easily change your UI without changing the functionality of your plug-in.

2.9.3. Observers

Observers are a class of InDesign objects that receive information when certain events occur. They are used extensively in user interface elements such as dialogs and panels. Observers are the mechanism that InDesign API uses to broadcast events such as when an InDesign command saves or closes a file.

Observers register their interest with bosses that have subject interfaces. For example, the document boss is shown in figure 2.9.3.0.a., which has an `IID_ISUBJECT` interface. An instantiation `kDocBoss` exists for each open document. Observers register their interest in the document by calling a method of the `IID_ISUBJECT` interface called `AttachObserver()`. The implementation of this interface, `kCSubjectImpl`, is derived from `ISubject`. `AttachObserver()` registers the observer with a change manager that records:

- a pointer to the object that's being observed
- a pointer to the object (observer) that is observing
- the interface ID of the observing object
- the interface ID of the object being observed

figure 2.9.3.0.a. indesign's document boss

```
Class{
      kDocBoss,
      kInvalidClass,{
            IID_IDOCUMENT, kDocumentImpl,
            IID_IWINDOWLIST, kDocWindowListImpl,
            IID_ICOMMANDMGR, kCommandMgrImpl,
            IID_ISUBJECT, kCSubjectImpl,
            IID_IOBSERVER, kDocObserverImpl,
            IID_IPMPERSIST, kPMPersistImpl,
            IID_ICLASSIDDATA, kClassIDDataImpl, // the doc file handler
            IID_ICONTENTMGRACCESS, kContentMgrAccessImpl,
            IID_IDOCUMENTLOG, kDocumentLogImpl,
```

```
            IID_IPMLOCKFILEDATA, kPMLockFileDataImpl,
        }
    };
```

There are more methods of `ISubject`, but most are for use by the agents changing the subject. The other method important to observers is the `ISubject::DetachObserver()` method that is used to discontinue interest in a particular subject.

Once an observer is attached, InDesign will call a method of the observer when changes in the observed object occur. So what does an observer look like? figure 2.9.3.0.b. shows a minimal observer boss that has only one interface, `IID_IOBSERVER`. The implementation for this interface, `kExampleObserverImpl`, would be derived from `CObserver`, a public implementation of `IObserver`. The class `kExampleObserverImpl` is written to override methods of `CObserver` and perform whatever actions are desired when the event occurs. This observer interface does not have to be isolated on a separate boss, and observers can be used to observe more than one subject.

figure 2.9.3.0.b. a simple observer boss

```
Class{
  kExampleObserverBoss,
  kInvalidClass, {
    IID_IOBSERVER, kExampleObserverImpl,
  }
};
```

The methods for the IObserver object are:

- `AutoAttach()` Attaches the observer to a subject.
- `AutoDetach()` Detaches the observer.
- `Update()` Respond to a change in an observed subject. A call to this method is how the observer receives "notification" of change.
- `SetAttachIID()` Set unique IID rather than `IID_IOBSERVER`.
- `GetAttachIID()` Get the IID of this observer
- `SetEnabled()` Enable or disable the observer.
- `IsEnabled()` Accessor for enabled state

The `kExampleObserverImpl` implementation of the observer needs to override the method for `Update()`, `AutoAttach()`, and `AutoDetach()` methods. The 'auto' methods of the observer are a bit misleading in name. Except in the case of panels, InDesign doesn't automatically call them, and so in general observers

are not automatically attached or detached! This means that some other code in the plug-in must attach and detach the observer.

By convention, the attach and detach code is placed in the "auto" routines if the object has enough information to perform the attach and detach operations. The attach process involves the following steps:

- Acquire the `IID_ISUBJECT` interface of the object being observed
- Call the `AttachObserver()` method of the `IID_ISUBJECT` interface.

And the detach process involves:

- Acquire the `IID_ISUBJECT` interface of the object being observed
- Call the `DetachObserver()` method of the `IID_ISUBJECT` interface.

The observer registers its interest by attaching to the subject. When a subject changes, it notifies any attached observers. This is done through the observer's `Update()` method.

The observer's `Update()` method contains the code to take action based on the subject's change. The `Update()` method receives the `ClassID` of the change, which is usually the `ClassID` of a command. Typically, an `Update()` method will use a switch construct to take action based on the `ClassID` of the change.

Now that we have all the pieces, let's review the sequence of how observers and subjects work.

- Objects exist (or are created by a plug-in programmer) that aggregate an `IID_ISUBJECT` interface with an implementation that derives from `ISubject`.
- Observers are created as a stand-alone boss or added to an existing boss. These observers aggregate an `IID_IOBSERVER` interface with an implementation that derives from `IObserver`.
- The observer is attached to the `IID_ISUBJECT` interface of an object of interest. This is done by an explicit call to subject's `AttachObserver()` method.
- Some time later, an agent of change (usually a command) effects some change in the object being observed. The agent calls the `Change()` method of the subject interface, triggering notification of the observers. For example, this is typically done by the `DoNotify()` method of a command.
- The change manager calls the `Update()` method of the observer, which is the act of notification. The `Update()` method performs what ever actions are desired.

- Sometime later the observer is detached from the `IID_ISUBJECT` interface of an object of interest. This is done by an explicit call to subject's `DetachObserver()` method.

Observers are a very versatile construct. One observer can observe many subjects, and any given subject may have many observers. They are a good solution in an environment where the developer has no control over what other plug-ins may be loaded at a given time. In the case of file actions, they work particularly well because they can support the parallel actions of many plug-ins. However, if a developer has control over the system configuration, a simpler construct can perform custom file actions: the document file handler.

2.9.4. Responders

Responders are a class of objects that can receive predefined InDesign signals when certain events or conditions occur. InDesign defines a set of events and corresponding signals, and events like before, during and after file-open and before, during and after file-new are examples.

A boss object for a minimal responder would look like figure 2.9.4.a.

figure 2.9.4.a. an example boss for a responder

```
Class {
  kExampleNewDocResponderBoss,
  kInvalidClass, {
    IID_IK2SERVICEPROVIDER, kDuringNewDocSignalRespServiceImpl,
    IID_IRESPONDER, kExampleResponderImpl
  }
};
```

This boss has two interfaces: a standard InDesign API service provider and an InDesign responder that has a custom implementation.

On start-up, InDesign builds a service registry that catalogs every class that supports the `IID_IK2SERVICEPROVIDER` interface. The registry contains the:

- Class ID (e.g. `kExampleNewDocResponderBoss`) which identifies the boss that contains the service provider interface.
- Interface ID (e.g. `IID_IK2SERVICEPROVIDER`) which identifies the interface on this boss that is a service provider. The methods in the implementation for this interface describe its type of service.

- Service ID (e.g. `kDuringNewDocSignalResponderService`) which tells InDesign what type of service this boss provides.

When InDesign builds the service registry, `kExampleNewDocResponderBoss` is effectively registered as wanting to receive signals for new document events, and the methods of the second interface on the boss will field those signals. The signals themselves are actually calls to a method in this second interface.

The service provider implementation (`kDuringNewDocSignalRespServiceImpl`) on this boss is a standard InDesign implementation.

`IID_IRESPONDER` is the ID for the interface class that will respond to the new document event. The specific implementation for the responder, `kExampleResponderImpl`, is derived from IResponder which has two methods:

- `Respond()`, which is called when the event of interest occurs. Calling this method is the "signal" InDesign sends this responder.
- `SignalFailed()`, which is called if an error is posted while InDesign is signalling all the responders for an event.

The `Respond()` method is where you insert code to perform whatever special task needs to be done. For example, this is where an observer (see next section) might be attached to a new document.

The `SignalFailed()` method is where you insert code to perform the tasks needed to recover should a signal fail. You should override `SignalFailed()` if your responder does something (other than execute a command) that would need to be undone if the operation is aborted. For example, you may need to detach an observer.

Both methods receive a pointer to a signal manager interface so that they can find out information about the event. Typically `Respond()` and `SignalFailed()` would question the service manager using the `GetServiceID()` method to verify the ID of the service that has occurred. This allows one responder implementation to be used for more than one type of service. For example, Document Watch sample plug-in uses the same responder to service file-open and file-new events.

2.9.5. Commands

A command encapsulates changes to an InDesign document (see the "Commands" chapter). A command is called to act on elements in a document.

It is processed by the Command Manager, and has three methods, `Do()`, `Undo()`, and `Redo()`. Commands broadcast notifications on the subject that they change so that observers can update the view.

2.10. Summary

InDesign is its own programming environment. It has an object model that defines a boss as a class. Bosses define the functionality of plug-ins. Bosses are accessed through interfaces.

InDesign managers provide access to areas of functionality. A manager keeps track of the state of the functionality, and updates it as needed. A manager is usually accessed by calling an accessor method that has knowledge of it from an interface.

Model/View/Controller is used by InDesign to factor its user interface. MVC formalizes the relationship between the document, user interface, and commands and messages that pass between them.
Observers are a class of InDesign objects that receive information when certain events occur, and responders are a class of objects that can receive predefined InDesign signals when certain events or conditions occur. Observers are the mechanism that InDesign API uses to broadcast events such as when an InDesign command saves or closes a file.

2.11. Review

You should be able to answer these questions:

1. What is a boss?
2. How do you access a boss?
3. When should you use InterfacePtr?
4. How do you get your unique prefix for your plug-in?
5. What is a manager?
6. How can your plug-ins reflect the MVC architecture?
7. Why should you not make changes to the model directly from the view?

2.12. Reference

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3.

Document Structure

3.0. Overview

This chapter describes the structure and geometry of an InDesign document. The application's measurement systems and coordinate systems are also discussed.

3.1. Goals

The questions this chapter addresses are:

1. What is an empty InDesign document structure?
2. Which object owns the content of a document?
3. What coordinate systems does the application support?
4. What is the application's measurement systems? How do you add your own custom unit of measure?

3.2. Chapter-at-a-glance

"3.3.Introduction" on page 92 shows an example of an InDesign document.

"3.4.Class Diagram" on page 94 shows the major objects in the document structure and their association.

"3.5.Application Document Structure" on page 96 illustrates the hierarchy structure of an empty document and with added content.

table 3.2.a. version history

Rev	Date	Author	Notes
2.0	23-Oct-02	Lee Huang	Update content for InDesgn 2.x API
1.1	12-Dec-02	Jane Zhou	Second Draft
1.0	16-Oct-02	Jane Zhou	First Draft

"3.6.Navigation Diagram" on page 100 shows the major navigation paths among the objects in an empty document.

"3.7.Interface Diagram" on page 102 iterates through the major interfaces in the document structure.

"3.8.Working With Document Structure" on page 107 gives examples on how to traverse the document hierarchy tree and obtain the information, such as the page items on a page and the spread layer.

"3.9.Application Measurement Systems" on page 108 describes the application's measurement systems and provides pointer for implementing custom units of measure.

"3.10.Application Coordinate Spaces" on page 111 shows various geometric data types and coordinate spaces. Examples are given to demonstrate how to create a text frame and a guide item with the right specified coordinates.

"3.11.Summary" on page 117 provides a summary of the material covered in this chapter.

"3.12.Review" on page 117 poses questions to test your understanding of the chapter.

"3.13.Exercises" on page 117 gives some exercises you might want to try after finish reading the chapter.

3.3. Introduction

From the user's point of view, a document is the final product that stores both layout and contents. Its content may be composed of frames, text and images. A document can be laid out on spreads that can have one or more pages. Content can be layered using document wide layers. From the developer's point of view, a document is the database which stores a tree of objects. Each object is owned by another object with a reference between them.

A document is represented by the boss class named `kDocBoss` which aggregates the interface `IDocument`, which provides the basic file operation. There are other interfaces that `kDocBoss` aggregates, for example, `IWindowList` maintains a list of windows (`IWindow`) that are associated with the document.

figure 3.3.a. shows a sample document. In this document, there are three pages, two pages per spread. By default in the Roman version of InDesign, the first page is a right page numbered 1. Odd-numbered pages always appear on the right. For the Japanese version, the first page if a left page numbered 1, odd-numbered pages always appear on the left by default.

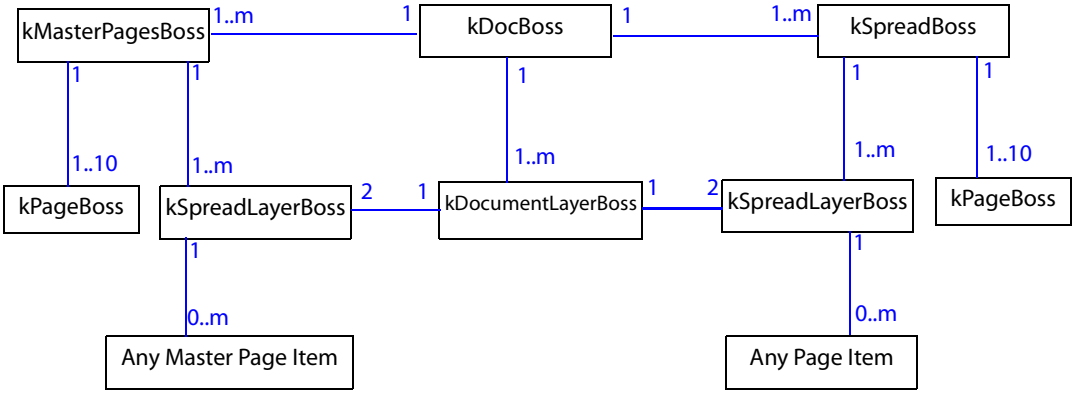
Each document includes at least one named layer. Pages and spreads are manipulated by the end-user via the **Pages** panel while layers are manipulated using the **Layers** panel. You as an end-user can add more layers to the document so that you can create and edit specific areas or types of content in your document without affecting other areas or types of content.

figure 3.3.a. Sample Document

3.4. Class Diagram

figure 3.4.a. shows the class diagram that illustrates the relationship between the document, spreads, document layers, spread layers, pages and page items.

figure 3.4.a. Document Structure Class Diagram



Each document (`kDocBoss`) is made up of one or more spreads (`kSpreadBoss`) and a global pasteboard. The spread is the root of the contents. Each spread contains one or more pages (`kPageBoss`).

A document has a list of document layers (`kDocumentLayerBoss`). Document Layer are document-wide. Individual layers may be renamed, hidden, locked programmatically or by an end user through application UI. The user may assign the color to be used for selection handles of items in a particular layer. Layers may be added, removed, and moved within the document's layer list. Changes to layers are document wide. They affect all spreads, including master spreads in the document.

The layer's z-order determines the drawing sequence. Layer one draws first, layer n draws last. For each document layer, there are two spread layers on each spread, one for content and one for guides. The spread has a tree structure whose children are spread layers. The children of each of the spread layers are the page items. The same rules apply to the master spread.

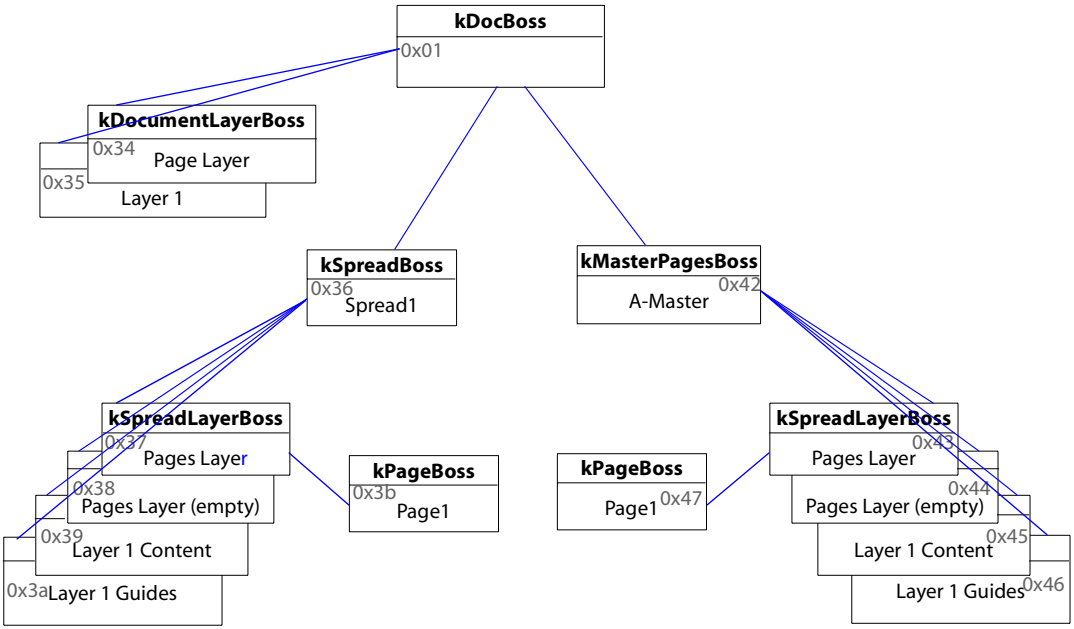
When the end-user creates a new spread, first the `kSpreadBoss` is created in the document database, and the document's (`kDocBoss`) ISpreadList is updated with the newly created, then spread layers (`kSpreadLayerBoss`) are added into the `kSpreadBoss's IHierarchy`. It is done by looping through each document layer (`ILayerList` of the `kDocBoss`) and add two spread layers (`kSpreadLayerBoss`) for each one, one is the normal spread layer, one is the guides spread layer. If guides are in back, all the guides spread layers come first,

followed by the regular spread layers. The next section will provide more details on how the spread layers are structured in the spread. After the spread layer is created, the pages are inserted into the page layer, the first `kSpreadLayerBoss` of the document (read more about page layer in the next section).

3.5. Application Document Structure

figure 3.5.a. shows objects that exist in a single page empty document with a single page spread. The `UID` of each object is shown in gray. Note the `UID` is just the number that representing the boss object in the database, it does not have any special meaning in this context; it is similar to a a record ID in a database, and the UID would depend on the exact document composition.

figure 3.5.a. Empty Document Boss Object Tree



The overall structure is implemented by mixture of lists and trees. An object of `kDocBoss` is at the hierarchy. `kSpreadBoss` is where `kDocBoss` hierarchy resides. The diagram also shows that each document layer has two spread layers, one for content and one for guides. The first document layer is the pages layer. It is associated with two spread layers, one contains the `kPageBoss` object and one layer is always empty. Page (`kPageBoss`) doesn't own the content that lies on it, kSpreadLayerBoss does. kPageBoss is responsible for drawing the page outline, margins, columns and drop shadow, and have knowledge of its master page.

The empty layer is kept as a placeholder to reinforce that each document layer has two spread layers. The master spread is structured in a similar manner.

For example, an empty document with one document layer will have a total of four spread layers. The spread layer list will look like this:

index[0] pages layer where the pages live
index[1] pages layer for guides (always empty)
index[2] layer 1 contents
index[3] layer 1 guides

Suppose you add a new document layer to this empty document. Then the total of spread layers will be six. The sample snippet, `SnipInspectSpreadLayer.cpp` will produce output similar to the following if there are 2 layers in the front document.

index[0] pages layer where the pages live
index[1] pages layer for guides (always empty)
index[2] layer 1 content
index[3] layer 2 content
index[4] layer 1 guides
index[5] layer 2 guides

There are couple observations from the above example. First, guides are kept as a separate layer rather than being combined into the content layer. The benefit for this is to be able to draw guides either in front of, or behind the content, or even turn them off completely. Second, all guide layers and all content layers are continuous in the hierarchy, except for the pages layer. Third, the following formulas exist if the guide is in front.

(1) index for content spread layer = index for document layer + 1;

(2) index for guide spread layer = total number of document layers + index for document layer;

If the guide is in back (the default setting is in front), the spread layer list for above example looks slightly different. Note that you can change the “guide in back” setting from the application preferences dialog, if you run the

SnipInspectSpreadLayer.cpp snippet after doing so, you will get the result similar to the following:

index[0] pages layer where the pages live
index[1] pages layer for guides (always empty)
index[2] layer 1 guides
index[3] layer 2 guides
index[4] layer 1 content
index[5] layer 2 content

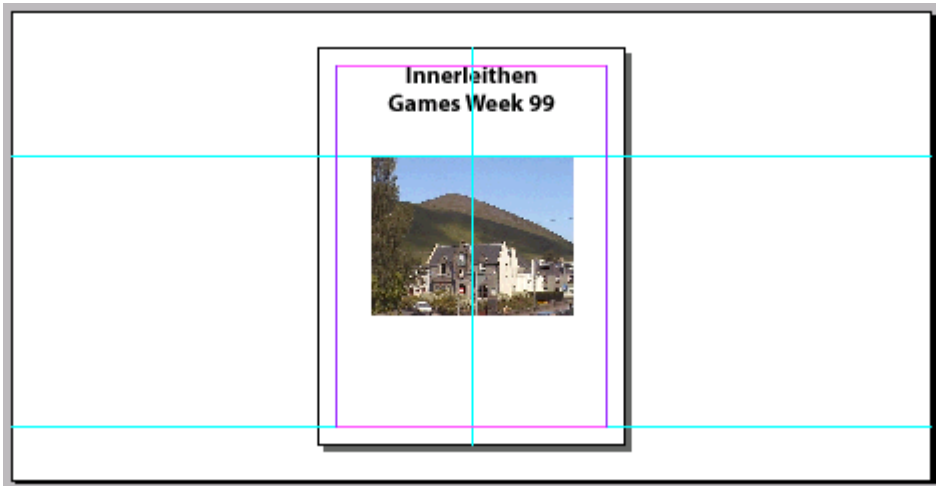
In this case, the formulas are different for the content and guide spread layer indexes.

(1) index for content spread layer = total number of document layers + index for document layer;

(2) index for guide spread layer = index for document layer +1;

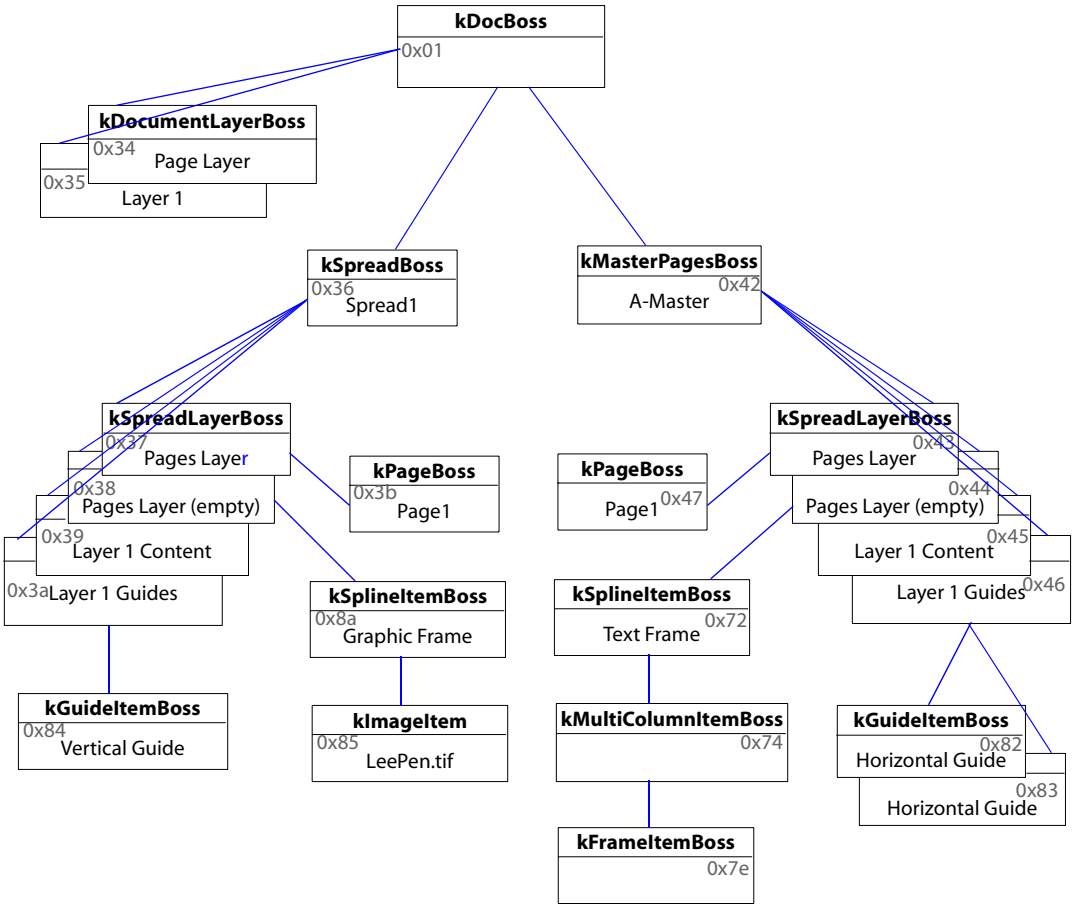
Now we are going to add some content to this empty document. Page one contains one image and one vertical guide. The master page contains one text frame and two horizontal guides. figure 3.5.b. shows the sample document.

figure 3.5.b. Sample Document



Which object is going to own each piece of content we added to the empty document? figure 3.5.c. reveals the objects layout for this example. Note in the following diagram, we assume that the guides are in front.

figure 3.5.c. Sample Document Boss Object Tree

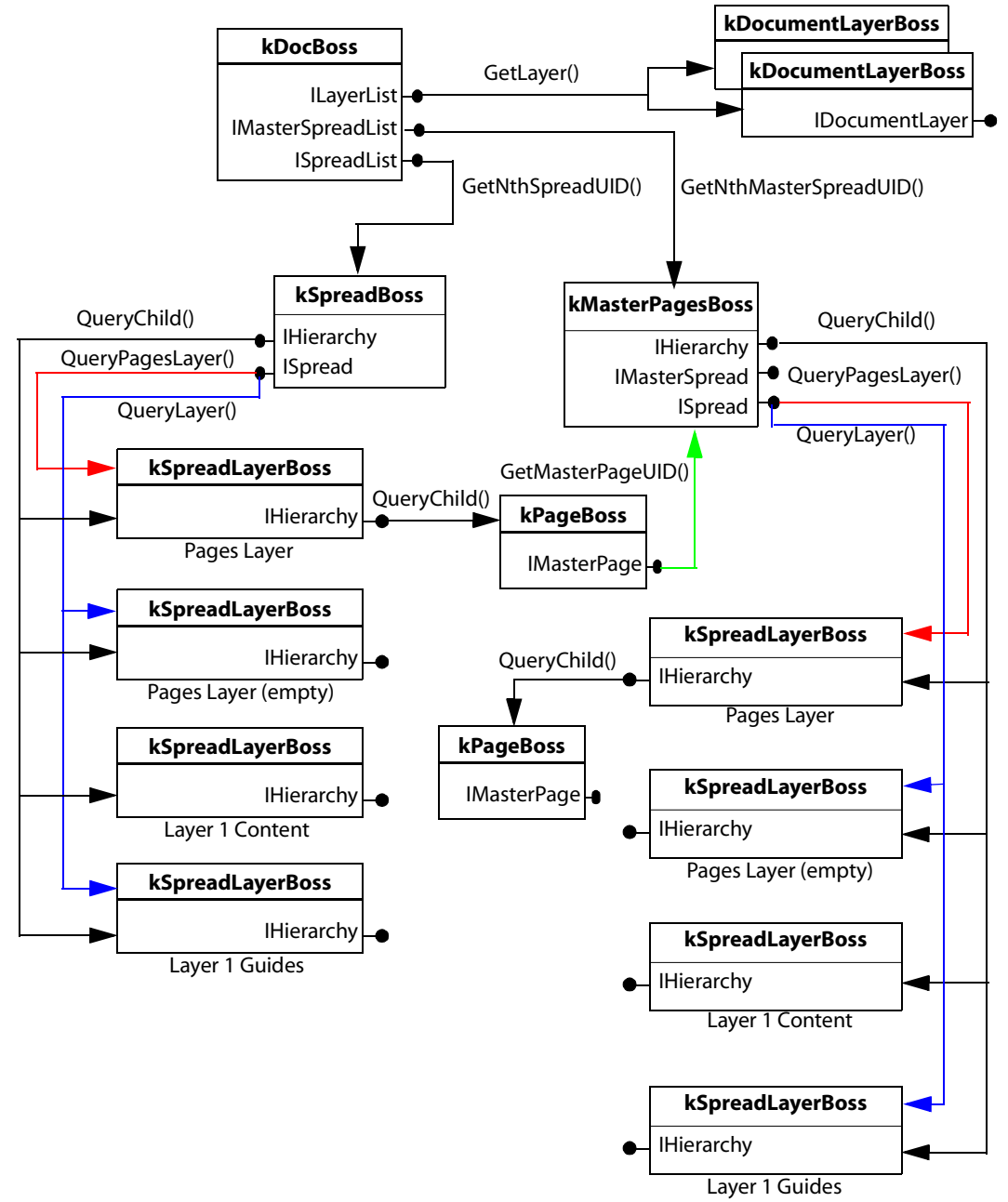


The key point here is that the tree grows as content is added to the document. Content is associated with a spline which is a frame that owns its content. Spread layers (kSpreadLayerBoss) own the splines (kSplineItemBoss) and guide items (kGuideItemBoss), we call the spread layers the parents. Spreads (kSpreadBoss) implement the parent and child relationship on interface `IHierarchy`.

3.6. Navigation Diagram

You can navigate from one boss object to another boss object in the document object tree via the appropriate interface. is the navigation diagram for the above empty sample document. Its objects tree is shown in figure 3.5.a.

figure 3.6.a. Navigation Diagram

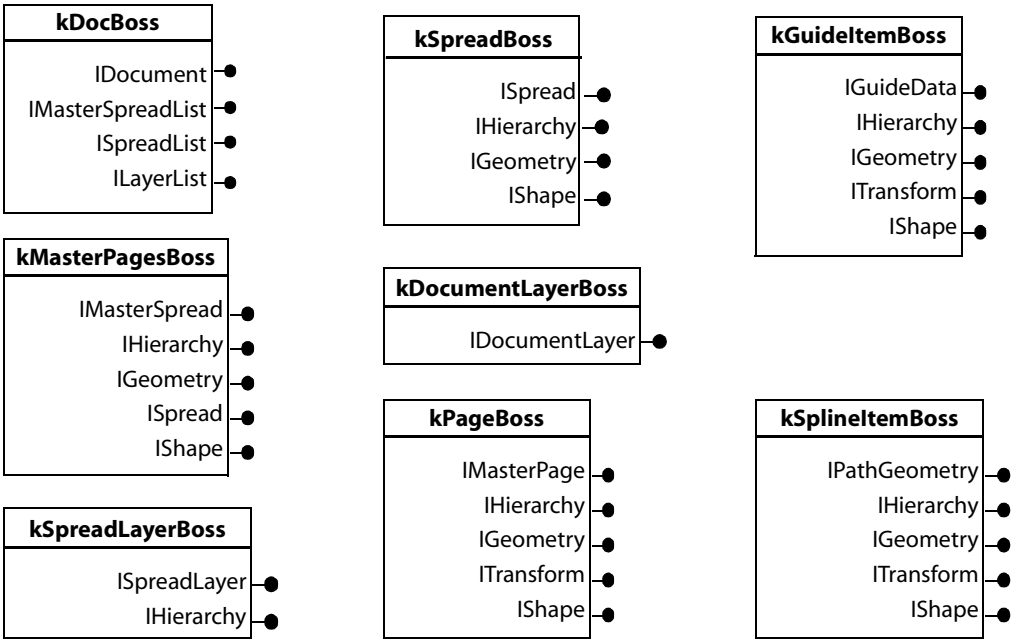


Notice that the special pages layer contains the `kPageBoss`, which points back to its master spread via the interface `IMasterPage`.

3.7. Interface Diagram

figure 3.7.a. shows the major interfaces involved in document structure.

figure 3.7.a. Document Structure Interface Diagram



3.7.1. IDocument

This interface represents a document. It also provides the basic file operations and method to access the document work space.

Figure 3.7.1.a. Major IDocument Methods

```
// Return the name associated with the document. The name is used for
// the default window title, and for the default "save-to" file the
// first time it is saved.
// Do not use the document's name to make assumptions about the
// name of the actual publication file in the file system.
virtual void GetName(PMString& name) const = 0;

// Get the document level workspace.
virtual UIDRef GetDocWorkSpace() = 0;
```

3.7.2. ISpread

InDesign documents are laid out as a set of spreads where each spread contains one or more pages. Via this interface, you can query different spread layer for the specified document layer.

Figure 3.7.2.a. Major ISpread Methods

```
// Return the spread layer associated with the given document layer.
// If pPos is not nil, it's filled in with the position of the spread
// layer within the spread. If wantGuideLayer is kFalse, the spread
// content layer is returned. This is the default. If wantGuideLayer
// is kTrue, the corresponding spread guide layer is returned.
virtual ISpreadLayer * QueryLayer(IDocumentLayer * docLayer, int32 *
pPos = nil, bool16 wantGuideLayer = kFalse) = 0;

// Returns the spread layer for pages. It is at index 0 position of the
// spread hierarchy.
virtual IHierarchy * QueryPagesLayer() = 0;

// Returns the items on the page. By default, the returned item UIDList
// will include the UID of the page itself, but not the items on the
// pasteboard.
virtual void GetItemsOnPage(int32 pgPos, UIDList * items, bool16
bIncludePage = kTrue, bool16 bIncludePasteboard = kFalse) = 0;

virtual int32 GetNumPages() = 0;
virtual IGeometry * QueryNthPage(int32 n) = 0;
virtual UID GetNthPageUID(int32 n) = 0;
virtual int32 GetPageIndex(UID pageID) = 0;

// Returns a pasteboard bounding box that tightly encloses
// all the pages on the spread.
virtual PBPMRect GetPagesBounds() = 0;
```

3.7.3. ISpreadList

This interface maintains a persistent UID list of spreads in a given document.

Figure 3.7.3.a. Major ISpreadList Methods

```
//Return the IGeometry associated with the 'spreadIndex' spread. This
//will add a ref count, and will instantiate the spread if necessary.
virtual IGeometry * QueryNthSpread(int32 spreadIndex) = 0;

virtual UID GetNthSpreadUID(int32 spreadIndex) = 0;
virtual int32 GetSpreadCount() const = 0;
virtual int32 GetSpreadIndex(IGeometry * spread) = 0;
virtual int32 GetSpreadIndex(UID spreadUID) = 0;
```

3.7.4. IMasterSpread

A master spread is like a template background that you can quickly apply to any pages in the document. In most cases, as you can see from figure 3.5.c, master spreads are similar to spreads in structure. They form their own hierarchy in a document database. In addition, you can apply one master to another master. Or you can create a new master spread based on another master spread.

Suppose you've got two master spreads A and B with a different set of boilerplate items on each. When you drag master spread B onto master spread A in the **Pages** panel, master spread B formats the master spread A. All the master page items on master spread B will be applied onto master spread A. However, those master page items on master spread B are still owned by master spread B, not master spread A. If you later alter master spread B, the change applies to master spread A. But master spread A can override those items on a per attribute basis, just like you can override the master page items applied on the spread in the document.

`IMasterSpread` contains the incremental information beyond what is already contained in a regular spread. This information includes the name of the master spread, the layout spread UID to which the master spread is applied, and the offset position that has been applied to the view in order to draw the page.

Figure 3.7.4.a. Major IMasterSpread Methods

```
// The name is the combination of the single character prefix and the
// base name (separated by a '-'). e.g. for the first/default master
// spread, the base name will be 'Master', the prefix will be 'A', and
// the name returned by GetName will be 'A-Master'.
virtual void GetName(PMString *pName) = 0;

// Get and Set the spread that is being drawn (i.e. the UID of
// the layout spread to which the master spread is applied).
// Do NOT call SetCurrentLayoutSpreadUID directly. It is called by the
// drawing code.
// If you need to set the current spread, use kSetSpreadCmd instead.
virtual const UID& GetCurrentLayoutSpreadUID() = 0;
virtual void SetCurrentLayoutSpreadUID(const UID &newSpread) = 0;
```

3.7.5. IMasterSpreadList

The interface contains a persistent UID list of master spreads.

Figure 3.7.5.a. Major IMasterSpreadList Methods

```
// Return the master spread at index spreadIndex. This will add a ref
```

```
// count to the object.
virtual IGeometry * QueryNthMasterSpread(int32 spreadIndex) = 0;
virtual UID GetNthMasterSpreadUID(int32 spreadIndex) = 0;

virtual int32 GetMasterSpreadCount() = 0;
virtual int32 GetMasterSpreadIndex(IGeometry * spread) = 0;
virtual int32 GetMasterSpreadIndex(UID spreadUID) = 0;
```

3.7.6. IMasterPage

Each page (kPageBoss) aggregates an IMasterPage interface, this interface keeps track of the master spread (kMasterPagesBoss) associated with the page and the index within the master spread that this page has assigned to.

figure 3.7.6.a. Major IMasterPage Methods

```
// Get and set the UID of the master spread assigned to the page.
// Note: the UID returned is the master spread UID.
virtual UID GetMasterPageUID() = 0;
virtual void SetMasterPageUID(UID mpUID, uint16 mpIndex =
IMasterPage::kPositionDependant) = 0;

// Get and set the index within the master spread that this page has
// assigned to. This is to allow, for example, a single page to have
// the right-most page of a master spread assigned to it (rather than
// the left-most as would be the default without these methods). By
// default, the kPositionDependant is assigned - this allows the
// master to change based on where within a spread the page falls.
virtual uint16 GetMasterIndex() = 0;
virtual void SetMasterIndex(uint16) = 0;
```

3.7.7. ILayerList

The document's `ILayerList` maintains a list of document layer (kDocumentLayerBoss) UIDs. It supports adding, moving, and deleting layers.

Figure 3.7.7.a. Major ILayerList Methods

```
// Returns the number of layers in this document.
virtual int32 GetCount() const = 0;
// Return the UID of the document layer with the specified name
virtual UID FindByName(const PMString& name) = 0;

virtual IDocumentLayer * GetLayer(int32 n) = 0;
virtual int32 GetLayerIndex(IDocumentLayer * docLayer) = 0;
virtual int32 GetLayerIndex(UID layerUID) = 0;

// Returns the next candidate for an active layer.  It looks for the
// first visible, unlocked layer in front of the given one, then behind
// this one, then the next visible, but perhaps locked (in front and
// behind), then the next UI layer in front and behind this one.
```

```
// Returns nil, if there are no other layers.
virtual IDocumentLayer * GetNextActiveLayer(IDocumentLayer * docLayer)
= 0;

// This version is useful if the old layer has already been removed and
// you know its index.
virtual IDocumentLayer* GetNextActiveLayer(int32 layerIndex) = 0;
```

Document layers are the layers the user sees in the **Layers** panel. In addition there is a special layer, the *pages layer*, which is not displayed in the **Layers** panel. It is always the first entry in the document layer list. It can not be made writable or moved in the z-order. It also has two corresponding spread layers. One layer contains the `kPageBoss`, another is always empty.

3.7.8. IDocumentLayer

This interface describes the attributes of a document-wide layer attributes like name, color, etc. And it has an associated content spread-layer and guide spread-layer as explained in the "Class Diagram" on page 94 and "Application Document Structure" on page 96

Figure 3.7.8.a. Major IDocumentLayer Methods

```
// Get and set the name of the layer.
virtual void GetName(PMString * pName) const = 0;
virtual const PMString& GetName() const = 0;
virtual void SetName(const PMString& newName) = 0;

// return TRUE if the layer appears in the Layers Panel. Pages layer is
// not in the Layers panel, so it is not a UI layer.
virtual bool16 IsUILayer() = 0;
```

3.7.9. ISpreadLayer

ISpreadLayer is aggregated onto kSpreadLayerBoss. A spread layer (kSpreadLayerBoss) is the container for all the page item in that layer through the IHierarchy interface on the kSpreadLayerBoss. ISpreadLayer interface maintains a relationship back to the corresponding document layer boss. (kDocumentLayerBoss).

Figure 3.7.9.a. Major ISpreadLayer Methods

```
// Returns a pointer to the associated document layer.
// The caller is responsible to release the pointer when it is done!
virtual IDocumentLayer * QueryDocLayer() const = 0;
// Return the UID of the associated document layer.
virtual UID GetDocLayerUID() const = 0;
```

The default implementation of this interface actually forwards all methods to the document layer associated with the spread layer. It only allows the name and other attributes of a spread layer to be queried, but not changed. Any changes must be made directly to the document layer.

3.8. Working With Document Structure

3.8.1. The DocumentStructure Snippet

The SnipDocumentStructure.cpp in the SDK is very useful to examine the structure of a document. The snippet can be found in the folder SampleCode\CodeSnippets in the SDK. For information on how to run the SnippetRunner plug-in, please refer to SnippetRunnerDesign.html available from the SDK. The snippet is a great way to discover what lives inside a document. It is also a great debugging tool, for example, an often encountered problem in the InDesign plug-in development is a page item is not created in the desired location. This snippet's ReportDocumentGeometry() function will report a page item's geometry and transformation matrix so you can gain some insight into a page item.

3.8.2. Get All Page Items On A Page

Page items are held in spread layers (kSpreadLayerBoss) and can be accessed through the IHierarchy interface on an instance of a kSpreadLayerBoss. There is a method that provides you a way to get all the items on a specified page. It is ISpread::GetItemsOnPage(). The prototype is as following:

figure 3.8.2.a. ISpread::GetItemsOnPage() Prototype

```
virtual void GetItemsOnPage(int32 pgPos, UIDList * items, bool16
bIncludePage = kTrue, bool16 bIncludePasteboard = kFalse) = 0;
```

The code snippet SnipInspectItemsOnPage.cpp shows a sample usage of the function GetItemsOnPage.

3.8.3. Finding The Spread Layer

For each document layer, there are two corresponding spread layers. One is for content and the other one is for guides. Sometimes, we call the spread layer that holds the content a regular spread layer. The snippet SnipInspectSpreadLayer.cpp shows how to iterate through the front doc's spreads and its associated spread layers.

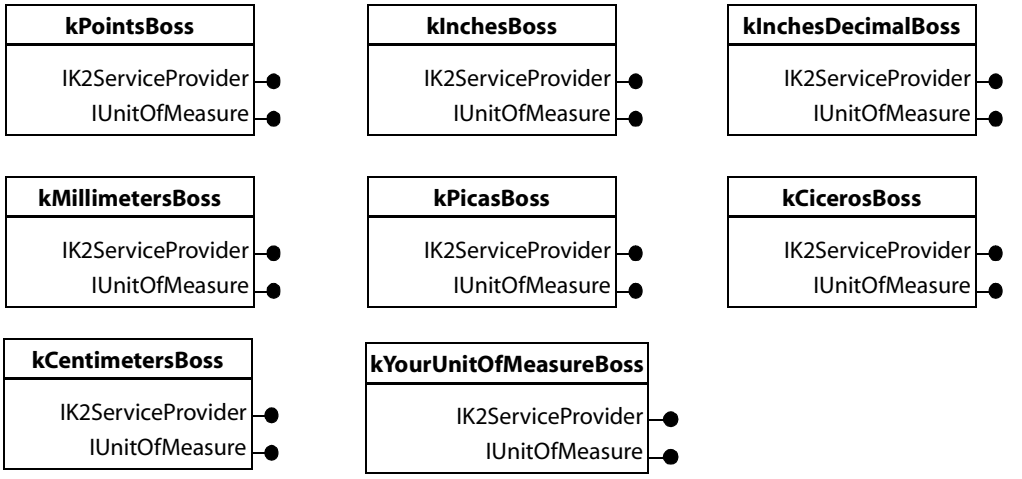
3.9. Application Measurement Systems

3.9.1. Introduction

InDesign's internal unit of measure is points, although it also supports other units of measure, such as centimeters, inches, picas, ciceros etc. Points were chosen because AGM (Adobe Graphics Manager) uses points as its unit of measure. Using the same unit of measure as AGM reduces one source of potential round-off error. Points are stored as `PMReal`, which is type double.

There are seven default units of measure that Roman feature InDesign supports in its Preferences panel. You can add your own units of measure to the panel too. They are available as service providers. They are shown in the following boss diagram.

figure 3.9.1.a. Seven Units Of Measure Bosses



Each unit of measure boss class aggregates two interfaces, `IK2ServiceProvider` and `IUnitOfMeasure`.

A unit of measure boss is a boss class that aggregates the `IUnitOfMeasure`. Plug-ins can add new units of measure to the application by simply constructing a unit of measure boss and registering it with the measurement system as a service provider. The sample `CustomUnits` demonstrates the technique to create such a customized unit. In addition, a plug-in needs to provide a resource description of how the ruler tick markers are specified for the custom units. `CustomRuler.fr` from the sample shows an example of ruler resource for inches

from the CustomUnits sample. For a complete explanation of each parameter, please refer to RulerType.fh in API:Includes.

3.9.2. IUnitOfMeasure

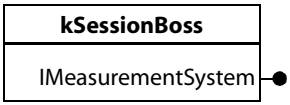
IUnitOfMeasure is an interface responsible for converting between the unit of measure and the internal unit of measure (points). It also has methods for producing a formatted string representation from units and for tokenizing a string to produce a formatted number from the string.

figure 3.9.2.a. Major IUnitOfMeasure Methods

```
virtual void GetName(PMString * pName) = 0;
virtual PMReal UnitsToPoints(const PMReal& units) = 0;
virtual PMReal PointsToUnits(const PMReal& points) = 0;

virtual void Format(const PMReal& units, PMString& str) = 0;
virtual bool16 Parse(const PMString& str, PMReal& points) = 0;

// Get the ruler resource spec for the specific unit of measure
virtual RsrcSpec GetRulerSpecRsrcSpec() const = 0;
```

3.9.3. IMeasurementSystem

figure 3.9.3.a. Class Diagram



IMeasurementSystem is an interface of the session that is used to manage the available units of measure within the application. Units of measure can be referred to by either their ClassID or an index which the measurement system hands out. The index is used while referring to a unit of measure in memory. But it should be converted into the ClassID when writing or reading from a stream.

Figure 3.9.3.b. Major IMeasurementSystem Methods

```
// Return the index of the measurement system whose class id
// is specified in 'classId'.
virtual int32 Location(const ClassID& classId) = 0;

// Query the unit of measure for the specified index.
virtual IUnitOfMeasure* QueryUnitOfMeasure(int32 index) = 0;

// Get the number of unit of measure the application available.
```

```
virtual int32 GetNumberOfUnits() = 0;
```

Since the unit of measure was loaded by iterating over the object model, this interface only has methods for accessing units of measure.

3.9.4. IUnitOfMeasureSettings

figure 3.9.4.a. Class Diagrams

The interface `IUnitOfMeasureSettings` is aggregated into the session workspace (kWorkspaceBoss) and document workspace (kDocWorkspaceBoss). It provides the ability to set and get the unit of measure for text, and the x and y dimensions. You can change the unit of measure setting via the **Preferences** dialog. When a new document is created it inherits its default unit of measure settings from the session. The snippet `SnipInspectUnitOfMeasure.cpp` shows how to get the unit of measure that is currently used.

3.9.5. Rulers

The ruler widget is used to display rulers. The layout of the ruler is completely determined by the data defined in the ruler resource description (resource type of RulerDataType). A ruler resource description (RulerDataType) contains a postscript font name, font size, units of measure boss ID, major division length, flags for fraction and decimal, and a list of tick marks within a major division. See `RulerType.fh` for more details. A tick mark is specified by the number of subdivisions of the previous sub-tick level, and the tick mark's length as a percentage of the full tick length. If the workspace is scaled smaller than the specified scaling limit, the ticks will not show in the workspace.

Typically a ruler is associated with a particular unit of measure object. The resource description for the ruler is in the same plug-in as the unit of measure. The unit of measure object will return the resource ID of the ruler description in its override of `GetRulerSpecRsrcSpec` in the implementation of interface `IUnitOfMeasure`.

When a new view is created on a document, the unit of measure is retrieved from the unit of measure settings interface on the document. The unit of

measure is then queried for the resource ID of a ruler description. If one exists, that description is used to create a new ruler as part of the new view of the document.

3.9.6. Custom Unit Of Measure

Third party developers can add their own unit of measure if there is a need. Your plug-in needs to do three things to make your custom unit of measure appear in the *Units & Increments* drop down list in the application **Preferences** dialog.

1. Derive your custom unit of measure class from `CUnitOfMeasure` and provide an implementation for `IUnitOfMeasure`.
2. Provide implementation for interface `IK2ServiceProvider`, the helper implementation `kUnitOfMeasureService`, which will register the custom unit with the application measurement system can be used as default implementation.
3. Include a ruler resource description of the type `RulerDataType` for your custom unit of measure in the resource file on each platform. For a complete sample, please see the plug-in `CustomUnits` in the SDK under `ServiceProviders\CustomUnits`.

3.10. Application Coordinate Spaces

3.10.1. Geometry Data Types

The application supports various geometry data types, such as `PMReal`, `PMPoint`, `PMRect`, `PMMatrix`, etc., see their corresponding headers for details. For example, `PMReal.h` would have the class declaration for `PMReal`.

There are also a set of data types that are designed primarily for use to indicate the expected coordinate system of input parameters or the coordinate system of output values. Those data types are shown in figure 3.10.1.a.

figure 3.10.1.a. Synonyms For Geometry Data Types

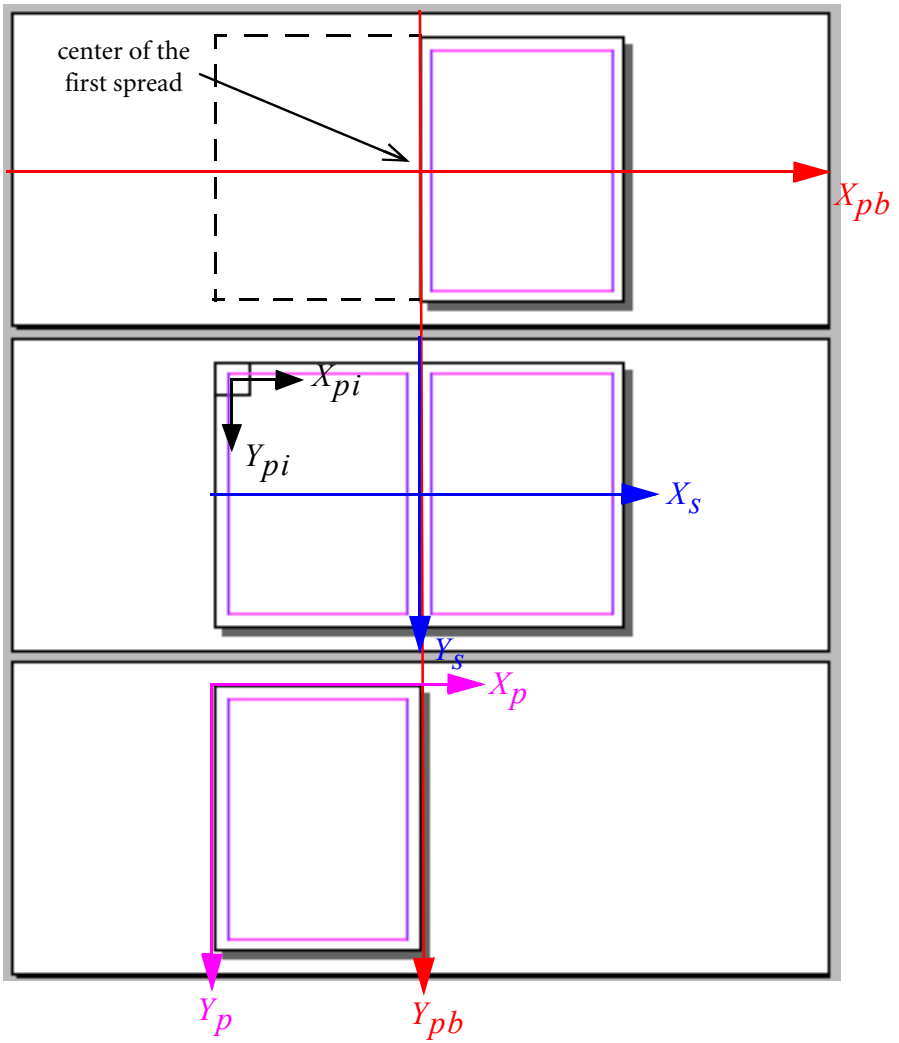
```
// The following types are synonyms of PMPoint
typedef PMPoint PBPMPoint; // point in pasteboard coordinate
typedef PMPoint IPMPoint; // point in inner coordinate of page item
typedef K2Vector<PMPoint> PMPointList;
typedef K2Vector<PMPointList*> PMPointListCollection;

// The following types are synonyms of PMRect
typedef PMRect PBPMRect; // rectangle in pasteboard coordinate
typedef PMRect IPMRect; // rectangle in inner coordinate of page item
typedef K2Vector<PMRect> PMRectCollection;
```

```
typedef K2Vector<PMMatrix> PMMatrixCollection;
```

3.10.2. Coordinate Systems

There are at least four coordinate systems InDesign supports. When you try to describe a page item's location, you can specify it in terms of the pasteboard geometry, the spread geometry, the page geometry or the page item's own geometry. figure 3.10.2.a. shows their geometry arrangement inside the application workspace.

figure 3.10.2.a. Application Coordinate Systems



In this diagram, the document has four pages. The master spread has two pages, hence each spread contains two pages. There is also a page item, a black square with dimension of 100 points at the origin of the page two.

- Pasteboard Geometry - The pasteboard encloses all the spread in the document, The origin of the pasteboard is the center of the first spread in

the document. In the figure above, the pasteboard coordinates is represented by the red axes (X_{pb}, Y_{pb}). The x axis is right increasing, the y axis is down increasing. Page items with locations outside the bounds of the pasteboard will be clipped and will not be drawn.

- Spread Geometry - Each spread is enclosed by its own spread geometry. Its origin is the center of the spread. In the figure above, the spread coordinates is represented by the blue axes (X_s, Y_s).
- Page Geometry - Each page is enclosed by its own page geometry. Its origin is the top left corner of the page. In the figure above, the spread coordinates is represented by the magenta axes (X_p, Y_p).
- Page Item Geometry - Finally, page item has its own coordinate system, the origin is at the item's center. In the figure above, the spread coordinates is represented by the black axes (X_{pi}, Y_{pi}).The square's inner bounds are saved in interface `IGeometry`. A transform to position the square in its parent's coordinate space is saved in interface `ITransform`. In this case the square spline item is positioned relative to the geometry of its parent, the second spread.

It is important to note that when creating a spline item, it is necessary to specify its location in the global pasteboard coordinates. `InnerToPasteboard` method of the `TransformUtils` can be used to get the pasteboard coordinate. If you try to specify a location in the above figure, depends on which origin you use as the reference point, the locations are different. Therefore, to correctly describe a location, not only you need to know the (X, Y) coordinates, you also need to know which geometry this coordinates based upon. When you use the function `InnerToPasteboard`, you have to let the method know which geometry (`IGeometry`) the point you are trying to convert is based upon. Most of the InDesign objects that can be manipulated by the end-user, including spread (`kSpreadBoss`), page (`kPageBoss`), spline item (`kSplinItemBoss`) all aggregate an `IGeometry` interface. So when you try to use the `TransformUtils::InnerToPasteboard` method, you have to ask yourself which geometry my new page item will lie upon, if you are thinking about the location in terms of the current page, then you have to get to the `IGeometry` interface of the corresponding `kPageBoss`, if you are thinking about the location in terms of spread, then you have to get to the IGeometry interface of the corresponding `kSpreadBoss`. The snippet `SnipCreateFrame.cpp` demonstrates the difference when you specify the same coordinates with different geometry, a spline item will be created at different locations in the document.

As briefly noted above, the interface ITransform is used to transform a coordinate from its own geometry to its parent's geometry. In fact, `TransformUtils::InnerToPasteboard` will first try to get to the ITransform interface pointer from the same boss object that aggregates the IGeometry, The ITransform has a method that would return a transformation matrix that transforms the inner coordinates of the item all the way to the pasteboard by walking up the page item's hierarchy. Then this transformation matrix is used to convert the point from coordinate you pass in the `InnerToPasteboard` to the pasteboard coordinate. The snippet `SnipDocumentStructure` has an option for you to explore the relationship between a page item's geometry and transformation matrix.

It is also interesting to note that, when you use the rectangular (or other) tool to create a shape in the document, the transformation matrix is 1:1 which means inner and parent are the same. That is because the tool tracker converts the global mouse points directly into the pasteboard coordinates when it is doing the tracking. Each tracker decides if its going to change the `IGeometry`, the `IPathGeometry` or the `ITransform`.

The important things about coordinate systems are:

1. The coordinates within interface `IPathGeometry` and `IGeometry` are stored in inner coordinates.
2. Different page items can have different coordinate systems.
3. A page item's `ITransform` can be used to transform a page item to its parent's inner coordinates.
4. To compare coordinates between two or more page items, the coordinates should first be transformed to a common coordinate space. The pasteboard space is often used for this purpose and some transformation utilities are defined in TransformUtils.h, which can be used to transform from an object's inner coordinates to its pasteboard coordinates.

3.10.3. Working With Coordinate Spaces

3.10.3.1. Create A Text Frame

When creating a spline page item, you define its bounding box in pasteboard space. The item itself stores its inner bounds in interface `IGeometry` and a transform matrix in interface `ITransform` to position itself in its parent's

coordinate space. For items that are not contained within other items, the parent would be the spread.

The snippet `SnipCreateTextFrame.cpp` illustrates how to create a simple text frame.

3.10.3.2. Create A Guide Item

Guides are different from the page items. Unlike page items, guides are not defined by a list of points. A guide is instead defined by the `IGuideData` interface. When you are creating them, you specify the coordinates in their parent's space, normally a spread, not the pasteboard space.

figure 3.10.3.2.a. demonstrates how to create a vertical guide item on the first page of the active spread. Again, error checking is omitted for code simplicity.

figure 3.10.3.2.a. Create A Vertical Guide Item

```
InterfacePtr<ILayoutControlData>
layoutData(::QueryFrontLayoutData());
// Get the active document layer
InterfacePtr<IDocumentLayer> docLayer(layoutData->
QueryActiveDocLayer());

InterfacePtr<ISpread> spread(layoutData->GetSpread(), IID_ISPREAD);
IDataBase *db = ::GetDataBase(spread);

// Get the guide spread layer for the active spread.
InterfacePtr<ISpreadLayer> spreadLayer(spread->QueryLayer(docLayer,
nil, kTrue));

// The parent for the new guide is the guide spread layer.
UID parent = ::GetUID(spreadLayer);
UIDRef parentUIDRef(db, parent);

// Get the first page UID. Each page owns its guides.
UID ownerUID = spread->GetNthPageUID(0);

// Note: The parent for the guide we are to create is the spread. Each
// page owns its guides. We need to convert the guide coordinates
// to its parent space - spread space.

// Get the bounding box of the page in spread space.
InterfacePtr<IGeometry> geometry(db, ownerUID, IID_IGEOMETRY);
PBPMRect bBox = geometry->
GetStrokeBoundingBox(::InnerToParentMatrix(geometry));
```

```
InterfacePtr<ICommand>
newGuideCmd(CmdUtils::CreateCommand(kNewGuideCmdBoss));

InterfacePtr<INewGuideCmdData> newGuideCmdData(newGuideCmd,
IID_INEWGUIDECMDDATA);

// The distance the guide is located at.
PMReal distance = bBox.Left() + bBox.GetHCenter();

// Ge the default guide preference
InterfacePtr<IGuidePrefs>
iGuideDefault((IGuidePrefs*)::QueryPreferences(IID_IGUIDEPREFERENCES,
kGetFrontmostPrefs));

// Get the guide threshold amd the color index
PMReal guideThreshold = iGuideDefault->GetGuidesThreshold();
int32 guideColorIndex = iGuideDefault->GetGuidesColorIndex();

newGuideCmdData->Set(parentUIDRef, kFalse, distance, ownerUID, kTrue,
guideThreshold, guideColorIndex);

if (CmdUtils::ProcessCommand(newGuideCmd) != kSuccess)
  // Report process command failure.
```

3.11. Summary

This chapter outlines the document's structure, built-in measurement systems, and different coordinate systems. Related bosses and interfaces are examined.

3.12. Review

You should be able to answer the following questions:

1. Where are the origins for the pasteboard and the spread? How does the pasteboard relate to a spread?
2. Give two ways you can extend an InDesign document?
3. How do you add a custom unit of measure to the application?
4. What is the relationship between the document layer and the spread layer?
5. What object owns page items?
6. Which coordinate space should you use to specify the bounding box when creating a new page item or a guide item?

3.13. Exercises

3.13.1. Find The Objects That Exist In An Document

Run the debugger version of InDesign with the Diagnostic plug-in provided in the SDK. Create an empty InDesign document. Go to the Diagnostic panel and

choose the fly-out menu *Report Document Hierarchy*. This will output the document hierarchy information into the trace window. Try the other two menus: *Report Document Layers* and *Report Document Geometry*. Then add some page items to the document and try the different menus to see the output.

3.13.2. Create A Horizontal Guide Item

After studying the sample code in section "3.10.3.2.Create A Guide Item" on page 116, write a sample code to create a horizontal guide item.

4.

Plug-ins

4.0. Overview

This document covers the basic architecture and components of a plug-in. The BasicMenu plug-in supplied with the SDK is used here to demonstrate programming principles. We dissect this plug-in file-by-file and discuss the way in which its bosses, interfaces, and implementations interact with the InDesign object model.

Once you understand the plug-in components, this document describes:

- how InDesign uses plug-ins.
- the tools for creating a plug-in.
- the development environment for building plug-ins.

In this document, you are repeatedly directed to look at the BasicMenu plug-in; so now is a good time to open either the Windows or Macintosh project file using your compiler.

4.1. Goals

The questions this chapter answers are:

1. What is in a plug-in?
2. How do I add functionality to InDesign by implementing a plug-in?
3. What special-purpose macros are used to build an InDesign plug-in?
4. How does InDesign locate and load a plug-in?
5. What development tools should I use to make an InDesign plug-in?

4.2. Chapter-at-a-glance

"4.3.The Anatomy of a Plug-in" on page 120 discusses the components of a plug-in and how they are combined to provide new functionality in InDesign.

"4.4.The Life-Cycle of a Plug-in" on page 130 discusses how InDesign locates, catalogs, loads, and unloads a plug-in.

"4.5.The InDesign Plug-in Development Environment" on page 133 describes the development tools, settings, and build procedures for making InDesign plug-ins on the Macintosh and Windows platforms.

"4.6.Code Re-Use" on page 134 discussed specific opportunities for sharing and reusing code.

"4.7.Summary" on page 136 wraps up the chapter for you.

"4.9.Exercises" on page 137 gives you review questions.

"4.10.References" on page 137 shows you where to look for additional information.

4.3. The Anatomy of a Plug-in

If you've browsed the sample plug-ins, you know they're made up of lots of different kinds of files and they all seem to hold a piece of the puzzle but not the whole picture. This section discusses the components of a plug-in using the BasicMenu plug-in as our example. In cases where BasicMenu does not contain an example of a topic, you are directed to look at other example plug-ins in the InDesign SDK.

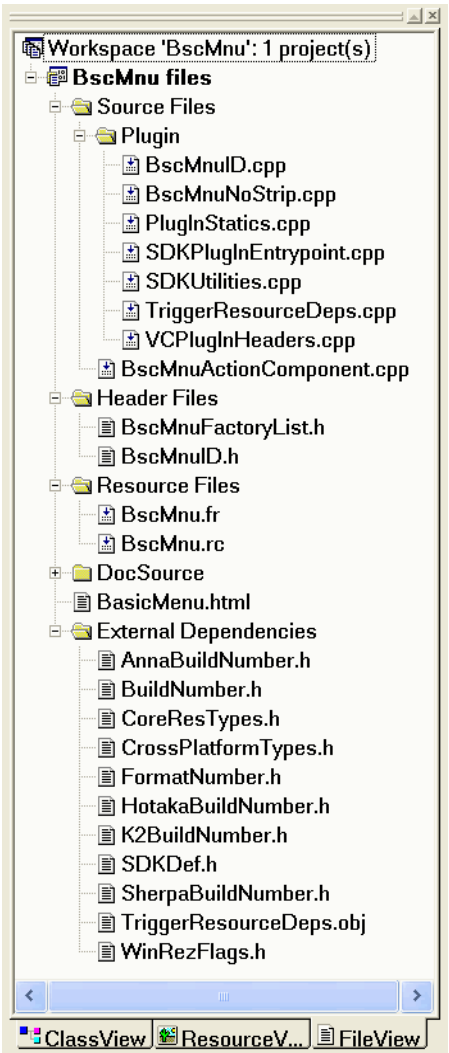
4.3.1. What is a Plug-in?

A plug-in is a library that extends or changes the behavior of the application.

For Windows, a plug-in is physically built as a DLL. The DLL must have the file type ".pln". For example, a DLL could be named "BasicMenu.pln".

For Macintosh, a plug-in is physically built as a shared library. The shared library must have the type "InD3" and creator "InDn". For example, a shared library could be named "BasicMenu"

Later we describe how to create a plug-in on each platform. But first, let's look at the files that make up a plug-in project, and then we'll see what's in them. Using your compiler now, open the BasicMenu project and in FileView look at the component files.



4.3.2. General Plug-in Anatomy

This section covers the basic types of files. The specific contents of these files are covered in later sections, as are the detailed project and compiler settings for a plug-in project.

4.3.2.1. Project files

A plug-in project is contained in a VisualC++ .dsp file for Windows and in a CodeWarrior .mcp file for Macintosh. Note: The plug-in project file includes both developer-supplied and SDK-supplied files.

4.3.2.2. Resource vs. C++ Files

InDesign plug-ins are programmed as both C++ source and header files and resource files. It is generally understood what a C++ file is, but what is a resource? A resource is data of any kind stored in a structured format. That's a pretty general statement so let's get a little more specific.

Much of the information that the application program needs are definable as small pieces of data that can be stored in standard formats. The information required to draw a window, create a menu or display a dialog box has constant elements. The data in those elements may vary depending upon what the window looks like, how the menu operates or the contents of the dialog box. However, each of these items has certain features that can be defined and stored in a standard format. Any data organized and stored in such a structured format can be a resource.

Key abstractions within a plug-in are: boss classes, interfaces, and implementations.

- A boss class (at its simplest) is a resource with a table that maps interfaces to implementations by their numeric identifiers (`IID_<whatever>` to `k<whatever>Impl`). Each boss class has a unique numeric identifier (`k<whatever>Boss`).
- An interface is an abstract C++ class that extends `IPMUnknown`. The abstract C++ class named `IPMUnknown` is at the root of the inheritance hierarchy for most interfaces defined in the API. Each interface has a unique numeric identifier (`IID_<whatever>`).
- An implementation is the C++ class that implements an interface. Each implementation has a unique numeric identifier (`k<whatever>Impl`).

4.3.2.3. General Description of the Files that Make an InDesign Plug-in

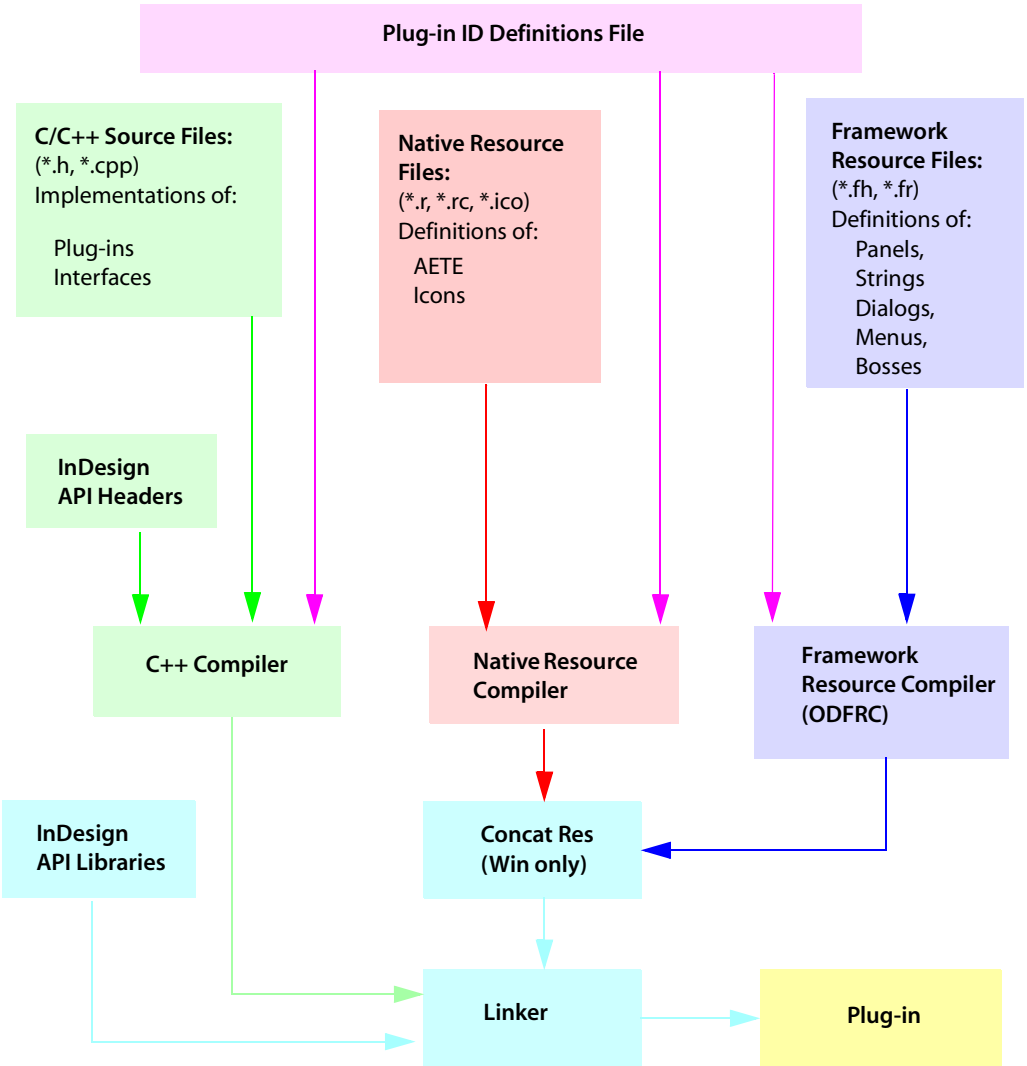
Let's start with the kinds of files that are used to make a plug-in. A general diagram of the files contained in a plug-in is shown below.

- Open BscMnuID.h now. At the top of the figure is the ID definitions file. This file contains the unique numeric identifiers for the plug-in, bosses,

and implementations. This file is included in most of the other types of files because these unique identifiers are used throughout the plug-in.

- The files in the group on the left side of the diagram contain implementation code for the plug-in and its interfaces. (See BscMnuActionComponent, as well as files contained under the Plugin subdirectory.) These are exclusively *.h and *.cpp files and are compiled through the C++ compiler along with the header files for the InDesign API.
- The files in the middle group contain the native (platform-dependent) resource definitions. (There are no examples of this in the BasicMenu plug-in.) For example, icon resource definitions are contained in a *.r file. These files are compiled through the native resource compiler for the integrated development environment.
- The files in the right group are the ODFRez (platform-independent) resource definitions. (See BscMnu.fr.) Typically these files include boss class definitions, string tables, and definitions for panels, dialogs, and menus. Additionally, localized strings are supplied. (See BscMnu_enUS.fr and BscMnu_jaJP.fr.) These files are of the types *.fr and *.fh, and are compiled through the OpenDoc Framework Resource Compiler (ODFRC) compiler supplied with the SDK.
- The output of the Windows resource compiler is concatenated and then linked with the output of the C++ compiler and the InDesign API library files. On the Macintosh, the output information from the Native and Framework resources are sent separately to the linker.
- There is a fourth type of compiler: the scripting compiler, but discussion of that compiler is deferred to the scripting guide. For more information on scripting compilers, please refer to *Scripting Your InDesign Plug-in* (described in **References**).

figure 4.3.2.3.a. the basic file types in a plug-in.



Three compilers just to make a plug-in seems complex, but it maximizes the amount of code that can be shared across platforms. The ODFRC compiler allows plug-in developers to use platform-independent definitions for things like menus and dialogs.

4.3.3. Detailed Plug-in Anatomy

The previous section generally described the types of files in a plug-in and provided an overview of how they are compiled. But what's really in those files, and why? This section examines the contents of each file.

4.3.3.1. ID Space - BscMnuID.h

Open BscMnuID.h now. It defines the IDs needed for a plug-in, its bosses, interfaces and implementations. The application uses these IDs to organize and manage objects. Later, we describe how they are cataloged by InDesign during initialization.

The IDs are all keyed from the globally-unique prefix, here kBscMnuPrefix. The value of this prefix is assigned by Adobe and defines a unique ID space for each developer. You must ensure that each ID you allocate based on this prefix is within your assigned ID space. You are free to define 256 globally-unique IDs per prefix.

Notice that IDs of different types belong to different ID sub-spaces and may share the same values. For example, `kBscMnuPluginID`, `kBscMnuActionComponentBoss`, `kBscMnuActionComponentImpl`, `kBscMnuAboutActionID`, and `kBscMnuPanelWidgetID` all resolve to the same numerical value (0x57200), but since these IDs are never used together they won't conflict.

The ID definition file BscMnuID.h defines the prefix kBscMnuPrefix as a base for the other ID numbers used in the plug-in. The file also defines:

- The plug-in name.
- The plug-in ID
- The boss, interface, widget, service, and implementation IDs
- It could also define some constants.

This file is used by all three groups of files: C++ source, native resources, and framework resources. Next, you'll see how these constants and IDs are used.

4.3.3.2. Bosses and Other Resource Definitions - BscMnu.fr

Open BscMnu.fr now. This file contains boss classes and the non-localized definitions for other resources. Notice that the statements are enclosed in a conditional compilation block indicating they are only meaningful to ODFRC.

4.3.3.2.1. Plug-in Version Definition

The PluginVersion statement defines the plug-in identity and the version of the application with which it is compatible. The parts of this definition are described below:

- The plug-in identification number, defined in BscMnuID.h.
- The version of the plug-in, defined in SDKDef.h. The first number is the major version of the plug-in and the second is the minor version, in the case of dot releases.
- The version of InDesign that the plug-in expects to run against, defined in SDKDef.h. The first of these two numbers is the InDesign major version number and the second is the InDesign minor version number.
- The persistent data format version for the plug-in. These format numbers get stored in databases (documents and defaults). The application determines the need for conversion by comparing the format numbers stored in a database for each plug-in to the format numbers declared by currently loaded plug-ins. If you change the persistent data format version and don't provide a converter you won't be able to open documents containing a different format. SDKDef.h provides some default values for these but if you store data persistently it is recommended that you change these to suit..
- The last entry (kWildFS) specifies that settings apply to all feature sets.

4.3.3.2.2. Boss Class Definition

Examine the ClassDescriptionTable. A plug-in provides functionality through its boss classes and their aggregated interfaces. BasicMenu implements the following boss classes: `kBscMnuActionComponentBoss`, `kBscMnuStringRegisterBoss`, `kBscMnuMenuRegisterBoss`, `kBscMnuActionRegisterBoss`.

The ClassDescriptionTable statement defines each boss class provided by the plug-in. The parts of any boss class definition are contained within a Class statement and are described below:

- Globally-unique boss ClassID the application uses to refer to the boss.
- The globally-unique parent boss ClassID (or kInvalidClass if no parent).
- Pairs of aggregated InterfaceIDs with each's ImplementationID. The block contains a list of the interfaces that provide functionality to a boss. The ID pair maps an interface onto an implementation.

4.3.3.2.3. Implementation Definition

The FactoryList statement #includes the plug-in's FactoryList.h, which contains macros that allow the application's object model to create and destroy instances of the implementation through factory classes.

4.3.3.2.4. Menu Definition

The MenuDef statement defines the characteristics of each menu item. See comments in the first definition for a description of the elements.

4.3.3.2.5. Action Definition

The ActionDef statement defines the action characteristics of each menu item. See comments in the first definition for a description of the elements.

4.3.3.2.6. String LocaleIndex

The LocaleIndex statement describes string localizations for various feature sets and languages.

4.3.3.3. Implementations - BscMnuActionComponent.cpp

Open BscMnuActionComponent.cpp now. It is here in the implementations section that functionality is finally applied to resources such as the boss classes. This file contains the C++ code that implements the action that happens when the when the plug-in's menu is used. This section examines the relationship between IDs, abstract classes, and resources. IDs of current discussion are bold.

```
IActionComponent
  CActionComponent
    BscMnuActionComponent
```

In BscMnuActionComponent.cpp, we connect an implementation to an ImplementationID defined in BscMnuID.h:

```
CREATE_PMINTERFACE(BscMnuActionComponent, kBscMnuActionComponentImpl)
```

...and in the Constructor, we derive our class from an application-supplied concrete class.

```
BscMnuActionComponent::BscMnuActionComponent(IPMUnknown* boss)
: CActionComponent(boss)
```

...which had provided an implementation for an abstract base class

```
class PUBLIC_DECL CActionComponent : public IActionComponent
```

In BscMnu.fr, we connect `IActionComponent` to `kBscMnuActionComponentImpl` in resource form:

```
Class
```

```
{
  kBscMnuActionComponentBoss,
  kInvalidClass,
  {
    IID_IACTIONCOMPONENT, kBscMnuActionComponentImpl,
    IID_IPMPERSIST, kPMPersistImpl,
  }
},
```

4.3.3.3.1. CPMUnknown

Open CstPrf.cpp in the CustomPrefs sample plug-in in the InDesign SDK now and look at the constructor declaration and implementation. `CPMUnknown` is a base class template to replace the `DEFINE_HELPER_METHODS` macro and is the preferred implementation to add the objects and `QueryInterface()`, `AddRef()`, and `Release()` methods needed to initialize and use an interface.

Open CPMUnknown.h now to view its methods.

4.3.3.3.2. Macros

Open WaveTrackerRegister.cpp in the WaveTool sample plug-in in the InDesign SDK now. Although `CPMUnknown` is the preferred implementation to add the objects and methods needed to initialize and use an interface, you can use the following macros:

- The macro `DECLARE_HELPER_METHODS()` adds declarations to an interface.
- `DEFINE_HELPER_METHODS()` adds the implementations of the methods declared by the `DECLARE_HELPER_METHODS()` macro.
- The constructor definition uses `HELPER_METHODS_INIT()`, which initializes a member variable for this interface.
- `CREATE_PMINTERFACE()` creates an association between the implementation class and its ImplementationID. This association allows InDesign to use the right construct and destruct functions for this interface.
- Look at **HelperInterface.h** now. `HelperInterface` makes it easier to define the functions from `IPMUnknown` that are required for every interface. The HelperInterface class implements `QueryInterface()`, `AddRef()`, and `Release()`. HelperInterface is designed to be included in the implementation class of an interface as a member variable -- it defines a set of macros that allow a mapping from the `QueryInterface()`, `AddRef()`, and `Release()` in the implementation class to the ones in `HelperInterface`.

4.3.3.4. Preventing Dead-Stripping - BscMnuNoStrip.cpp

Open BscMnuNoStrip.cpp now. This file prevents the C++ compiler optimizations from "dead stripping" -- removing what appears to the compiler as unreferenced code. BscMnuNoStrip.cpp is created with a dummy function DontDeadStrip() that includes BscMnuFactoryList.h. This header file contains `REGISTER_PMINTERFACE` macros that allow the object model to create and destroy instances of the implementations through factory classes.

4.3.3.5. GetPlugIn - SDKPlugInEntrypoint.cpp

Open SDKPlugInEntrypoint.cpp now. By convention, a plug-in for InDesign must provide an exported function named `GetPlugIn()`, and it must be an implementation of the C++ class `IPlugIn`.

`GetPlugIn()` is the initial entry point from the application into the plug-in. The application calls this function when the plug-in is registered or loaded into memory. The `GetPlugIn()` function should not be confused with the `Main()` function in a C or C++ program. All calls into plug-in code do *not* pass through `GetPlugIn()`. Once these implementation classes are installed, they are instantiated and called directly via the object model when needed.

The API class `PlugIn` provides the default implementation of IPlugIn. You can specialize PlugIn to change the behaviour of your plug-in when loading or unloading. Note: if you set conditions under which your plug-in should not load, then you will need to make sure your menus and panels do not load either.

For a demonstration of providing your own implementation of `PlugIn`, see CPScrPlugInEntrypoint.cpp in the CustomPrefsScript sample plug-in in the InDesign SDK.

4.3.3.6. BasicMenu Plug-in: A Summary

The BasicMenu plug-in illustrates the necessities of any plug-in:

- Defines IDs for the plug-in and how they are associated with the implementations.
- Defines plug-in and boss resources.
- Declares interfaces.
- Defines interface implementations.

- Derives from a base class to include interface boilerplate objects and methods. Note: otherwise, CPMUnknown or helper macros would have been required.
- Contains macro to prevent dead-stripping by the linker.
- Defines plug-in object itself.

We now discuss the life-cycle of a plug-in and the development environment required to compile the files into a plug-in.

4.4. The Life-Cycle of a Plug-in

The first subsection describes the stages of starting-up InDesign: the process of finding, registering, and loading plug-ins. The second subsection describes the details of what happens when a boss inside a plug-in is instantiated.

4.4.1. InDesign Startup Sequence

Note: Observe the stages on the application's splash screen during start-up.

- InDesign registers all plug-ins when it starts for the first time and again when you add, remove, or modify plug-ins. During registration, the bosses in the plug-in and the interfaces they aggregate are registered in the object model and resource data describing elements such as menus are saved. Subsequent start-ups skip this registration step and the application is initialized from the saved state. If you remove and re-add plug-ins, the application will re-register them.
- Plug-ins are loaded through a call to GetPlugIn().
- The Service Registry is started and start-up services such as trackers, menus, tools, panels, etc. are registered and instantiated.

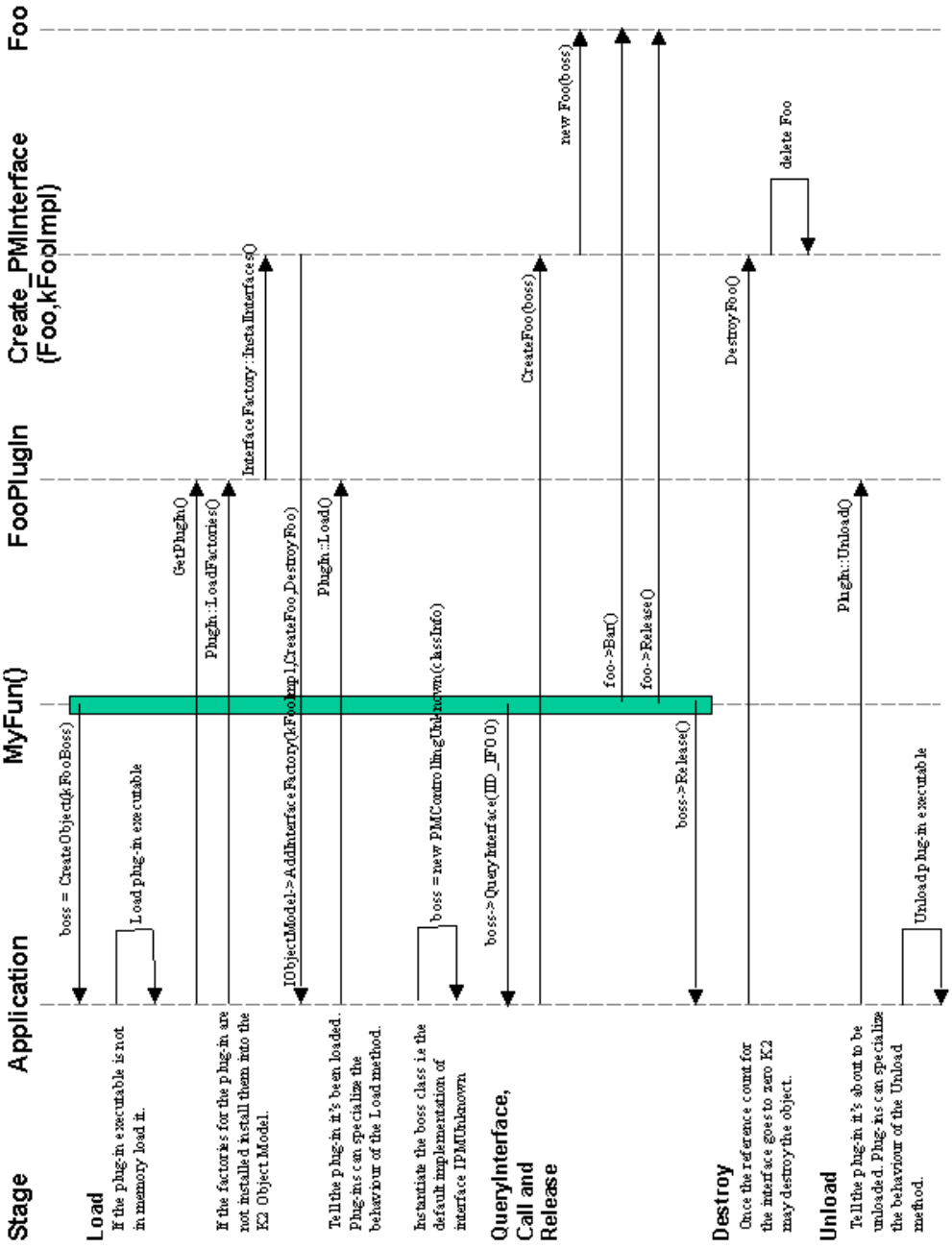
4.4.2. The Sequence of Instantiation in InDesign

Imagine you wanted to call a method from within InDesign code. Before the application can call a method on a boss interface, its implementation class must be instantiated. Below is hypothetical code to instantiate and call the method.

```
void MyFun()
{
  IPMUnknown *boss = CreateObject(kFooBoss);
  IFoo *foo = static_cast<IFoo*>(boss->QueryInterface(IID_IFOO));
  foo->Bar();
  foo->Release();
  boss->Release();
}
```

The code above creates a `Foo` boss object, acquires an `IFoo` interface, calls a method of `IFoo` called `Bar()`, and releases the interfaces it holds. This code is shown as a sequence diagram below and illustrates how InDesign loads the plug-in, queries for the `Foo` interface, calls the `Foo::Bar()` method, and then cleans up. In particular, the diagram shows the details of how C++'s `new` and `delete` operators are called by the object model to instantiate the implementation class for the interface.

figure 4.4.2.a. foo plug-in and boss lifecycle sequence diagram



The load stage is triggered by a request to create a `kFooBoss` object. InDesign calls the `GetPlugIn()` method for the Foo plug-in. InDesign then calls the `PlugIn::LoadFactories()` method which in turn calls the `InstallInterfaces()` method of the `IntefaceFactory` object that has been created for the `Foo` class. The `InstallInterfaces()` method installs the class factories for `Foo` in the InDesign object model using the `AddInterfaceFactory()` method of `IObjectModel`. Once this installation is complete, the Foo plug-in is loaded, and a `kFooBoss` object is instantiated by the InDesign object model.

Once the boss has been created, the code fragment queries for the `IFoo` interface, causing the object model to create a `Foo` class object on the boss using the `Foo` class factories registered with the object model. Now that the `Foo` interface has been created, the `Foo::Bar()` method is called and then the `Foo::Release` method is called.

Once the `Foo` interface is released, the boss can also be released. If the reference count for the `Foo` interface is zero, then the object model destroys `Foo` using the method registered for the `Foo` class. When the boss has no more interfaces, then it too is destroyed.

The last step is to unload the plug-in. First the `Unload()` method for the plug-in is called, then the plug-in itself is unloaded by InDesign.

4.5. The InDesign Plug-in Development Environment

Now that we have examined how plug-ins are constructed and how InDesign manages them, it's time to look more closely at the details of setting up a project and then compiling and linking a plug-in on a specific platform.

As a starting point, the specifications for the integrated development environment on each platform will be described, including how to set-up the ODFRC compiler. Sample projects and wizards will also be discussed.

4.5.1. ODFRC: The Framework Resource Compiler

User interface elements such as menus, palettes, panels, dialogs and string translation tables are defined in a platform independent form: the ODFRez (.fr) format.

Adobe supplies a compiler called ODFRC as part of the SDK that compiles framework files. ODFRC stands for OpenDoc Framework Resource Compiler.

ODFRC generates platform specific resources (Windows or Macintosh) from a platform independent *.fr file. The compiled resources are then built into the plug-in.

The Adobe ODFRC is supplied in the **Adobe InDesign SDK/Tools/** directory. There you will find another important tool, ConcatRes (Windows platform only). This second tool is used for concatenating the output of the resource compilers before linking with the compiled C++ code.

4.5.2. Plug-in Development on the Windows and Macintosh Platforms

This section describes how to set up and create an InDesign plug-in project on a Windows and Macintosh platforms. The following topics are covered:

- The specifications for the development environment.
- Installing software tools particular to InDesign plug-in development.
- Using the Dolly plug-in project wizard to create an InDesign plug-in.

The descriptions in this section assume that you are familiar with the VC++ and CodeWarrior environments. Sources for further information on each development environment are available in References below.

4.5.2.1. IDE and Platform Specifications

InDesign plug-ins use Microsoft Visual C++ for the PC and Metrowerks CodeWarrior for the Macintosh. For specific details on the recommended platforms and development environments, see “Development Environments” in the Readme.txt for the SDK you are using.

4.5.2.2. Dolly Wizard for Creating Plug-in Projects

The easiest way to create a new plug-in project is to use the Dolly wizard. The Adobe InDesign SDK includes the Dolly wizard to automatically generate your plug-in. For full instructions on the use of this wizard and any platform-specific operations, see “Dolly User Manual” in this SDK.

4.6. Code Re-Use

This section discusses specific opportunities for sharing and reusing code.

4.6.1. Default Implementations

The application provides many default implementations that can be re-used directly in your plug-ins without writing any C++. See the **InterfaceList.txt** document in **Adobe InDesign SDK/Documentation/** for descriptions of the

default implementation classes. Look at BscMnu.fr now to help understand the discussion below.

To use a default implementation, simply reference the default implementation by its `ImplementationID` in the boss definition. For example, in kBscMnuActionComponentBoss, notice that kPMPersistImpl provides the default implementation for IPMPersist interface. Notice also that this example plug-in provides the implementation for IActionComponent interface, as discussed below.

4.6.2. InDesign Implementation Classes

InDesign implementation classes (**Adobe InDesign SDK/API/ Implementation/** directory) provide the bulk of the C++ implementation for an interface. To use these you write some C++ to subclass and specialize a few methods to complete the implementation. Some prominent examples are:

- BscMnuActionComponent inherits from CActionComponent, which implements interface `IActionComponent`. By specializing some of the methods, you quickly provide a complete implementation for a new menu.
- Similarly, Command.h/.cpp implements interface `ICommand`. By inheriting from this implementationa and specializing some methods, you quickly provide a complete implementation for a new command.

4.6.3. Boss Inheritance

Look at BscDlg.fr now in the BasicDialog example plug-in in the InDesign SDK to help understand the discussion below.

In the Class resource statement for kBscDlgDialogBoss, notice that a boss may subclass another boss -- in this case kDialogBoss. This allows you to define an inheritance hierarchy in your boss definition rather than in your C++ implementation code. When a boss defines an interface it also inherits the local definition, overriding the parent's. This mechanism is used extensively by the user interface code.

The bulk of the behavior of the drop down list is provided by kDialogBoss. To specialize the behavior, this example overrides the interfaces with its own implementation classes. See BscDlgDialogController.cpp and BscDlgDialogObserver.cpp to see how this was done.

4.6.4. Adding Interfaces to Existing Bosses

Look at FrmLbl.fr now in the FrameLabel example plug-in in the InDesign SDK to help understand the discussion below.

In the AddIn resource statement for `kDrawablePageItemBoss`, notice that you can extend this existing boss by adding a IFrmLabelData interface to those it already aggregates. This mechanism allows a developer to add new code to existing objects in the object model.

4.6.5. PluginDependency Resource Statement

Look at HidTxtEd.fr now in the HiddenTextEditor example plug-in in the InDesign SDK to help understand the discussion below.

In the PluginDependency statement, notice that this plug-in declares that it is dependent on the HiddenText plug-in. If the HiddenText plug-in is not loaded, then HiddenTextEditor plug-in would not be loaded either.

4.7. Summary

This chapter described the anatomy of plug-ins, how InDesign uses them, and the development environments for building them. Although nearly all plug-ins are more complicated than the BasicMenu example, they're still composed of the same types of files, treated the same way by InDesign, and are built using the same development environment.

You've seen the basic architecture and components of an InDesign plug-in, their file types, and what compilers are needed to build them. The interaction between InDesign and a plug-in was also presented in the form the plug-in life cycle -- the messages on the InDesign splash page will have new significance in terms of the plug-in life-cycle.

Given the foundation presented in this chapter, you are now ready to look at a plug-in that does more.

4.8. Review

You should be able to answer the following questions.

1. What are the three general groups of source files that comprise a plug-in?
2. True or False: The easiest way to create a new plug-in project is to use the Dolly wizard.

3. Name the four macros used in declaring and defining implementations in InDesign plug-ins.
4. True or False: Plug-in registration occurs every time registration starts.
5. Name three common resource keywords used in a *.fr resource file (Can you name a fourth?)

4.9. Exercises

4.9.1. Create a Project

Create a project by following the Dolly User Manual.

4.9.2. Look at BasicDialog

Preview the BasicDialog example plug-in. It's similar to the BasicMenu plug-in presented in this chapter. Can you identify the components?

4.10. References

- Adobe InDesign SDK. *InDesign Plug-In Cookbook*, 2002.
- Adobe InDesign SDK. *Dolly User Manual*, 2002.
- Ivor, Horton. *Beginning Visual C++ 5*. 1999: WROX Press Ltd. Good introduction to the Microsoft Visual C++ development environment. http://www.microsoft.com.
- Metrowerks, et al. *Inside CodeWarrior*. 1999: Metrowerks Corporation. Introduction to the Metrowerks CodeWarrior programming environment. http://www.metrowerks.com.
- Apple, et al. *Develop Magazine*. 1980-1999: Apple Corporation. Details about all Apple internals. http://www.apple.com.
- Adobe InDesign SDK. *Adobe InDesign Scripting Guide*, 1999. See **InDesignScriptingGuide.pdf** on your installation disk.

5.

Commands

5.0. Overview

In this chapter, you will learn what commands are, how commands fit into the application architecture, how to find and use the commands provided by the application, and how to implement new commands of your own. This lesson continues to build on what you have learned in previous chapters.

5.1. Chapter Goals

The questions this chapter answers are:

1. How do commands fit into the application architecture?
2. What are commands?
3. What commands are provided for me to use?
4. How do I call an existing command?
5. How do I pass parameters in/out of commands?
6. What is a command sequence?
7. How do I create and use command sequences?
8. How do I design and write new commands of my own?

5.2. Chapter-at-a-Glance

"5.3.How Commands Fit into the Application Architecture" on page 140 reviews portions of the application architecture and shows where commands fit in that architecture.

table 5.1.a. version history

Rev	Date	Author	Notes
3.1	11/27/2002	Ken Sadahiro	Incorporated review comments from Paul Norton.
3.0	09/29/2002	Ken Sadahiro	Revised content for InDesign 2.0 SDK. First review.
2.0	4/15/99	Rodney Cook	Second draft.
1.0	3/17/99	Rodney Cook	First draft.

"5.4.Where to Find Command Reference Documentation" on page 151 describes how to use the command reference documentation contained in the SDK.

"5.5.When to Use a Command as a client" on page 152 describes when to use the commands provided by the application.

"5.6.How to Use a Command as a Client" on page 152 describes how to use a command as a client. arguments to and from commands.

"5.7.How to Use a Command Sequence" on page 156 describes how commands can be combined into a single undoable step.

"5.8.Protecting Documents Against Corruption" on page 158 describes tools for error handling in your code.

"5.9.Setting a Command Target" on page 158 describes the operation of the Command Processor and command managers.

"5.10.How to Implement a Custom Command" on page 161 describes how to implement your own command.

"5.11.How to Design Commands" on page 166 describes important consideration in designing a command.

"5.12.Summary" on page 171 recaps the material presented in this chapter.

"5.13.Review" on page 171 provides some questions and answers so you can review what you learned.

"5.14.Exercises" on page 171 provides suggestions for other areas to explore related to these topics.

"5.15.References" on page 171 provides sources for additional information related to the topics of this chapter.

5.3. How Commands Fit into the Application Architecture

This topic reviews portions of the application architecture covered in previous chapters and shows where commands fit in this architecture.

5.3.1. Review of the Model-View-Controller (MVC)

As described in chapter 3, the **MVC** design pattern is based upon the concept that there be a clear separation of internal and external object representations within an application.

- The internal representation is the **model**.
- The external representation is the **view.**
- Any source manipulating the model is a **controller**.

5.3.1.1. Model

The model is the internal representation of objects within the application. The actual form this takes is of little consequence to external elements. Users of the model do not need to understand how a square is represented. Within the application, the term "**subject**" is used to indicate an object whose state is of interest to other objects.

5.3.1.2. View

The view describes the projection of the model from the application domain onto the user domain. This view can be a graphical representation of the object, or it could be in the form of meta-information. As you would expect, multiple views of a model can co-exist. Views within the application are extended to include the notion of any object interested in the state of another. As such, objects interested in the state of other objects are termed "**observers**".

5.3.1.3. Controller

Manipulation of the model can be performed by controllers. These perform operations on the model, the model publishes its new state and any views of the model are updated to reflect this new state. The views are made aware of the new state by **notification**. A model can be manipulated by multiple controllers within the application.

5.3.2. How Application Requirements Affect Implementation of MVC

The application is not implemented in terms of the pure MVC model because of the following application requirements:

- Control of notification granularity - the number of times observers are updated should be controllable to prevent many lightweight changes causing a flurry of observer updates.
- Undoability - changes to the model should be **undoable**.

- Atomicity - if one step in a complicated sequence of operations fails, it is essential that all preceding steps are rewound and the operation as a whole is aborted.

5.3.2.1. Control of Notification Granularity

With traditional MVC, manipulation of the model is immediately reflected in any corresponding view. If many fine-grained manipulations are applied to the model, it may be cumbersome to propagate each to the observers.

In the application, a change in a model can be propagated through to an observer which itself is the subject of other observers. It is wholly undesirable to propagate every change of the model to the observers because it could cause a cascade of model updates throughout the application. Conversely, not every observer is interested in all updates to the model.

The application requires a mechanism to indicate *when* it wants a model to publish its new state (that is, to control the update of the observers).

5.3.2.2. Undoability

All actions manipulating the model should also have the ability to revert the model to its previous state. This adds a timing element to the application architecture; the model-state history becomes important.

The application requires the information necessary to revert the model to a previous state be maintained.

5.3.2.3. Atomicity

In order for the consistent global state of the application to be maintained, a mechanism is required to ensure any operation affecting multiple models is atomic. For example, imagine moving an object from one spread to another (this is necessarily a multi-step process).

The application requires that if one step in the operation fails, all preceding steps are rewound and the operation as a whole is aborted. The analogy with a transactional model is obvious.

5.3.3. How Commands Meet the Application's MVC Requirements

The requirements introduced above are implemented using **commands**. The command architecture is responsible for encapsulating compound modifications to the model(s), supporting the undo/redo protocol, and indicating to the model when it should republish its state to the observers.

5.3.3.1. Commands Support for Undoability

As well as encapsulating a series of manipulations on the model, commands also encapsulate the changes required to revert the model back to its previous state. They are responsible for maintaining the information required to do this. The application supports course-grained undoability by providing a history of the most recent commands executed.

5.3.3.2. Commands Support for Notification

Because commands provide the mechanism to encapsulate multiple manipulations of the model, it is essential they also determine when the changes to the model propagate through to the views. When a command wishes to do this, the command's `DoNotify()` method invokes the `Change()` method on the model's `ISubject` interface. (Note that all models wishing to be observed must support this interface.)

5.3.3.3. Model Support for Notification

After the model is informed of a `Change()` by the command, the model is responsible for notifying its observers, if any. Objects interested in a model register their interest using the `AttachObserver()` method on the `ISubject` interface of the model. This allows a list of dependencies between models and observers to be maintained (along with the particular interests of the observers).

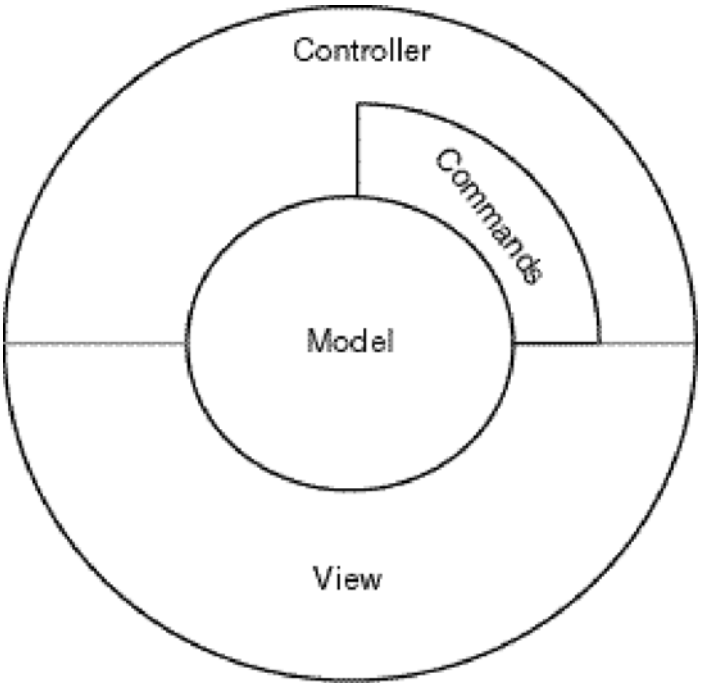
When a command indicates a model has changed, the model propagates this change to observers by invoking the `Update()` method of the `IObserver` interface. (Note that all observers must support this interface.)

5.3.4. The Application Architecture

The figure below (figure 5.3.4.a.) shows the relationship between views, models, controllers and commands. Both the controller and view can see the model. A controller can have a view of the model it is manipulating (indicated

by the line between controller and view). Commands are particular to controllers, and are used by controllers to manipulate the state of the model.

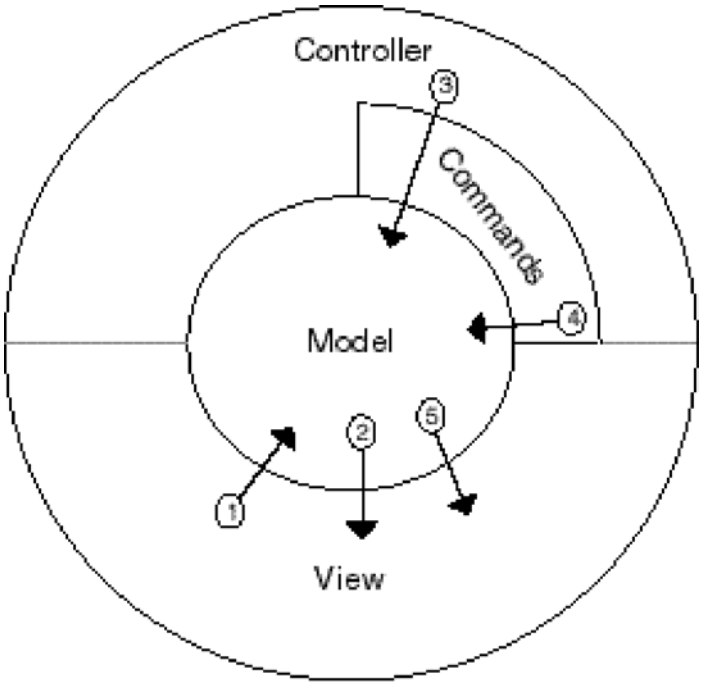
figure 5.3.4.a. relationship between view, model, controller and commands.



The figure below (figure 5.3.4.b.) shows the series of activities that might occur between the different components of the application:

1. A view registers interest in a model, by calling the `AttachObserver()` method of the `ISubject` interface of the model.
2. A view can directly see the model (through an interface provided by the model).
3. A controller can manipulate the model using commands, gaining all the advantages given above.
4. The controller (using a command) explicitly informs the model its state has been updated (through the `Change()` method of the model's `ISubject` interface).
5. The model informs interested views that its state has changed (through their `Update()` method on the `IObserver` interface).

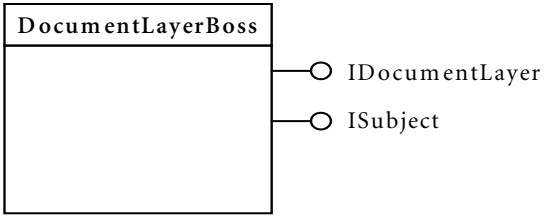
figure 5.3.4.b. system events



5.3.5. The Architecture in Action

Lets take a look at an example of how the architecture works in practice. figure 5.3.5.a. below shows the model for a layer (the document layer boss). The model exposes its values through an interface - in this case `IDocumentLayer`. In order to be observed by other parts of the application, the model must become a subject. To do this, it provides an implementation for interface `ISubject`.

figure 5.3.5.a. a model



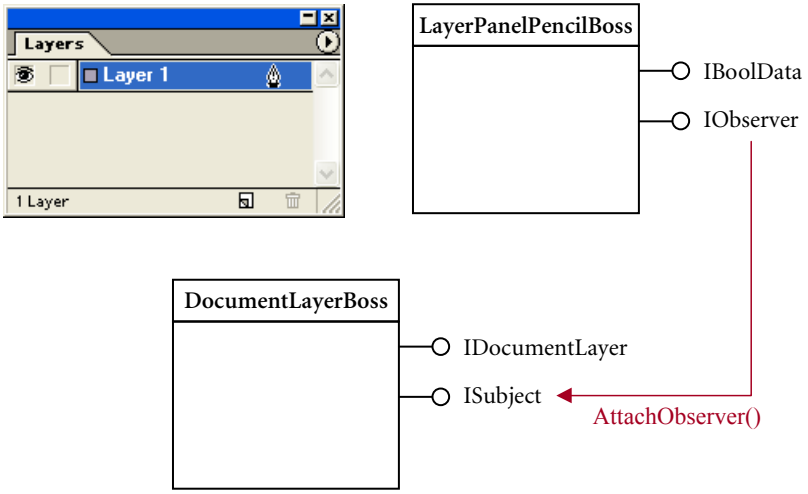

```
class IDocumentLayer : public IPMUnknown
{
public:
 virtual void GetName(PMString * pName) = 0 ;
       virtual const PMString& GetName() = 0 ;
       virtual void SetName(const PMString& newName) = 0 ;
       //...other methods...
       virtual bool16 IsLocked()  = 0;
       virtual void SetLocked(bool16 visible) = 0 ;
};
```

The figure below (figure 5.3.5.b.) shows a view onto the model, which is the layer panel view. The view can read values from a suitable interface (in this case, `IDocumentLayer`). Rather than the view interrogating the model, it is more desirable for the model to inform the view when it changes (that is, rather than the view polling the model synchronously to detect a change, the model asynchronously informs the view when a change occurs). In order for this to work, the view must become an observer. To do this, it provides an implementation for the interface `IObserver`.

The observer (in this case, the layer panel pencil boss) registers its interest with the subject (through the `ISubject` interface), as shown in figure 5.3.5.b. (NOTE: The actual architecture for detecting changes to the lock state of the layer involves an intermediate observer that invalidates the view, however, the architecture has been simplified for illustrative purposes.)

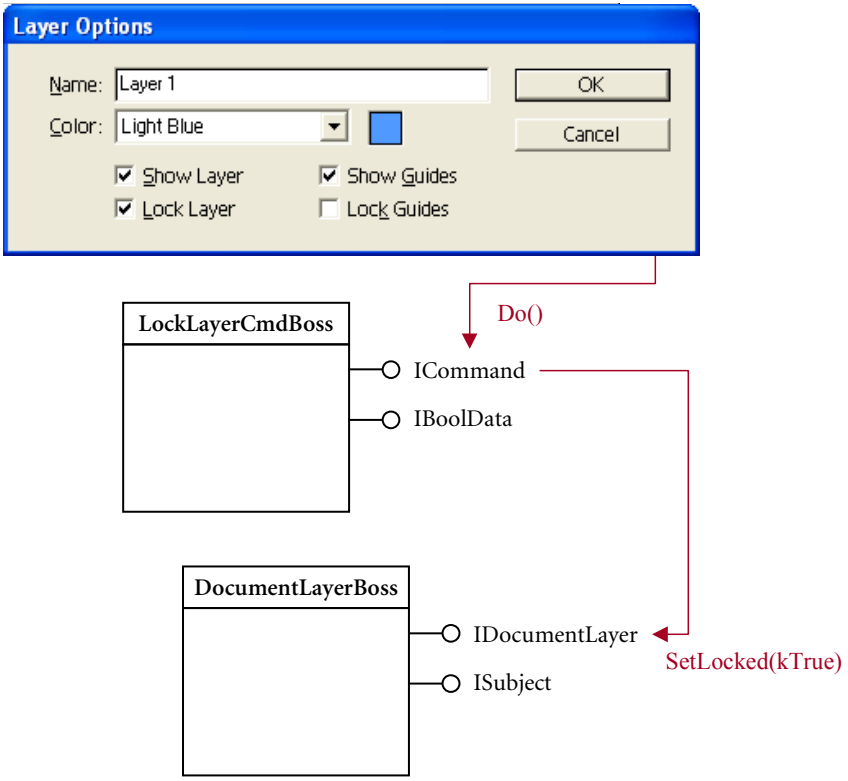
It is entirely possible to have more than one observer of a model. In fact, the overall layer panel shown has a number of observers all watching document layers; though for simplicity, these are not shown here.

figure 5.3.5.b. request for notification



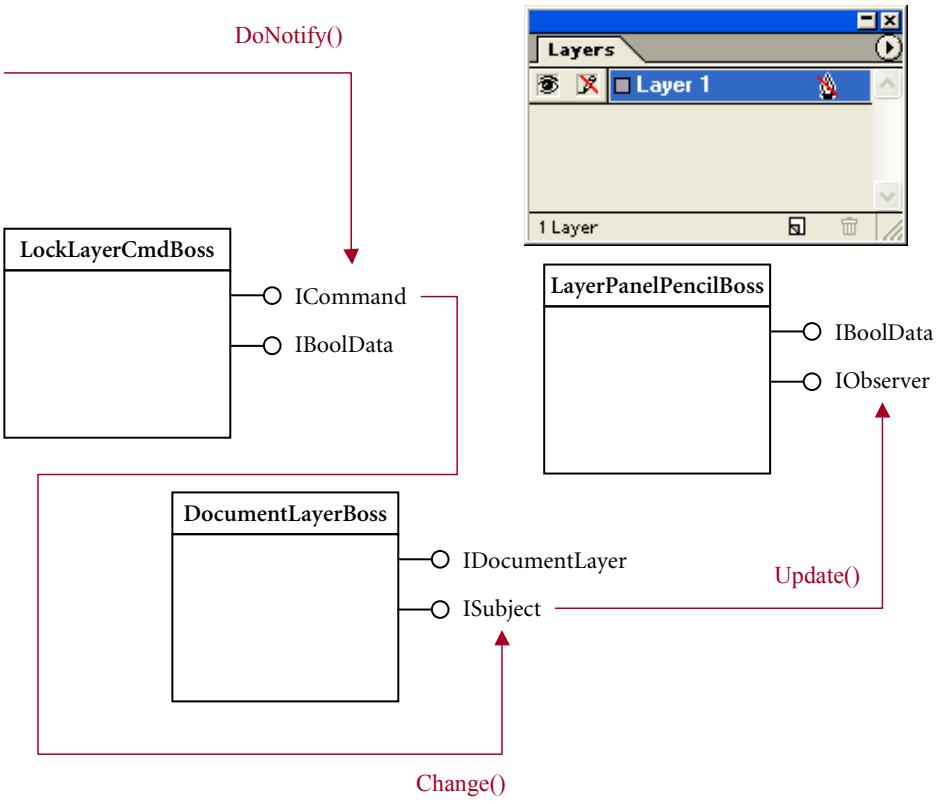
The figure below (figure 5.3.5.c.) shows another view onto the model - the layer options dialog (for simplicity, the boss implementing the dialog is left out). This modal dialog is being used to lock the layer. On clicking the OK button, the dialog uses a command to update the model (commands are implemented as bosses as well -- in this case, the `LockLayerCmdBoss`). The modification can occur through any interface supported by the model. In this example, the interface used by the command to modify the model is `IDocumentLayer`.

figure 5.3.5.c. modification of model



Finally, as shown in figure 5.3.5.d., the notification process is performed, the command boss indicates to the model its state changed using the `ISubject` interface, and the model propagates this signal through to the observers using their `IObserver` interface.

figure 5.3.5.d. notification



5.3.6. Interface Categories

To support undo, every modification of the model must occur within the scope of an undoable command. Does this mean you have to use commands every time you want to modify the model? Different rules and restrictions apply dependent on *where* your interface lies within the application architecture.(See "5.3.4.The Application Architecture" on page 143.)

The application provides many interfaces and these can be categorized as belonging to:

- Model
- Commands
- View/controller

The **model** implements the interfaces making up the document and session workspace (for example, `IDocument`, `IDocumentLayer`, `IFrame`, `ISpread` and `IBaselineGridPrefs`).

Commands implement the interface `ICommand` and are the glue allowing the view/controller to modify the model.

The **view/controller** implements the remaining interfaces (for example, panels, menu components, keyboard actions, observers, import providers and script providers). This category combines the manifestation of the model to the user (the view) and any source manipulating the model (a controller).

To successfully implement your plug-in within the application architecture, you must be aware that:

- New interfaces you implement must lie in one and only one of these categories.
- If you wish to be a legitimate client of another interface you must know the category it lies in.
- Different restrictions apply dependent on whether the interface method you want to call simply reads values or causes modification.

The rules governing whether you may use an interface in another category are tabulated in figure 5.3.6.a. below. To use the table, read along the row for your category and look upwards to see what access is allowed.

figure 5.3.6.a. Interface Access Rules

Access	Can Read	Can Modify	Can Use	Can Read	Can Modify
Category	**View/Controller**		**Commands**	**Model**	
View/Controller	yes	yes	yes	yes	no
Commands	yes	yes	yes	yes	yes
Model	no	no	no	yes	yes

You can see from figure 5.3.6.a.:

- Interfaces in the view/controller category must process commands to modify the model (of course, they are free to call model interfaces that simply read values).

- Commands can call model interface methods that cause modification to occur and/or can delegate their work to other commands (care must be exercised when a command does both).
- Interfaces in the model can only use other interfaces that are within the model. *They must not use commands or call any interfaces that use commands.*

5.3.7. Application Architecture Summary

This section presented key concepts in the application architecture:

- The implementation of MVC by the application is described.
- The role of commands and notification using subjects and observers is explained.
- An example showing how these elements interact when a model is manipulated by a command is reviewed.
- The rules governing access between different categories of interface in the application architecture is outlined.

5.3.8. Application Architecture Review

After reading this section the reader should be able to contemplate the following questions (and answer most).

1. Why does the application require atomicity?
2. What object supports the undoability protocol?
3. What are the differences between the application architecture and the MVC architecture?
4. What are the two main interfaces used to implement the notification mechanism within the application architecture?
5. Is it possible for a model (subject) to update a view (observer) without being prompted by a command?
6. What are the implications of the above?

5.4. Where to Find Command Reference Documentation

The application provides a vast set of commands for you to use. These commands offer building blocks from which you can create your plug-ins. They manipulate model interfaces on your behalf, saving time and effort. You should always check whether a command is available that performs the function you are looking for before embarking on implementing new commands of your own.

You can use the following references in the InDesign SDK to look for references on command bosses (commands generally take the boss name **`k***CmdBoss`**):

- InDesign Object Model references (InterfaceList.txt, IObjectModel*.txt/xls,
- Browsable HTML documentation) for a listing of commands available in InDesign
- InterfaceListViewer (Macintosh only)

The *InDesign Command Reference* describes and provides sample code for each command. See the description in "5.15.References" on page 171.
The browsable HTML documentation included with the InDesign SDK describes the interfaces used by the commands. See the description in "5.15.References" on page 171.

5.5. When to Use a Command as a client

Commands provide:

- A mechanism for encapsulating changes as a single transaction
- A powerful undo and redo mechanism
- Notification that changes have taken place

Therefore, you should use commands to make changes if any of the following are true:

- Any item in the model (document or workspace) is to be changed in an atomic manner.
- The user must be able to undo/redo the changes.
- There may be observers needing to be informed of the changes.

5.6. How to Use a Command as a Client

To use a command as a client, you must:

- Instantiate the command boss (with the command boss ID)
- Specify necessary input arguments
- Call the method the process the command
- Handle any errors
- If necessary, get output arguments

This general recipe is illustrated below:

figure 5.6.a. using a command

```
void MyPlugInClass::CreateAndProcessZoomToCmd
  (IControlView *view,
```

```
    PMReal scaleFactor,
    const PMPoint& centerPoint)
{
    // Create the command with the command boss ID kZoomToCmdBoss
    InterfacePtr<ICommand>
    zoomCmd(CmdUtils::CreateCommand(kZoomToCmdBoss));
    // Specify its input arguments (see InterfaceList.txt)
    InterfacePtr<IZoomCmdData> zoomData(zoomCmd, IID_IZOOMCMDDATA);
    zoomData->Set(view, scaleFactor, centerPoint);
    // Process the command
    ErrorCode err = CmdUtils::ProcessCommand(zoomCmd);
    // Handle any errors
    if (err !=kSuccess)
    {
        //your error handling code goes here...
    }
}
```

5.6.1. Instantiate the Command Boss

Commands are implemented bosses that aggregate the `ICommand` interface (See `{SDK}/API/Interfaces/Architecture/ICommand.h`). The first step in using a command is to instantiate the command boss with the command boss ID. Use the **`CmdUtils::CreateCommand()`** method to do this. Also, don't forget to include the API header file that declares the command boss ID.

5.6.1.1. About CmdUtils

The application provides a set of utility functions to manage commands, `CmdUtils`. Most `CmdUtils` methods return an `ErrorCode` to indicate their status. The functions you want to use to process a command are:

- `CmdUtils::CreateCommand()` creates the specified command boss.
- `CmdUtils::ProcessCommand()` passes the command to the command processor for execution.

Below are other methods that will be discussed later in this chapter.

- `CmdUtils::ScheduleCommand()` passes the command to the command processor for execution at a later time.
- `CmdUtils::BeginCommandSequence()` creates and starts a new sequence.
- `CmdUtils::EndCommandSequence()` commits, closes, and deletes your sequence.
- `CmdUtils::AbortCommandSequence()` rolls back (undoes) all commands in the sequence and deletes it.

- `CmdUtils::SetSequenceMark()` defines a point you may want roll back to later (there is no limit to the number of marks per sequence).
- `CmdUtils::RollBackCommandSequence()` rolls back to a state you marked using `SetSequenceMark()`.Commands processed after the mark are undone and released. The mark you set is deleted.

5.6.2. Specify Input Arguments and Get Output Arguments

Arguments can be passed to and from commands in two ways:
- Using the **ItemList** methods on `ICommand`
- Using **data interfaces** on the command boss

ItemList is accessed using the `ICommand` methods `SetItemList()` and `GetItemList()`. On input, you can call `SetItemList()` to specify the persistent objects on which the command should operate. After a command has been processed successfully, you can call `GetItemList()` to obtain output objects acted on or newly created by the command. Objects in **ItemList** are passed using their `UID`. (See the chapter titled "Persistence" for more information on UIDs.)

Data interfaces can also be used to pass arguments into and out of the command. They are implemented as additional interfaces on the command boss. Just a few of the data interfaces provided by the application are tabulated below. You can find the header files for these interfaces in `{SDK}/API/Interfaces/Architecture/`. Alternatively, commands can implement new data interfaces of their own. Refer to InterfaceList.txt for details on which command aggregates what data interface.

figure 5.6.2.a. data interfaces for basic types

Type	Interface	PMIID	ImplementationID
bool16	IBoolData	IID_IBOOLDATA	kBoolDataImpl
int32	IIntData	IID_IINTDATA	kIntDataImpl
PMReal	IRealNumberData	IID_IREALNUMBERDATA	kRealNumberDataImpl
PMString	IStringData	IID_ISTRINGDATA	kStringDataImpl
UID	IUIDData	IID_IUIDDATA	kUIDDataImpl

5.6.3. Process the Command

Once you have specified the necessary input arguments to the command, you can use **`CmdUtils::ProcessCommand()`** to process the command.
On occasions where you don't need to process the command immediately, or don't know how long the command will take to process but you need to proceed, you can use **`CmdUtils::ScheduleCommand()`**. Refer to **`{SDK}/API/Includes/CmdUtils.h`** for more information.

5.6.4. Handle Any Errors

The **`CmdUtils::ProcessCommand()`** method returns an **`ErrorCode`** value. Make sure you check that the return value is **`kSuccess`**. If it is not **`kSuccess`**, you must make sure to handle the error in an appropriate way.

If you called **`CmdUtils::ScheduleCommand()`**, the return code indicates whether the command was successfully scheduled. Since you don't know when exactly the command will be called, you won't be able to check the return status of the command.

5.6.4.1. Provide Error Handling

In addition to checking the status returned by **`CmdUtils::ProcessCommand()`**, the application maintains a global error state you can access using the methods in **ErrorUtils.h** (in **`{SDK}/API/Includes/`**):

figure 5.6.4.1.a. data interfaces for basic types

```
static void PMSetGlobalErrorCode (ErrorCode errCode, bool16
isPlatform = kFalse, const PMString* errString = nil, IPMUnknown*
errInfo = nil, const PMString* contextInfo =  nil);

static ErrorCode PMGetGlobalErrorCode();
```

If you encounter an error you have two choices:
- Tidy up and stop
- Deal with the error and continue

If you tidy up and stop, you should *not* clear the global error state before returning to the code that called you. Your caller may deal with the error or, if it does not, the application will bring up an alert.

If you deal with the error and continue, you should clear the global error state before processing any more commands. If you continue to process commands without clearing the global error state, you will get an assert, followed by a protective shutdown. (See “Protecting Documents Against Corruption” on page 158.) To deal with the error, you could notify the user with an alert, fix the underlying problem, or retry your operation using a different strategy.

5.7. How to Use a Command Sequence

Command sequences combine several commands into a single undoable step. They are similar to the concept of a transaction on a database; that is, a command sequence represents a logical unit of work. A command sequence is therefore a series of several commands transforming a consistent state of the model into another consistent state (without necessarily preserving consistency at all intermediate points).

Here are some features of command sequences. Command sequences:

- Are nestable.
- Can affect more than one document. To do this requires a knowledge of targets (see “5.9.Setting a Command Target” on page 158).
- Assimilate any commands processed by observers. Note that this means if notification triggers an observer to execute another command then this command will be assimilated into the sequence.

5.7.1. Create and Carry Out a Command Sequence

To create and carry out a command sequence, you must:

- Begin the sequence using **`CmdUtils::BeginCommandSequence()`**
- Give the seqeunce a name
- Process multiple commands
- Handle errors
- If an error was returned, abort the sequence using **`CmdUtils::AbortCommandSequence()`**, or end the sequence using **`CmdUtils::EndCommandSequence()`**.

This general recipe is illustrated below:

figure 5.7.1.a. Writing a Command Sequence

```
// Begin the sequence
    ErrorCode err = kFailure;
```

```
ICommandSequence* seq = nil;
do {
  seq = CmdUtils::BeginCommandSequence();
  if (seq == nil) break; //out of do-while loop
// Name the sequence
  seq->SetName(PMString("My Command Sequence"));
// Execute first command
  InterfacePtr<ICommand> foo(CmdUtils::CreateCommand(kFooCmdBoss);
  err = CmdUtils::ProcessCommand(foo);
  if (err != kSuccess) break; //out of do-while loop
// Execute next command
  InterfacePtr<ICommand> bar(CmdUtils::CreateCommand(kBarCmdBoss);
  err = CmdUtils::ProcessCommand(bar);
} while(false);
// End the sequence
if (seq != nil)
{
  if (err == kSuccess)
    CmdUtils:: EndCommandSequence(seq);
  else
    CmdUtils:: AbortCommandSequence(seq);
}
```

5.7.2. Handle Errors in a Command Sequence

If you encounter an error after processing a command within a command sequence, call `CmdUtils::AbortCommandSequence()` rather than `CmdUtils::EndCommandSequence()`. Commands processed before you encountered the error will be undone.

5.7.3. Using SequenceContext

If you implement a method of a view/controller interface that processes commands (or calls other methods that process commands), you should wrap these commands in a command sequence.

A lightweight way to do this is to define a local `CmdUtils::SequenceContext` object at the beginning of your method. If a command sequence already exists, your commands will join it. Otherwise, `SequenceContext` begins a new sequence for you and ends it when the local object goes out of scope. `SequenceContext` does not give you the ability to abort or partly roll back the command sequence. If you need this support, you should begin your own command sequence.

5.8. Protecting Documents Against Corruption

Protective shutdown is a built-in safety feature protecting documents against corruption. It exits the application without saving or closing any files when unresolved or unhandled problems are detected. This is the safest way to prevent document corruption and, since the application supports an automated recovery process, the document will be re-opened when the application is restarted with a minimal loss of work.

A protective shutdown will occur when:

- Client code continues to process commands in the face of an error condition flagged by the global error state (See "Handle Any Errors" on page 155.)
- Rollback fails
- Undo fails
- The application fails to allocate a vital resource while it is in a command or a command sequence

Protective shutdown dumps out a status log that can be used to help trace the cause of the shutdown. The file name for the log is "ProtectiveShutdownLog" and it is stored in the application's document recovery folder.

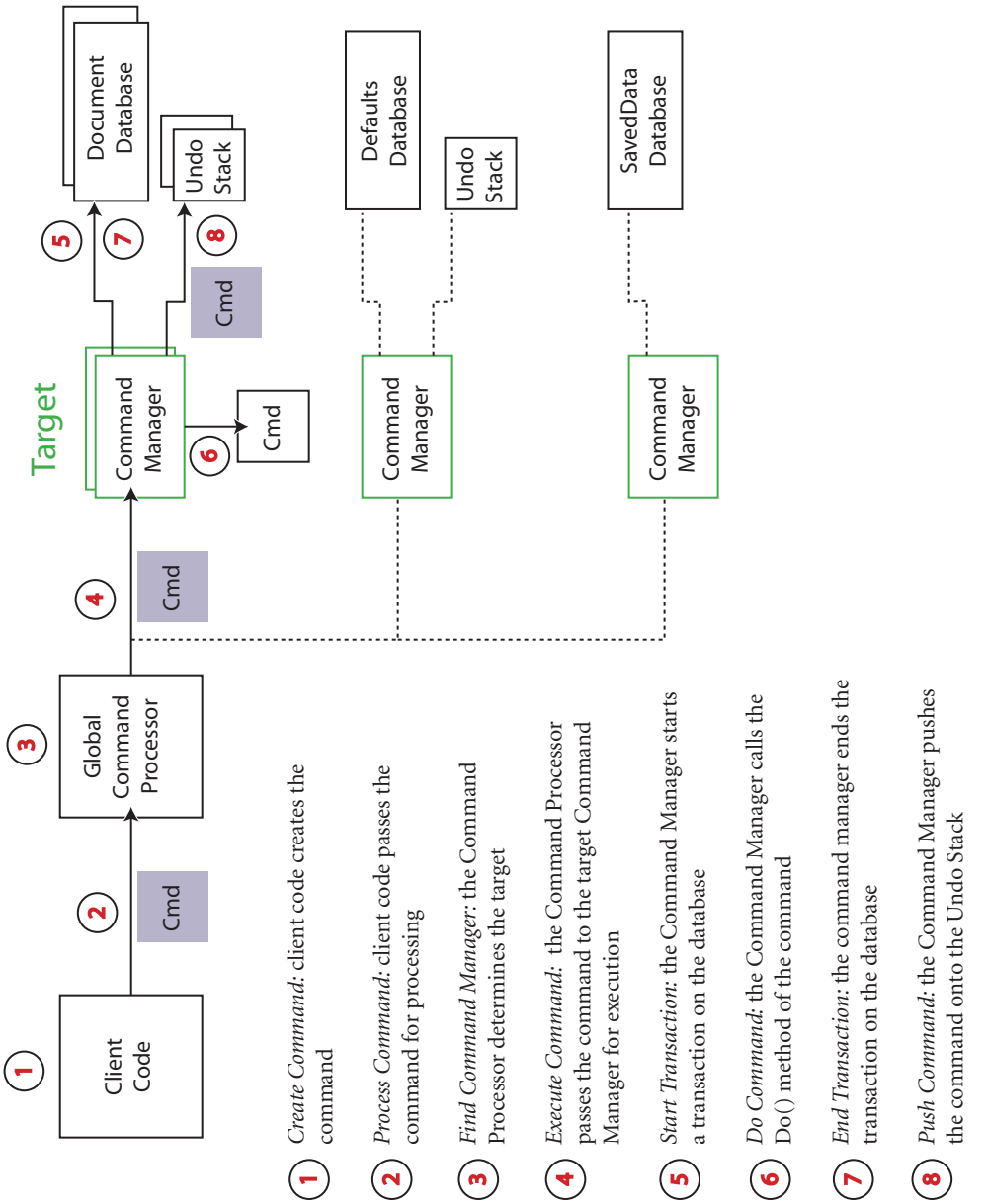
5.9. Setting a Command Target

The target of a command is important in the following situations inside your command implementation:

- If you need to call unusual commands like `CopyCmd` that work on multiple targets
- If you implement a command that needs to be directed at a specific target

To explain what a command target is, we must examine what the application does when it processes a command. Figure 5.9.a on page 159 shows an internal view of this:

figure 5.9.a. Processing a Command



Each database shown in Figure 5.9.a on page 159 has a command manager. The command manager handles transaction management and maintains an undo stack. Now *a command can change data in one database and one database only*. Note that this important restriction applies to all commands (it does not apply to command sequences however). The command manager of this database is called the *target* of the command.

The target is accessed using the `ICommand::GetTarget()` and `Command::SetUpTarget()` and methods, which are shown below:

figure 5.9.b. ICommand::GetTarget() and Command::SetUpTarget()

```
// ICommand.h
typedef UIDRef Target;
virtual const Target& GetTarget() = 0;

// Command.h:
// Override this if your command has a target that is not known at
// construction time and that is not equivalent to the command
// manager of the database of the item list at the time of execution.
virtual void SetUpTarget();
```

As shown in Figure 5.9.a on page 159, the command processor must select the command manager it passes the command to for execution. In order to do this, it calls the command's `GetTarget()` method. Default behavior for a command (unless overridden) is for the `GetTarget()` Method to use `SetUpTarget()` to establish the command's target. `SetUpTarget()` uses the itemlist's `IDataBase*` to establish the command's target.

Some typical signs of a command being directed at the wrong target are as follows:

- An assert that says “Database change outside of a transaction”
- An assert that says "CmdBehaviorMonitor: Command kFooCmdBoss changes data in a database other than its target database".
- Commands showing up in the wrong undo stack.

Note regarding changes from InDesign 1.x: Command Targetting changed in a significant, but subtle way. All the `SetTarget()` methods in `Command` are still there but aren't used the same way. All responsibility for setting the command target has been effectively delgated to the command. `SetTarget()` is no longer called by the application (you would need to do so explicitely in either

SetUpTarget() or your command's constructor.) The application's Command Processor now just calls GetTarget() and marches on using the result -- so a nil result from a command is now considered an error (one that will crash the application, unfortunately.) The default implementation of GetTarget() calls SetUpTarget() and the default implementation of SetUpTarget() sets the command's target to the database given in the itemlist. A good change, since it reduces those situations where a command is targetted to one database, but subtle in that it there were no significant changes to the API.

5.10. How to Implement a Custom Command

The general recipe for implementing your own custom command is as follows:

- Define the command boss.
- Reuse or implement data interfaces.
- Implement the ICommand interface.

5.10.1. Define a Command Boss

5.10.1.1. Define a Command Boss with no Data Interfaces

You can define a minimal command boss with no data interfaces, as command bosses are not required to have any data interfaces. This is shown below. In this case, the only way to pass an argument into or out of such a command is using the ItemList.

figure 5.10.1.1.a. Command Boss definition - no data interfaces

```
Class
{
  kFooCmdBoss,
  kInvalidClass,
  {
    IID_ ICOMMAND, kFooCmdImpl,
  }
}
```

5.10.1.2. Define a Command Boss Using Existing Data Interfaces

You can define a command boss that uses a data interface. The example shown below passes a boolean flag, which is a data interface with an implementation provided by the application:

figure 5.10.1.2.a. Command Boss definition - standard data interfaces

```
Class
{
  kFooCmdBoss,
```

```
  kInvalidClass,
  {
     IID_ICOMMAND, kFooCmdImpl,
     IID_IBOOLDATA, kBoolDataImpl,
  }
}
```

5.10.1.3. Define a Command Boss Using Custom Data Interfaces

You can define a command boss with a custom data interface you defined. The example below passes an `IFooData` object carrying the data you want into and out of the command:

figure 5.10.1.3.a. command boss definition - custom data interface

```
Class
{
  kFooCmdBoss,
  kInvalidClass,
  {
     IID_ICOMMAND, kFooCmdImpl,
     IID_IFOODATA, kFooDataImpl,
  }
}
```

5.10.2. Reuse or Implement Data Interfaces

5.10.2.1. Reuse an Existing Data Interface

There are a number of data interfaces provided by the application. Some of these are tabulated in Table 5.6.2.a on page 154. These generally have an implementation you can reuse as well. The boss definition for this case was illustrated in 5.10.1.2.

5.10.2.2. Implement a Custom Data Interface

Alternatively, you can implement your own custom data interface carrying the data you want in and out of your command. The boss definition for this case was illustrated in 5.10.1.3. To do this, you must define the interface and provide an implementation for it as shown below for the hypothetical interface `IFooData`:

figure 5.10.2.2.a. implementing a custom data interface

```
//Interface Definition
class IFooData : public IPMUnknown
{
```

```
    public:
      virtual void Set(const PMReal& myReal, const PMPoint& myPoint) = 0;
      virtual const PMReal& GetMyReal() const = 0;
      virtual const PMPoint& GetMyPoint() const = 0;
    };
//Implementation
    class FooData : public CPMUnknown<IFooData>
    {
    public:
      FooData(IPMUnknown *boss) : CPMUnknown<IFooData>(boss) {}
      virtual ~FooData(void) {}
      virtual const PMPoint& GetPMPoint() const
        { return fPoint; }
      virtual void Set(const PMReal& myReal, const PMPoint& myPoint)
        { fMyReal = myReal; fMyPoint = myPoint; }
      virtual const PMReal& GetMyReal() const
        { return fMyReal; }
      virtual const PMPoint& GetMyPoint() const
        { return fMyPoint; }
    private:
        PMReal fMyReal;
        PMPoint fMyPoint;
    };

    CREATE_PMINTERFACE(FooData, kFooDataImpl)
```

5.10.3. Implement ICommand

The majority of the implementation of the `ICommand` interface is provided for you by the helper implementation class `Command` (See **`{SDK}/API/Includes/Command.h`**). By specializing a few methods, you can implement a new command. Sample code demonstrating how to do this is shown below for the hypothetical command `FooCmd`:

figure 5.10.3.a. foocmd implementation

```
    class FooCmd : public Command
    {
    public:
      FooCmd(IPMUnknown *boss);
      virtual ~FooCmd();
    protected:
      virtual PMString *CreateName();
      virtual void Do();
      virtual void Undo();
      virtual void Redo();
      virtual void DoNotify();
    private:
```

```
  ErrorCode VerifyArguments();
};
CREATE_PMINTERFACE(FooCmd, kFooCmdImpl)
```

5.10.3.1. Command Constructor

The constructor must call the constructor of the `Command` class. Also, if your `Command` implementation contains any member variables that need to be initialized, you can do that in this constructor.

figure 5.10.3.1.a. FooCmd::FooCmd() Constructor

```
FooCmd::FooCmd(IPMUnknown *boss) : Command(boss)
{
}
```

5.10.3.2. CreateName()

Every undoable command has a name is uses to identify the command to users. A command provides a default name using the `ICommand::CreateName()` method (Note that the name must have a translation in the string translation database so it can be displayed to users in a localized form). Client code can override this name with one of its own choosing by calling the `ICommand::SetName()` method:

figure 5.10.3.2.a. FooCmd::CreateName()

```
PMString* FooCmd::CreateName()
{
  PMString *str = new PMString("Foo");
  return str;
}
```

5.10.3.3. Do()

`Do()` is called to execute the command. This is where you would put the heart of your command's implementation:

figure 5.10.3.3.a. FooCmd::Do()

```
void FooCmd::Do()
{
  InterfacePtr<IFooData> fooData(this, IID_IFOODATA);
  if(VerifyArguments(fooData) == kSuccess)
  {
    // Implement the Foo command action here...
  }
```

```
  else
  {
    ErrorUtils::PMSetGlobalErrorCode(kInvalidFooDataErr);
  }
}
```

5.10.3.4. Undo()/Redo()

`Undo()` is called to reverse the command. `Redo()` is called to reapply the command:

figure 5.10.3.4.a. FooCmd:Undo()/Redo()

```
void FooCmd::Undo()
{
  // Undo the Foo command
}

void FooCmd::Redo()
{
  // Redo the Foo command
}
```

5.10.3.5. DoNotify()

`DoNotify()` is called after a successful call to `Do(), Undo() or Redo()` to initiate notification:

figure 5.10.3.5.a. FooCmd:DoNotify()

```
void FooCmd::DoNotify()
{
  //Get the list of objects we've changed
  const UIDList *items = this->GetItemList();
  //Iterate over the list...
  for (int32 i = (items->Length()-1); i >= 0; i--)
  {
    //...and call the change method on each ISubject interface...
    InterfacePtr<ISubject> subject(items->GetRef(i), UseDefaultIID());
    if (subject != nil)
    {
      //...this will cause observers to be notified of the change
      subject->Change(kFooCmdBoss, IID_IFOO, this);
    }
  }
}
```

Some commands call `DoNotify()` themselves at the beginning of their `Do(), Undo(), or Redo()` methods in order to pre-notify observers about changes they are going to apply. You must not call `DoNotify()` in the middle of `Do(), Undo(),` or `Redo()` because the observers may process commands as a result of the notification.

Beware if you are implementing a specialized version of an existing command. The parameters in the call to the `ISubject::Change()` method create a dependency between the observer and notifier. For example, an observer interested in the movement of page items may be looking for the `ClassID` of the `MoveRelativeCmd`. If you implement your own specialized version of `MoveRelativeCmd`, then you should be careful to use the `ClassID` of the original (`kMoveRelativeCmdBoss` in this case) as the first parameter `ClassID theChange` in the `ISubject::Change()` method, since this is the one existing observers will be looking out for.

5.10.3.6. VerifyArguments()

To complete our implementation, we use a private method to check command arguments:

figure 5.10.3.6.a. FooCmd::VerifyArguments

```
ErrorCode FooCmd::VerifyArguments(IFooData *fooData)
{
  //Check arguments passed via ItemList or data interfaces here...
  if( fooData == nil || fooData->GetMyReal() <=0)
    return kFailure;
  return kSuccess;
}
```

5.11. How to Design Commands

You now have an empty shell for a new command (see "5.10.How to Implement a Custom Command" on page 161).

So, what shall you put in your `Do()` method?

You may want to do some document manipulation using existing commands. You may wish to call existing model interfaces directly. Perhaps you need to do both of these to achieve what you want. Or, you may be implementing commands that manage a new model implemented by your own plug-in.

To do these things successfully, you need to understand how to design commands.

5.11.1. Define Undoability

There are four different types of undoability of interest:

- `kRegularUndo`
- `kUndoNotRequired`
- `kAutoUndoWithPrevious (or kAutoUndo)`
- `kAutoUndoWithNext`

The majority of commands are undoable (`kRegularUndo`), which is the default behavior. A few commands are not undoable and have type `kUndoNotRequired`. A few commands are auto-undoable and have type `kAutoUndo`, `kAutoUndoWithPrevious`, or `kAutoUndoWithNext`.

If your command changes the model, it must be undoable. What does this mean? Well, the model supports interface methods allowing modification to occur. If one of these methods is called directly within the scope of your command, you must make your command undoable.

The undoability is accessed using the `ICommand` methods shown below:

figure 5.11.1.a. ICommand::GetUndoability() and SetUndoability()

```
virtual Undoability GetUndoability() = 0;
virtual void SetUndoability(Undoability newUndoability) = 0;
```

If your command is not undoable, it should call `SetUndoability(kUndoNotRequired)` in its constructor. Commands of this type do not need to specialize the `ICommand::Undo()` and `Redo()` methods. `OpenFileCmd` and `SetActiveLayerCmd` are examples of commands that are not undoable. These commands do not change the model.
Note that the `ICommand::GetUndoability()` and `SetUndoability()` should only be called from within the implementation of a command, not from a client.

5.11.2. Classifying Commands as Atomic, Macro, or Hybrid

Commands can be classified according to how they implement `Do()`, `Undo()`, and `Redo()` as:

- Atomic commands
- Macro commands

- Hybrid commands

5.11.2.1. Atomic Commands

Atomic commands call model interface methods that cause modification to occur. They store data about what they have changed and use this data in `Undo()` and `Redo()` in order to reverse or to reapply these changes.

5.11.2.2. Macro Commands

Macro commands create and process commands (or call interfaces that do this) to modify the model. They delegate their work *completely* to these commands. Macro commands must have empty implementations of their `Undo()` and `Redo()` methods. They are undoable but `Undo()` and `Redo()` are provided by the underlying "sub-commands".

5.11.2.3. Hybrid Commands

Hybrid commands do both direct modification and indirect modification, that is, they:

- Call model interface methods that cause modification
- Create and process commands (or call interfaces that do this) to modify the model

There are some important guidelines to follow in order to make hybrid commands undoable:

1. In their `Undo()/Redo()` methods, hybrid commands should only reverse/reapply the direct modifications they have made to the model (the following rule is useful "*You must not process a command in Undo() or in Redo()*").
2. Beware of the order in which the direct modifications and indirect modifications occur.

We can differentiate the order according to the following patterns:

- Type 1: PC-DM
- Type 2: DM-PC or PC-DM-PC
- Type 3: DM-PC-DM, PC-DM-PC-DM, or any other order with multiple occurrences of DM (not supported by the application)

where:

- **PC** represents indirect modification of the model through the *p*rocessing of *c*ommands
- **DM** represents any sequence of *d*irect *m*odification of the model.

A Type 1 Hybrid Command pattern is undoable and no further special action is required.

A Type 2 Hybrid Command pattern requires you to do two things to make it undoable:

1. Let the command processor know when you are done with your direct changes. Do this by calling the `ICommand::DirectChangesAreDone()` method immediately after you have done your direct changes and before you process any command (or call a method that might process a command). This ensures these subsequent commands will be pushed to the undo stack after your command. If you fail to do so, you will get an assert like "CmdBehaviorMonitor: FooCmd processes cmds after having done changes to the model. Please call DirectChangesAreDone."
2. Wrap the commands you process after your direct model modifications in a command sequence so you have control over error handling.

Figure 5.11.2.3.a on page 169 shows how to implement this pattern:

figure 5.11.2.3.a. Type 2 Hybrid Command Code Sample

```
void FooCmd::Do()
{
  // 1. process some commands
  ErrorCode error = this->ProcessSubCmds1();
  // 2. direct modification
  if(error == kSuccess)
    error = this->DoDirectModification();
  // / 3. let the command processor know that you are done with your direct
  // changes so the following commands are pushed to the undo stack
  // in the right order
  if(error == kSuccess)
    this->DirectChangesAreDone();
  // 4. process more commands wrapped in a command sequence
  if(error == kSuccess) {
    ICommandSequence *cmdSeq = CmdUtils::BeginCommandSequence();
    error = this->ProcessSubCmds2();
    if(error == kSuccess)
        CmdUtils::EndCommandSequence(cmdSeq);
    else
        CmdUtils::AbortCommandSequence(cmdSeq);
  }
  // 5. error handling
  if(error != kSuccess && this->AreDirectChangesDone())
```

```
    this->UndoDirectModification();
}

void FooCmd::Undo()
{
  this->UndoDirectModification(); // reverse direct modification
}

void FooCmd::Redo()
{
  this->RedoDirectModification(); // reapply direct modification
}
```

A Type 3 Hybrid Command pattern is not supported. It is very important that the direct modifications done by the command (or any method called by the command) occur as one uninterrupted block. If not, you will get an assert like "CmdBehaviorMonitor: FooCmd's direct changes to the model are intermitted by commands (action: Delete UID)". Basically, this assert indicates a source of publication corruption. If one of your commands triggers this assert, follow these strategies to make it undoable:

1. Try to rearrange the code so the direct modifications are bundled and the command falls into one of the other patterns described above.
2. If this is not possible, you must either make the command into an atomic command or create new commands encapsulating the direct modifications.

5.11.3. Command Destructors

The destructor of a command should normally be empty. If you do need one, for instance, to delete variables allocated on the heap, then take care not to change the model within the destructor. Changes to the model in the destructor are not supported, and would represent changes outside a transaction. (This would break the required atomicity of commands.)

5.11.4. Error Handling Inside Commands

If you are implementing the `Do()` method of a command and you encounter an error, you must undo any direct modifications you have done to the model before you return to your caller.

5.11.5. Rules for Implementing New Commands

Here are some rules you need to know:

1. Commands that change the model must be undoable (see "5.11.1.Define Undoability" on page 167).
2. A command can change data in only one database (see "5.9.Setting a Command Target" on page 158).
3. Don't process any commands in your `Undo()` and `Redo()` methods (see "5.11.2.Classifying Commands as Atomic, Macro, or Hybrid" on page 167).
4. Don't modify the model in your command's destructor (see "5.11.3.Command Destructors" on page 170).

5.12. Summary

This section gives you an introduction to commands and the command documentation. It outlines general recipes for calling commands, command sequences and implementing new commands. Finally, it describes the issues you must consider when designing new commands.

5.13. Review

You should be able to answer these questions:

1. What is a command?
2. Describe the two mechanisms for passing arguments into and out of commands?
3. What is the general recipe for calling a command?
4. What is the general recipe for writing a command sequence?
5. Which interface does every command boss implement?
6. What is the general recipe for implementing a new command?
7. What helper implementation class do you use to implement a new command? Also, which methods would you have to specialize to complete the implementation?

5.14. Exercises

1. Look up `NewLayerCmd` in the *InDesign Command Reference* or InterfaceList.txt.
2. Write someclient code to process `NewLayerCmd`.

5.15. References

- Buschmann. *A System of Patterns*, 1996.
- Gamma, E., et.al. *Design Patterns*. 1995: Addison-Wesley. Elements of reusable object-oriented software.
- Adobe InDesign SDK. *InDesign Command Reference*, Revised 2002. See `{SDK}/Documentation/CommandReference.pdf` (filename may be different).

- Adobe InDesign SDK. Browsable HTML documentation.

6.

Persistence

6.0. Overview

This chapter looks at how persistence is implemented in the application and how it can be used in plug-ins to store object data.

6.1. Goals

The questions this chapter answers are:

1. How does the application store its data?
2. How is an object made persistent?
3. How is a persistent object referenced?
4. What is a stream?
5. How do I create a new stream?

6.2. Chapter-at-a-glance

"6.3.Introduction to Persistence" on page 174 introduces the concept of persistence in InDesign.

"6.4.Persistent Objects" on page 176 discusses how persistence object is created, deleted, manipulated.

"6.5.Streams" on page 183 discusses how streams are used to move information in and out of InDesign document..

table 6.2.a. version history

Rev	Date	Author	Notes
2.0	23-Oct-02	Lee Huang	Update content for InDesgn 2.x API
0.1	2000		First Draft

"6.6.Missing Plug-ins" on page 186 details how to handle the situation when a plug-in is missing while you try to open a document that contains data saved by that plug-in.

"6.7.Data Conversion" on page 189 provides different approaches to convert data in an old document so it can be opened in a newer version of InDesign.

"6.8.Summary" on page 207 recaps everything presented in this chapter.

6.3. Introduction to Persistence

6.3.1. Persistence

For the purposes of this guide, **persistence** is defined as the ability of an object to remain unchanged while it is removed from main memory and returned again. A persistent object may be part of a document, like a spread or a page item, or part of the application, such as a dialog, a menu item, or a default settings.

6.3.2. Databases

The Adobe InDesign application uses light weight databases as the stores for the persistent objects. The host creates a database for each document created. The host also creates a database for the scrap (the clipboard storage space), the ObjectModel information (the SavedData file), and the workspace information (the Defaults file).

Each document is contained in its own database. The database has two major parts, a table with the object classes and a stream with the object data. The table of object classes [figure 6.3.2.a.] contains **UID**s and **ClassID**s. A UID is a unique identifier for an object in the database, and a ClassID gives us the class (boss) of the associated object.

figure 6.3.2.a. persistent objects and their classids

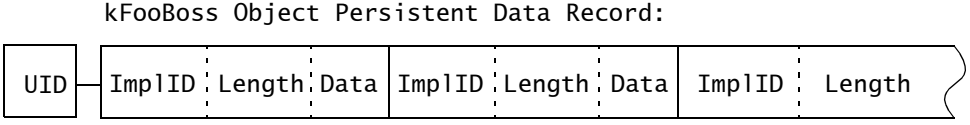
UID (Object ID)	ClassID (Type information for the Object)
0	kDocBoss
1	kFooBoss
2	kCodeHawgsBoss
3	kPageBoss
4	kSpreadBoss

The stream with the object data [figure 6.3.2.b.] contains a series of records which correspond to the persistent object. The object's UID is stored with the object as a key for the record. The object records are variable length records consisting of one segment for each persistent interface. Every segment has the same structure:

```
ImplementationID tag
int32 length
<data>
```

The format and content of the `<data>` is determined by the implementation of the interface. See "6.4.2.3.Reading and Writing Persistent Data" on page 182 about the `ReadWrite()` method.

figure 6.3.2.b. conceptual diagram of an object's data



The figures above ("Persistent Objects and Their ClassIDs" and "Conceptual diagram of an Object's Data") are conceptual diagrams of the database contents, and do not represent the actual contents of any database.

An important issue to note is for each object, the ClassID is stored in the table and the ImplementationIDs are stored in the stream, but the InterfaceID is not stored with either, so adding an existing (SDK supplied) Implementation to an existing boss is dangerous, and can cause problems if another developer adds

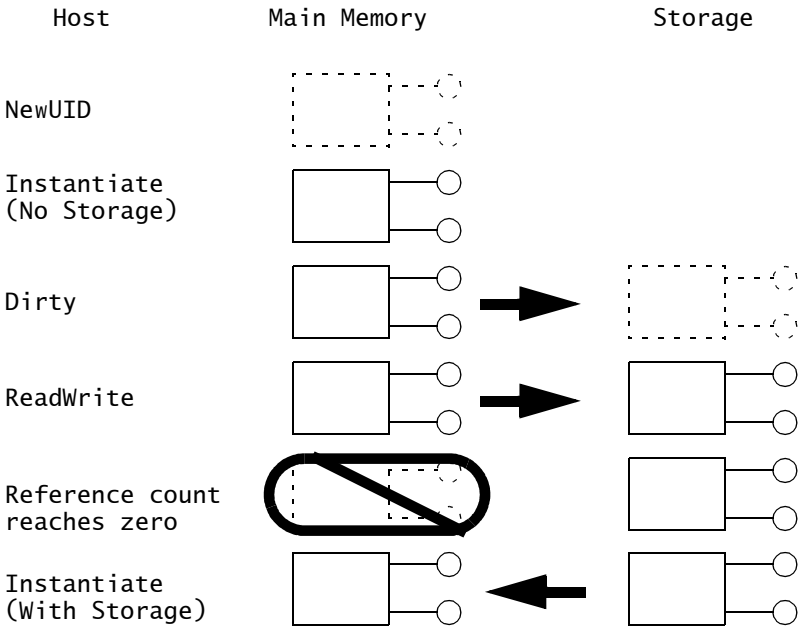
the same implementation to the boss. For this reason it is strongly recommends creating a new implementation for any persistent interface added to a boss (using `AddIn`).

6.4. Persistent Objects

6.4.1. Using Persistent Objects

The host stores persistent objects in a database and each object has an identifier unique within the database. The methods used for creating, instantiating, and using a persistent object are different from the methods used for non-persistent objects. When a persistent object is created its record exists in memory. Certain events, such as a user's request to save the document, trigger the writing of the record out to the storage. Persistent objects, as boss objects, are reference counted. If the reference count for any persistent object reaches zero, the object may be asked to write itself to its database, and could then be deleted from memory. Any object with a reference count greater than zero will remain active in memory. Other events, like drawing or manipulating the object, requiring access to the object, trigger the host to read the object back into memory. This strategy allows individual objects to load into or purge from memory, so the host does not have to load the entire document into memory at one time.

figure 6.4.1.a. creating and storing persistent objects



6.4.1.1. Instantiating a New Object

A new instance of a persistent boss is created differently than a non-persistent object is.

A new instance of a non-persistent boss can be created using `CreateObject()`:

```
IPMUnknown *CreateObject(const ClassID clsID, const PMIID iid =
IIDIUNKNOWN)
```

This method takes the `ClassID` (**boss**) for the object created and an interface ID for one of the interfaces on the boss, and returns an interface pointer to a newly created boss object. The interface pointer points to the interface identified by the IID. There is a new inline `CreateObject2` function in InDesign 2.0 that calls the `CreateObject` under the hood, but you can omit the interface ID if the `kDefaultIID` is deinfed in the interface. Either CreateObject or CreateObject2 is sufficient for a non-persistent object, but to create a persistent object requires a little more. The new object is going to need a UID to associate the object with its record in the database.

6.4.1.1.1. Creating a New UID

Any persistent object instantiated, must be instantiated for a specific database. To instantiate a new object, you must first have a pointer to the database. The most common way to get a database pointer is to use a PersistUtils:

```
IDataBase *GetDataBase(const IPMUnknown *obj);
```

The `GetDataBase()` method takes an interface (`IPMUnknown`), this can be an interface from any object in the database, so if you already have an interface on the document you can get the database from that:

```
// theDocument is an IDocument* but could be any IPMUnknown
IDataBase *docDatabase = GetDataBase(theDocument);
```

Note that `IDataBase` itself is not an `IPMUnknown`, and therefore is not refcounted, does not appear in any boss objects, and cannot be wrapped in an `InterfacePtr`.

Once you've got the database pointer, you can use the `IDatabase::NewUID` method shown below. Creating a new UID in the database adds an entry into the database relating the UID to the class of the object being created, but the object has not been instantiated yet, and no other information about it exists in the database.

```
UID NewUID(ClassID clsID);
```

6.4.1.1.2. Instantiating the Object

To instantiate a new object, use the InterfacePtr template to retrieve one of the object's interfaces:

```
InterfacePtr<IFace> facePtr(IDatabase*, UID, InterfaceID);
```

This takes a pointer to the database, the UID of the object to instantiate, and the interface on the boss which is to be returned. The `InterfacePtr` calls the database to instantiate the object using the `Instantiate()` method:

```
IPMUnkown* IDatabase::Instantiate(UID id, PMIID interfaceID)
```

This method will actually check to see if the object is already in memory, and only if it is missing does it instantiate the object. When an object is instantiated, the application first checks for previously stored data in the database, if it is found the object is instantiated from this data, otherwise the object is instantiated from the object's constructors (every implementation has a constructor so the boss and all its implementations are instantiated.) Only when the object is changed, and thus marked "dirty" will it then need to be

written to the database (via the interfaces' `ReadWrite()` methods.) For more information on `Dirty()` and `ReadWrite()`, see "6.4.2.Implementing Persistent Objects" on page 181.

Whether it instantiates an object from the database, or returns a reference to an object previously instantiated, the `IDatabase::Instantiate()` method increments the reference count on the object and returns an `IPMUnknown*` to the requested interface (if the interface is available).

6.4.1.1.3. Use the Commands

Commands are used to encapsulate changes to the model, and since creating a new object is a change to the model, there are commands for creating new objects of many of the existing classes (`kNewDocCmdBoss`, `kNewPageItemCmdBoss`, `kNewStoryCmdBoss`, etc.) The command architecture provides a level of protection for the database as the commands are transaction based changes, and any command attempting to process when the application is already in an error state will cause the application to perform a "**Protective Shutdown**" which quits the application rather than permit a potentially corrupting change being made to the document. The commands also provide notification for the changes to the **model**, allowing **observers** to be updated when the change is made (and at undo or redo). When the commands are available they should be used to create the objects, and the objects should *not* be created manually.

If you are implementing a new type of persistent object, you will need to implement a command creating objects of your new type (using the methods outlined in this section).

6.4.1.2. Instantiating an Object from a Database

Instantiating an object already existing in the database is done in exactly the same way a new object is instantiated (see "6.4.1.1.2.Instantiating the Object" on page 178). To the plug-in, the two functions are the same. A single object could potentially exist and be used in several user sessions without ever being written to the database since an object only stores data to the database if it has been changed (making the default object data no longer applicable). Persistent objects not having data stored in the database are constructed from the object's constructors.

6.4.1.3. References to an Object

There are several types of references to a persistent object: InterfacePtrs, UIDs, UIDRefs, and UIDLists. Each type of reference serves a different purpose and understanding these references will make working with persistent objects much easier.

A UID is a unique identifier within the scope of a database. The UID by itself is not sufficient to identify the object outside the scope of the database. Like a record number, it only has meaning within the database. UIDs are useful for storing, passing, and otherwise referring to a boss object because they have no runtime dependencies (no pointers are involved) and there is an instance cache ensuring fast access to the instantiated objects. There is a value used to identify a UID not pointing at a valid object, `kInvalidUID`. Any time a UID is retrieved and needs testing for a valid object, the UID should be compared to `kInvalidUID`.

A UIDRef represents two pieces of information, a pointer to a database, and the UID of an object within this database. A UIDRef is useful for referring to objects because it identifies both the database and the object. UIDRefs are a common method for referring to a persistent object, especially when they are to be passed around or stored, since a UIDRef does not require the object it points at to be instantiated. UIDRefs cannot be persistent data because they have a runtime dependency, the database pointer. An 'empty' or invalid UIDRef will give kInvalidUID for its UID and a nil pointer for its database pointer.

An InterfacePtr holds a pointer to an interface (on any type of boss object) it identifies an instantiated object in main memory. While an InterfacePtr on the boss is necessary for working with the boss, they shouldn't be used to track a reference to a persistent object, as this forces the object to stay in memory. In many cases a nil pointer returned from InterfacePtr is not an error state, but simply means the requested interface does not exist on the boss indicated.

A UIDList contains a list of UIDs and a single pointer to a database. All of the objects identified by a UIDList must be objects within the same database. A UIDList is a class object containing a list of UIDs and the database pointer and should be used any time a list of objects is needed (selections and commands use UIDList objects).

6.4.1.4. Destroying an Object

Similar to creating them, deleting persistent objects is done through commands and the `DeleteUID()` method is not called directly. Deleting an object from the database using `DeleteUID()` does not take care of all the references to the object or items the object contains references too.

If you are implementing a command to delete a persistent object, and you've removed the references to the object and need to delete the object from the database, then the database method `DeleteUID()` is the method to use. It looks like this:

```
IDataBase::DBResultCode dbResult = database->DeleteUID(uid);
```

6.4.2. Implementing Persistent Objects

A boss is made persistent by adding the `IPMPersist` interface. Any boss having an `IPMPersist` interface, is persistent, and when an object of the boss is created the object is assigned a `UID`. If you've added the `IPMPersist` interface to a boss, then any persistent interface on the boss can save data into the database.

6.4.2.1. Add the IPMPersist Interface to the Boss

For a boss to be persistent you must add the `IPMPersist` interface, and since all instances of this interface can and should use the same implementation - `kPMPersistImpl`, adding the interface is simply a matter of making sure you've got it as an interface on your boss. The following boss definition is an example of a boss with the `IPMPersist` interface.

figure 6.4.2.1.a. the definition of a persistent boss

```
Class
{
  kFooBoss,
  kInvalidClass,
  {
    IID_IBARDATA, kBarDataImpl,
    IID_IPMPERSIST, kPMPersistImpl,
  }
},
```

Once the interface is added to the boss, any objects of the boss will get a `UID` assigned when the object is instantiated. Though the object will have a `UID`, and this `UID` has an entry in the `ClassID/UID` pairings in a database, the object may

not yet be storing any data. It is up to the interfaces to store the data they need. This is done by adding the `ReadWrite()` method to the interface and making sure when the information is changed the `Dirty()` method is called.

6.4.2.2. Use the CREATE_PERSIST_PMINTERFACE Macro

As mentioned earlier in this guide, when an interface is implemented the `CREATE_PMINTERFACE` macro is used to create an `InterfaceFactory`, or a set of classes used to create and destroy instances of the implementation class. For a persistent implementation, there are some additional requirements, so the `CREATE_PERSIST_PMINTERFACE` is used.

6.4.2.3. Reading and Writing Persistent Data

Any interface you want to store data for, must support the `ReadWrite()` method. This method does the actual reading and writing of the persistent data. The `ReadWrite()` method is called with a stream and uses this stream to read or write its data. The `IPMStream` methods for reading and writing data have been generalized, so that they are the same for both cases. In other words, if you have a read stream, the `XferBool()` method will read a boolean value. If you have a write stream, its `XferBool()` method will write out a boolean method. The read and write stream methods are generalized in this way so a single `ReadWrite()` method handles both situation and reduces the possibility of bugs due to discrepancies in reading and writing methods.

figure 6.4.2.3.a. implementing a readwrite method

```
void BarData::ReadWrite(IPMStream *stream, ImplementationID
implementation)
{
  stream->XferInt32(fWidth);
  stream->XferInt32(fHeight);
}
```

6.4.2.4. Marking Changed Data

When the data for a persistent object residing in memory is changed, there is a difference between the current version of the object, and the object as it exists in the database's storage. When this happens the object in memory is said to be "dirty," meaning it doesn't match the version in storage. Any object made "dirty" needs to have its `Dirty()` method called (so that it can notify the database of the difference).

figure 6.4.2.4.a. marking data as dirty

```
void FooCountData:: SetFooCount( int32 newFooCount )
{
  if( fFooCount != newFooCount)
  {
    fFooCount = newFooCount;
    Dirty();
  }
}
```

The `Dirty()` method is implementation independent, and therefore you won't need to implement it yourself, but simply rely on the version provided by the `HELPER_METHODS` macros defined in HelperInterface.h (`DECLARE_HELPER_METHODS`, `DEFINE_HELPER_METHODS`, and `HELPER_METHODS_INIT`).

Note if you add an interface to an existing boss, and this boss is persistent, the interface may also be persistent. To make such an interface persistent, you would follow the same steps in the implementation as if the interface were on a boss you have defined (use the `CREATE_PERSIST_PMINTERFACE`, create the `ReadWrite`(), call `Dirty`() when changes are made)

6.5. Streams

Streams are used by persistent objects to store their information to a database. Streams are also used by the host application to move information around whether it be images placed into the document, copying information to the clipboard, or objects being stored in the database. The public interface to the streams in the `IPMStream` interface. Implementations of the `IPMStream` interface typically use the `IXferBytes` interface to move data.

The first part of this section ("6.5.1.StreamUtil" on page 183 and "6.5.2.The IPMStream Methods" on page 184)covers information needed any time you're working with a stream. The rest of this section ("6.5.3.Implementing a New Stream" on page 184) is not normally needed.

6.5.1. StreamUtil

The `StreamUtil` methods (**StreamUtil.h**) are helper methods for creating all of the common types of streams you may need when moving information around within or between InDesign databases.

6.5.2. The IPMStream Methods

`IPMStream` is a generalized class of both reading and writing streams. In other words, the `IPMStream` methods gives you access to streams both reading information and writing information. Any particular stream implementation will be either a reading or a writing stream, and the type of stream can be determined by using the `IPMStream::IsReading()` and `IPMStream::IsWriting()` methods.

Any persistent implementation will have a `ReadWrite()` method, as mentioned above. The `ReadWrite()` method will use a stream, and in particular a set of data transferring methods on the stream, to read and write its own data. The methods are used for transferring data in or out of a stream are all the same regardless of which direction the data is moved. The `IPStream` methods starting with the `Xfer` prefix are used for transferring the data type identified in the method name. `XferByte()` will transfer a byte, `XferInt16()`, a 16 bit integer, `XferBool()`, a boolean value, and so forth. All of the transferring methods are overloaded, so they can take a single item, or an array of items. (The `XferByte(uchar, int32)` version is typically used for buffers.)

The streams will also handle byte swapping, if required. The default, if swapping is not set (`SetSwapping(bool16)`), is to not do byte order swapping.

At times it is not bytes, ints or bools you're interested in, but boss objects and references to objects. `IPMStream` has a couple of methods specifically for these cases `XferObject()` and `XferReference()`. `XferObject()` is used to transfer an owned object, and `XferReference()` is used to transfer a reference to an object not owned by the object using the stream. One way to decide which method to use is to think about what should happen to the object if the owning object were deleted. Should the object still be available (like a Color a PageItem refers to), then `XferReference()` should be used. If the item is actually owned by the object (like a **Page** a **Document** refers to) then `XferObject()` should be used.

6.5.3. Implementing a New Stream

There may come times when the existing streams are not sufficient, and you find you need to create a new type of stream. This would happen any time you want to read or write to a location the host application doesn't recognize. Importing and exporting files stored on an ftp site or in a database storage would require a new stream.

6.5.3.1. Stream Boss

The first step in implementing a new stream would be to define the boss. Typically a stream boss will contain `IPMStream` and any interface required to identify either the type of information in the stream, the target/source of the stream, or both. The following is a hypothetic datalink boss

figure 6.5.3.1.a. simplelinkreadstream - for importing files from an external database

```
Class
{
  kSimpleLinkStreamReadBoss,
  kInvalidClass,
  {
    IID_IPMSTREAM, kSimpleLinkStreamReadImpl,
    IID_IDATALINK, kSimpleLinkImpl,
    IID_IFORMATTYPE, kFormatTypeImpl,
  }
};
```

The `IPMStream` is the only interface all stream bosses have in common. In the example above, the `IDataLink` interface identifies the source of the data in the stream and the `IFormatType` interface gives creator, type, and file extension information about the data in the stream. A stream that is commonly used in importing is the `kFileStreamReadBoss`.

figure 6.5.3.1.b. filestreamread

```
Class
{
  kFileStreamReadBoss,
  kInvalidClass,
  {
    IID_IPMSTREAM, kFileStreamReadLazyImpl,
    IID_IFILESTREAMDATA, kFileStreamDataImpl,
  }
};
```

6.5.3.2. IPMStream Interface and the IXferBytes Class

When implementing your own stream there are a couple of classes you'll want to take advantage of. There are a couple of default implementations of `IPMStream` making writing new implementations easier, `CStreamRead` and `CStreamWrite`. The default implementations (`CStreamRead` and `CStreamWrite`) of `IPMStream` use an abstract base class, `IXferBytes` to do the actual reading and writing, so most of the work in creating a new data source is in creating an `IXferBytes` that can read and write to the data source.

6.6. Missing Plug-ins

The plug-ins you create can add data to the document. When the plug-in is there to open and interpret the data, everything is fine, but what happens when the user removes the plug-in, or gives the document to someone else?

There are a couple of ways to handle these situations. First, you have control over what happens when the user without the plug-in opens the document (what sort of warning is shown). Second, you can implement code to "fix-up" or update the data when the plug-in is available again. This section outlines how both these methods are used.

6.6.1. Critical, Default, and Ignore

If the user opens a document containing data created by any plug-in now missing, the application can give a warning. There are three warning levels: critical, default, and ignore. A critical warning tells the user the document contains data from missing plug-ins, and strongly advises the user not to open the document. The user may continue the open, and it will open as an untitled document (a copy of the original) to try to preserve the document. A default warning tells the user the document contains data from missing plug-ins, and asks if they want to continue the open, if they continue the open, the original document is opened. An ignore warning puts up no warning message at all, but proceeds with the open as if there were no missing plug-ins. These warnings can be set to trigger on ClassID or ImplementationID. This is useful if your plug-in both creates new bosses, and adds interfaces to existing ones, as the warnings for each can be established.

Plug-ins store two sorts of data in a document: ClassIDs, and ImplementationIDs (see "6.3.2.Databases" on page 174). The plug-in can specify how important a ClassID or ImplementationID is. All data is considered to be default priority unless otherwise specified. You can override the setting, and make it either critical or ignored. You do this by adding a resource to the plug-in's boss definition file. For example, to make data in the PersistentList plug-in as ignored, you would add the following two resources to `PstLst.fr`:

figure 6.6.1.a. marking implementation ids as ignored

```
resource IgnoreTags(1)
{
  kImplementationIDSpace,
  {
    kPstLstDataPersistImpl,
    kPstLstUIDListImpl,
  }
};
```

figure 6.6.1.b. marking boss classes as ignored

```
resource IgnoreTags(2)
{
  kClassIDSpace,
  {
    kPstLstDataBoss,
  }
};
```

`CriticalTags` are used if you want the data marked critical. To mark it `ignore`, you would use the exact same resource format, but start it out as `IgnoreTags`. The ID `kImplementationIDSpace` specifies the IDs following are ImplementationIDs, not ClassIDs (conversely, use `kClassIDSpace` if the IDs in the list are ClassIDs). You can put any number of IDs in the list, but all the IDs must be of the same type. You can have a second resource, as shown, to mark IDs of another type. You do not need to mark any IDs not appearing in the document (for instance, data only written out to saved data, or implementations that are not persistent). You do not need to mark IDs if the default behavior is desired.

If there is data that is currently stored in the document by your plug-in, and the data does not reference objects supplied by other plug-ins, and the user will not be able to see any difference in the document because your plug-in is missing, then consider marking the data ignore. For instance, your plug-in may store preference information in every document. If the preference data is in the document, but no objects are, then the user does not need a warning when your plug-in is missing. You can make this happen by marking the preference data `ignore`.

6.6.2. Updating Data in a Changed Document

What should happen when a document is opened, and the document contains data placed there by a plug-in not on the system? Many times there is no problem with this. But if the plug-in's data is dependent on anything else in the document, the data could get stale if the document is edited without the plug-in. For instance, suppose there is a hyperlink attribute linked to another frame. Double click on the link to go to the frame, etc. Your plug-in supplies an observer, so if the frame is deleted, the link will be severed. Now lets suppose you give your document, with the hyperlinks, to someone else who does not have the hyperlink plug-in. The other person edits the document, deletes the frame, saves, and then hands the document back to you. You open the document and double click on the frame. Disaster, right? In fact, the other person may also think the document looks pretty strange, since the hyperlinks aren't showing up.

Suppose the user decides to edit the document, even though the hyperlink plug-in is missing, and deletes the frame. There is still a problem, because the hyperlink didn't get updated when the frame was deleted. When you open the document later, and double click on the hyperlink, the host could crash looking for the frame which was deleted. The fix for this is for the plug-in to override the `IPlugIn::FixUpData()` method. `FixUpData()` will be called when the document is opened, if the plug-in was used to store data in the document, and if the document was edited (and saved) without the plug-in. The hyperlinks plug-in could override `FixUpData()` to scan all its objects checking to see if the linked frame UIDs were deleted. Then when the document opened, the links are severed correctly by `FixUpData()`.

So, here are some guidelines for what you need to do in your plug-in:

- Do nothing if your plug-in does not store data in documents.
- Mark data as ignore if it doesn't reference other data in the document, and if it doesn't appear visually in the document.
- Mark data as critical if you believe editing the document without your plug-in could corrupt the document.
- Supply a `FixUpData()` method if there are checks your plug-in could do on opening a document edited without the plug-in, to bring its data back in sync.

6.7. Data Conversion

Converting data from an old document to a new one is complex because each plug-in may independently store data in the document. When the host opens a document made with an older version of the application, or an older version of any of the plug-ins used in the document, then the older data must be converted and updated to match the new format. Additionally there are multiple methods available for handling the data conversion process.

6.7.1. Two Different Approaches

There are two approaches to converting persistent data. One approach to data conversion is to use the host's **ConversionManager** to manage the conversion process. The second method is to for the owning plug-in to manage when and how data should be converted, using version information or other data embedded with the object data.

6.7.1.1. Using the Host's ConversionManager

Each document contains some header information about the content in the document. The header includes a list of all the plug-ins supplying data to the document and the version number of the plug-in last used to write the data. When a document is opened, the application checks to see if any of the plug-ins are missing or out of date. If a plug-in is missing it may put up an alert (see "6.6.Missing Plug-ins" on page 186). If a plug-in is out of date then the information stored by the old plug-in must be updated to match the format required by the currently running plug-in before the document can be opened. A plug-in may register a conversion service doing this. InDesign contains a `ConversionMgr` checking to see what conversions are required for opening the document, and calls the appropriate plug-in to do the conversion

There are two things you have to do when making a format change in order to maintain backwards compatibility with the old format. First, you have to update the version number of the plug-in(s) whose data format you have changed. This is required so the host can detect the data format has changed. Second, you must provide a converter that can convert between the previous format and the new format.

6.7.1.2. When is a Converter Necessary?

A converter is necessary anytime the document format is changed. When the persistent data for any plug-in changes it is a document format change.

Any of the following can change the document format:

6.7.1.2.1. Changes to ReadWrite()

If the `ReadWrite()` method is used to stream data to the pub, then changing the `ReadWrite()` method will change the document format. An implementation may have a `ReadWrite()` which doesn't work with the document, but some other database or other data source. Widgets, for instance, have a `ReadWrite()` method used for streaming to/from resources and to/from the SavedData file. Changes to a method that does not work with the document database do not require any special conversion.

6.7.1.2.2. Changes to an Object's Definition

If you add or remove an implementation from the definition of a persistent boss in the .r file, then you have changed how the object will be streamed out. If you add a new implementation then you would stream in an old version of the object, but it will not contain the data normally appearing for the implementation you've added. This is fine if the data can be initialized adequately from the implementation's constructor - otherwise, you may need to add a converter. If you change the implementation of an interface from one ImplementationID to another then you must convert the data. If you remove an ImplementationID from a class, you should add a converter to strip the old data from the object, since the data would otherwise be carried around with the object indefinitely.

6.7.1.2.3. Renumbering an ImplementationID or ClassID

If an ImplementationID or ClassID changes, then you must register a converter so occurrences of the ImplementationID or ClassID in old documents can be updated. In practice, renumbering ClassIDs and ImplementationIDs is a source of a lot of bugs, and typically leads to corrupt documents, so we strongly recommend against renumbering.

6.7.1.3. Version Numbers

Every plug-in has a plug-in version resourceof the type `PluginVersion`. The `PluginVersion` resource appears in the boss definition file. The first entry of this resource describes the application's build number, on the realese build, it is the final release version number. The second entry of the resource is the plug-in's ID. Then it is followed by three sets of version numbers, then finally is an array of feature set IDs, If any one of the ids in this list matches the current feature set id, then the plug-in is loaded. For an example of the PluginVersion,

open any sample code .fr file, there is one defined for every plug-in. Each version number has a major number and a minor number. The first version number is the version of the plug-in, and gets updated for every release of the plug-in. The second version number appearing in the version resource is the version of the application the plug-in expects to run against. The application version number is used to make sure the user doesn't drop in a plug-in compiled for the 1.0 application into installation of the 2.0 application. The last version number is called the format version, and it is the version of the plug-in last having a change to the file format. This is the version number written into the document, and it is the number the `ConversionMgr` will check to see if conversion is required.

The third version number (the format version) will not always match the plug-in's version number, and in many cases will not change as often as the plug-in version number. The plug-in version number will change for every release of a plug-in, but the format version will only change if the data the plug-in stores in the document has changed and the ConversionManager is required to convert the data.

6.7.1.4. Adding a Converter

InDesign supports 2 types of service provider based data conversion, where converters are implemented as conversion services. The first type of InDesign converters is Schemas-based provider, the second type is code-based. Each plug-in may supply a conversion service, and the service is responsible for all conversions done by the plug-in. So a converter might be set up and at first only handle a single conversion (the conversion from the first format to the second). Later on, it may be necessary to change the format again, so another conversion would be added to the converter, to support converting from the second format to the third.

It is important to point out the Schemas-based converters are configured through resources, it is much easier to use schemas converters and it covers majority of format change need that a regular plug-in would require. The Schemas-based data conversion is discussed in great detail in the **Technical Note #10021, Schema-based Data Conversion**. Schema-based converison should be used whenever possible until it can't handle the special need of your plug-in.

Suppose you are working on a plug-in having persistent data, a "date-stamp" for instance. Imagine you had two releases - version 1 and 2 - of the date-stamp plug-in without changing the format. Now the available versions of the plug-in are version 1 and version 2, but both versions of the plug-in have the same format version - version 1. (Note the examples in this section all use a change in the minor version only, but the principles would remain the same for a change in major version number as well.) For the third version of the plug-in you need to add additional information - say a time stamp. So you would update the "format version number," or the last version numbers in the plug-in resource, to match the current plug-in number. For plug-in version 3 the format version would be 3 as well. Because you've made a change to the format version number, you need to create a converter that would convert from version 1 to version 3.

figure 6.7.1.4.a. versions of the date-stamp plug-in

Plug-in Version	Format Change	Format Version
1	New	1
2	No	1
3	Yes	3
4	Yes	4

For the fourth version of the plug-in, you again change the format (allowing a date-stamp to be "signed"). you then change the plug-in and format versions to version 4 and would add an additional converter capable of converting from version 3 to version 4. Conversions from version 1 to version 4 can now be done by the ConversionManager which would chain the converters together. (Use the first to convert from 1 to 3 and the second to convert 3 to 4.)

If you're working with the first format change for a plug-in you will have to add a converter (either schema or code based) to your plug-in (there can only be one converter per plug-in). This means adding a new boss, having two interfaces, `IK2ServiceProvider`, and `IConversionProvider`. `IK2ServiceProvider` should be implemented with `kConversionServiceImpl`, which is provided by the system. `IConversionProvider` is the part you will have to write. Here's an example boss:

```
/**
   This boss provides conversion service to the conversion manager
   to use the schema-based implementation.
*/
Class
{
  kCstPrfConversionProviderBoss,
  kInvalidClass,
  {
    /** Manages file format conversions between different versions
      of plug-ins. Implementation provided by the API.
    */
    IID_ICONVERSIONPROVIDER,    kSchemaBasedConversionImpl,
    /** Identify this boss as a conversion service.
      Implementation provided by the API.
    */
    IID_IK2SERVICEPROVIDER,     kConversionServiceImpl,
  }
},
```

Most of the work is done in the conversion provider. The interface for conversion provider provided in IConversionProvider.h

`CountConversions()` and `GetNthConversion()` are used by the conversion manager to find out what conversions are supported by the converter. If you are implementing a new converter, you would want `CountConversions()` to return 1, and `GetNthConversion()` would return with from`Version` set to the old version before your change, and to`Version` set to the new build having your change in it. `VersionID` is a data type in the Public library, it consists of the `pluginID`, the major format version number, and the minor format version number.

So for a new converter, the `fromVersion` should be `VersionID(yourPlugInID, kOldPersistMajorVersionNumber, kOldPersistMinorVersionNumber)`. The `toVersion` should be the new format version number.

Your new conversion is added as conversion index 0. So, for a new converter, it would look like this:

```
int32 TextConversionProvider::CountConversions() const
{
  return 1;
}

void TextConversionProvider::GetNthConversion(int32 i, VersionID
*fromVersion, VersionID *toVersion) const
{
  *fromVersion = VersionID(kTextPluginID,
  kOldPersistMajorVersionNumber, kOldPersistMinorVersionNumber);
  *toVersion = VersionID(kTextPluginID, kNewPersistMajorVersionNumber,
  kNewPersistMinorVersionNumber);
}
```

If you are adding it on to some existing change, the change numbers should chain together so the conversion manager can do changes across multiple formats. So if your plug-in has had three format changes, starting with build 1, then changed in 3 and 5, it should register a conversion handling 1 to 3, and a second handling 3 to 5. If necessary, the conversion manager can chain them together to convert a document from version 1 to version 5. So then the same two method would look as follows:

```
const int32 kFirstFormatVersion = 1;
const int32 kSecondFormatVersion = 3;
const int32 kThirdFormatVersion = 5;

const int32 kFirstChange = 0;
const int32 kNewChange = 1;

int32 TextConversionProvider::CountConversions() const
{
  return 2;
}

void TextConversionProvider::GetNthConversion(int32 i, VersionID
*fromVersion, VersionID *toVersion) const
{
  if (i == kFirstChange)
  {
    *fromVersion = VersionID(kTextPluginID, kMajorVersionNumber,
    kFirstPersistMinorVersionNumber);
    *toVersion = VersionID(kTextPluginID, kMajorVersionNumber,
    kSecondPersistMinorVersionNumber);
  }
  else if (i == kNewChange)
  {
    *fromVersion = VersionID(kTextPluginID, kMajorVersionNumber,
    kSecondPersistMinorVersionNumber);
    *toVersion = VersionID(kTextPluginID, kMajorVersionNumber,
    kThirdPersistMinorVersionNumber);
  }
}
```

Next, you have to tell the conversion manager which information you have actually changed. The `ConversionMgr` will call `ShouldConvertImplementation()` with each implementation in the document supplied by your plug-in. Depends on the data status of the implementation, you need to return `kMustConvert` when the content will be modified, `kMustRemove` when the data is obsolete and must be removed, or `kMustStrip` when the content will be stripped., and `kNothingToConvert` for all the rest. Let's suppose for this example it was `kTextFrameImpl`. You need to define a method for `ShouldConvertImplementation()` returning `kMustConvert` when the tag is `kTextFrameImpl`, and `kNothingToConvert` for all others. You want to do this when the conversion manager is doing your conversion, and not some other, so you need to check the conversion index and make sure it is the one you added. Here's how it might look:

```
IConversionProvider::ConversionStatus
TextConversionProvider::ShouldConvertImplementation(
ImplementationID tag, ClassID context,
int32 conversionIndex) const
{
  IConversionProvider::ConversionStatus status =
  IConversionProvider::kNothingToConvert;

  switch (conversionIndex)
  {
  case 0:
    if (tag == kTextFrameImpl)
      status = IConversionProvider::kMustConvert;
    break;
  default:
    break;
  }

  return status;
}
```

Next, you will need to implement `ConvertTag()` to do the actual conversion. Let's suppose TextFrame's `ReadWrite()` is used to write an `int` and a `real`, and you are adding a boolean. It might look like this:

```
ImplementationID TextConversionProvider::ConvertTag(
ImplementationID tag, ClassID forClass, int32 conversionIndex, int32
inLength,
IPMStream *inStream, IPMStream *outStream,
IterationStatus whichIteration)
{
  ImplementationID outTag = tag;
  switch (conversionIndex)
  {
  case 0:
    if (tag == kTextFrameImpl)
    {
      if (inLength > 0)
      {
        int32 passThruInt;
        inStream->XferInt32(passThruInt);
        outStream->XferInt32(passThruInt);

        int32 passThruReal;
        inStream->XferInt32(passThruReal);
        outStream->XferInt32(passThruReal);

        // Adding the new field
```

```
        bool16 smartQuotes = kTrue;
        outStream->XferInt32(smartQuotes);
      }
    }
    break;
  default:
    break;
  }
  return outTag;
}
```

This is what most converters will look like. If the converter needs to convert a class, then it can implement `ShouldConvertClass()` and `ConvertClass()`. This is necessary only if the class is being deleted, or it is a container for some other data (see section on containers below).

6.7.1.4.1. Removing Classes or Implementations

If you are removing a classID or an implementationID, then it needs to be removed from the documents as they are converted also. This can be done by converting to invalid, and the conversion manager will do the deletion for you. For example, to remove a tag, you could implement `ConvertTag()` as follows:

```
ImplementationID TextConversionProvider::ConvertTag(
  ImplementationID tag, ClassID forClass, int32 conversionIndex, int32
  inLength,
  IPMStream *inStream, IPMStream *outStream,
  IterationStatus whichIteration)
{
  ImplementationID outTag = tag;
  switch (conversionIndex)
  {
    case 0:
      if (tag == kTagToRemove)
        // kInvalidImpl is defined in the SDK
        outTag = kInvalidImpl;
      break;
    default:
      break;
  }
  return outTag;
}
```

Deleting a class is similar, just make ConvertClass return kInvalidClass.

6.7.1.4.2. Changing an Implementation in a Single Class

Let's suppose there is a boss defined which has an IBoolData interface, implemented as kPersistBoolTrue, meaning it defaults to true. You have changed it to kPersistBoolFalse. When you read in an old document with the new boss, you want it to use the new implementation. You can write a converter to take the data now stored out as kPersistBoolTrue, and switch it to be marked as kPersistBoolFalse. Then when you access the boss, it will have the old value. If you do not make a converter, the boss will not read in the old data, since there is no interface in the new boss using the kPersistBoolTrue ImplementationID. Instead, it will look for kPersistBoolFalse, but it won't find it because the old boss didn't have it. So the value, instead of being the old value, will be false because it is the default value.

To change the ImplementationID of the data in the pub, you have to make a conversion to catch the old ImplementationID, and change it to the new one. You want to do it for your boss only -- you don't want to change other bosses using kPersistBoolTrue, which means the ConvertData might look as follows:

```
ImplementationID TextConversionProvider::ConvertTag(
  ImplementationID tag, ClassID forClass, int32 conversionIndex, int32
  inLength,
  IPMStream *inStream, IPMStream *outStream,
  IterationStatus whichIteration)
{
  ImplementationID outTag = tag;
  switch (conversionIndex)
  {
    case 0:
      if (tag == kPersistBoolTrue && forClass == kMyBoss)
        outTag = kPersistBoolFalse;
      bool16 theBool;
      inStream->XferBool(theBool);
      outStream->XferBool(theBool);
      break;
    default:
      break;
  }
  return outTag;
}
```

forClass is the boss the data was found in. The conversion should be done only if `forClass` is the one you want changed.

You will also have to implement ShouldConvertImplementation. *forClass* is the class the data was found in, or it is kInvalidClass if any class should match. So the implementation of ShouldConvertImplementation is:

```
IConversionProvider::ConversionStatus
TextConversionProvider::ShouldConvertImplementation(
ImplementationID tag, ClassID forClass,
int32 conversionIndex) const
{
  IConversionProvider::ConversionStatus status =
  IConversionProvider::kNothingToConvert;

  switch (conversionIndex){
    case 0:
      if (tag == kTextFrameImpl &&
       (forClass == kMyBoss || forClass == kInvalidClass))
        status = IConversionProvider::kMustConvert;
      break;
    default:
      break;
    }

  return status;
}
```

6.7.1.4.3. Containers and Embedded Data

Any plug-in having implementations embeding data from other plug-ins must call the content tracker, so the data embedded is registered with the content manager. It must register a container conversion, so converters for the embedded data have a chance to get activated.

InDesign does not have very many instances of containers. One example of where the host uses containers is in the text attribute code. A text style is a UID-based boss object containing an implementation called TextAttributeList. A TextAttributeList contains a list of attribute bosses (these could be Bold, Point Size, Leading, etc.). These attribute bosses are not UID-based bosses: instead, TextAttributeList streams out the ClassID for a boss, followed by the boss's data, then streams out the next boss in the list. TextAttributeList therefore must call the stream's content tracker to notify the content manager a new class was added to the pub. Why is this important?

Let's suppose a new "red-line text" plug-in adds an attribute to the style, and the text will not compose correctly if "red-line" is pulled out. "Red-line" can list the attribute as critical, so the host will put up a strongly worded warning when the user tries to open up the document without the "red-line" plug-in. But if TextAttributeList doesn't register the attribute boss with the content manager, the application will never know that the attribute is in the pub, and it will not be able to warn the user. Or suppose the "red-line" plug-in is updated, and the attribute boss in particular is updated to store its data differently. The "red-line" registers a converter handling the format change. If the host doesn't know the attribute appears in the pub, "red-line" will never be called to convert. The document will appear to open correctly, but will crash on the attribute's `ReadWrite()` method the first time the style is read in.

In fact, in order for the "red-line" attribute to be converted, `TextAttributeList` must register a converter. If the content manager was notified when the attribute was streamed out, the `ConversionMgr` will know that the attribute needs to be converted. It will even know that the attribute was streamed out by TextAttributeList. But the conversion manager has no way of knowing where the attribute is, inside the data streamed out by TextAttributeList. So TextAttributeList should register a converter which calls back to the conversion manager to convert each piece of embedded data. Otherwise the embedded data will not be converted.

6.7.1.5. Content Manager

The host has a content manager that keeps track of what data is stored in the document, which plug-in stored it, and the format version number of the plug-in that was last used to write the data.

Think of this as a table that is attached to the root of the document:

figure 6.7.1.5.a. version information table

ImplementationID	Plug-in ID	Format version number (Only showing minor #)
kSpreadImpl	kSpreadPluginID	0
kSpreadLayerImpl	kLayerPluginID	0
kTextAttrAlignJustImpl	kTextAttrPluginID	1
kCMSProfileListImpl	kColorMgmtPluginID	3
...		

Every ImplementationID part of the document appears in the table.

This table also includes all the ClassIDs in the document:

figure 6.7.1.5.b. class ids

ClassID	Plug-in ID	Format version number (Only showing minor #)
kSpreadBoss	kSpreadPluginID	1
kSpreadLayerBoss	kLayerPluginID	1
kTextAttrAlignBodyBoss	kTextAttrPluginID	3
kDocBoss	kDocFrameworkPluginID	1

When an object is streamed to a document, the document receives the classID of the object, and the data streamed out by each of the object's `ReadWrite()` methods. The data written out by a `ReadWrite()` method is marked with the `ImplementationID` of the `ReadWrite()`, so when it is later read in, the system will know what C++ class to instantiate in order to read in the data. The ContentMgr maintains an overall list of the ClassIDs and ImplementationIDs used in the document. When a new ClassID or ImplementationID is added to the document, the ContentMgr looks to see what plug-in supplied the ClassID or ImplementationID, notes the plug-in ID and the format version number, and adds the new entry to the table.

The plug-in supplying a ClassID is the one supplying the class definition. Only the plug-in supplying the original class definitions is considered: add-in classes do not count. The plug-in supplying an ImplementationID is the one that registered a factory for the ImplementationID (by using the `CREATE_PMINTERFACE` macro).

This data is used for detecting missing plug-ins, and for managing document conversion. When the user opens a document containing data supplied by a missing plug-in, the host puts up an alert warning the user the document contains data from a missing plug-in . The host can detect missing plug-ins by looking in the content manager to see which plug-ins supplied data to the document, and then it can check this list against the list of currently running plug-ins to see if any are missing.

It is also used for document conversion. When the user opens a document, the `ConversionMgr` checks the format version number of the plug-ins supplying data to the document, and compares it against the format version number of the currently running plug-ins. Any mismatch, as noted above, means a conversion is required before the pub can be opened. If there is a format version change without a supplied data converter, then the document will not open.

The ContentMgr also keeps track of where the data appears in the document. For every ImplementationID, the ContentMgr keeps a list of the classes the ImplementationID appears in. This way, if an ImplementationID updates, the `ConversionMgr` can quickly identify all the objects in the pub needing convertion, rather than converting the entire document for a single change.

figure 6.7.1.5.c.

ImplementationID	Containing ClassID
kSpreadImpl	kSpreadBoss,kMasterPagesBoss
kSpreadLayerImpl	kSpreadLayerBoss
kTextAttrAlignJustImpl	kTextAttrAlignSingleBoss
kCMSProfileListImpl	kWorkspaceBoss, kDocWorkspaceBoss

6.7.1.6. Content Tracker

The content tracker is an interface attached to the database write stream. It keeps track of the classes and implementations streamed out to the database, and calls back to the content manager. This is how the content manager is notified of additions to the document.

Most additions to the document are registered automatically by either the database or PMPersist. The database registers the ClassID of every UID created in the document with the content tracker. PMPersist, for example, is the interface handling persistence for UID-based objects. It calls each interface in turn to stream out, and as part of this process, it calls the content manager to let it know each implementation is streamed out.

If an object streams out a ClassID or ImplementationID in its ReadWrite, then it also has to call the content tracker to register the ClassID or ImplementationID streamed out. Most objects do not do this. However, for

those that do, it is critical they call the content tracker to register the data with the content manager. If it is not done, then the host will not notice when the plug-in is missing or needs to be converted.

There aren't many places in the application streaming out ClassIDs or ImplementationIDs. But, for instance, the attribute streaming code does it when a boss is streamed out as part of an attribute boss list. The attribute list streams out the ClassID, the number of interfaces, the ImplementationID, length, and data for each interface. The ClassID and ImplementationID streamed out are registered with the content manager.

As another example, let's suppose there is an object having a ClassID as part of its data, and the ClassID is an algorithm necessary for redrawing the object. The object must register the ClassID with the content manager, so users are warned when they open the document the plug-in is missing (and therefore some objects may not redraw correctly).

Here's an example of how to do this:

```
void Foo::ReadWrite(IPMStream* stream, ImplementationID prop)
{
  InterfacePtr<IContentTracker> contentTracker(stream,
  IID_ICONTENTTRACKER);

  //_____________________________________________________________________
  //Write out the render object meta data.
  //_____________________________________________________________________
  stream->XferInt32 ((int32&)fFillRenderObjectClass);
  stream->XferInt32 ((int32&)fStrokeRenderObjectClass);
  if (contentTracker != nil)
  {
    contentTracker->AddClass(fFillRenderObjectClass, kFooImpl);
    contentTracker->AddClass(fStrokeRenderObjectClass, kFooImpl);
  }
}
```

It is important to check for a nil contentTracker, since the only stream having one now is the database write stream. For streaming to memory, for instance, there is no content tracker.

In fact, the XferID() method of the IPMStream call the content tracker to register the class ID for you, which effectively does the above exactly for you. For details, please refer to CStreamWrite::XferID() of the CStreamWrite.cpp in the SDK

6.7.1.7. Conversion Manager

When a document is opened, the conversion manager is called to check to see if any of the data in the pub requires conversion. If it does, then the pub is converted, and opens as untitled. If a converter cannot be found, the host puts up an alert warning the user the pub cannot be opened because it cannot be converted.

This initial check, implemented in `ConversionMgr::GetStatus()`, happens very early in the open, before any of the objects in the pub are accessed (i.e., before any of their `ReadWrite()` methods are called). This is critical, because the `ReadWrite()` will not succeed if the object needs to be converted. The conversion manager accesses the content manager (converting it if necessary), and uses the content manager to find out what plug-ins supplied data to the document. If any of the plug-ins used in the document have different formats than the formats of the currently running plug-ins, conversion will be necessary. Then the conversion manager looks to see if there is a conversion service to convert from the format in the document to the currently running format. If there is, then conversion is possible. At this time, the document may be closed, and opened again as untitled.

If `GetStatus()` returns stating the conversion is not necessary, the open proceeds without calling the conversion manager again. If `GetStatus()` returns stating the conversion is not possible, the open is aborted. If `GetStatus()` returns conversion is required, then the conversion manager's `ConvertDocument()` method is called to actually do the conversion.

The first thing `ConvertDocument()` does is to compile a list of the actual classes and implementations in the document needing to be converted. A plug-in may have many different implementations that added data to the pub, but it may be that only one of these requires conversion. The conversion manager uses the content manager to iterate over classes and implementations supplied by the plug-in, and calls the converter to find out which ones require conversion. Any class or implementation in the pub, and that the converter says must be

converted, is added to the list of classes or implementations to be converted.Other data added by the plug-in is ignored by the converter: it will not be converted.

The next step is to iterate over the UIDs in the pub. For each UID, the conversion manager gets the class of the UID. If the class is on the list of classes to be converted, then the conversion manager calls a converter for the class. If, as is more common, the class contains an implementation needing to be converted, then the conversion manager opens up an input stream on the UID, and iterates through the implementations in the UID. If there is any implementation in the UID requiring conversion, an output stream is opened on the UID. The conversion manager uses the input stream to iterate over the implementations in the UID. Any implementation not requiring conversion, is copied to the output stream. If an implementation does require conversion, its converter is called. The converter gets passed the input stream and the output stream. It reads from the input stream in the old format, and writes to the output stream in the new format.

Once the UID iteration is completed, then the content manager is called to update the format numbers for all the plug-ins that were outdated, to show their data was converted and is up to date. It is now safe for `ReadWrite()` methods to be called on objects in the document.

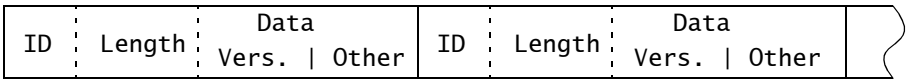
If any converter requires access to another object in order to do its conversion, it is called now in the last phase of conversion. For example, suppose up to now, there was a single document wide preference for whether text in frames has smart quotes turned on, but we would like to make this a per frame setting. The text frame needs to store a new flag for smart quotes on/off. The converter adds a new flag in the first phase of conversion, but it can't set the correct value for the flag until the preferences is converted. So the converter needs to get called once again, after the first phase is complete and it is safe to instantiate the preferences, to get the value of the document-wide smart quotes setting so it can set the frame's new smart setting correspondingly.

6.7.2. Conversion without the ConversionManager

It is possible to do conversion without the ConversionManager, and to gain forward compatibility at the same time by using the persistent data itself to identify which version of the plug-in had written the information.

Since the ConversionManager won't be used with this method, there still needs to be some method of determining which version of the plug-in last wrote the data to the database. The recommended way to do this is to add a version number to the implementation classes, so the first thing written out by the `ReadWrite()` method would be the version number.

figure 6.7.2.a. persistent data with version number



Using this approach the `ReadWrite()` method would be implemented in the first version of a plug-in to have a version number.

Imagine you have written a plug-in needing to store two byte values, `fOne` and `fTwo`. Additionally you have chosen to use a byte value to store the data's version number. The `ReadWrite()` method for this implementation would be much like seen in the following code.

figure 6.7.2.b. readwrite method supporting multiple versions (version 1 of the plug-in)

```
FooStuff::ReadWrite(IPMStream * stream, ImplementationID
implementation)
{
  stream->XferByte(0x01);
  stream->XferByte(fOne);
  stream->XferByte(fTwo);
}
```

For the second version of the same plug-in, you need to add a 16 bit integer value (`fThree`). In the second version of the plug-in, what you are trying to accomplish is to read either the version one or version two information, but always write the version two information.

figure 6.7.2.c. readwrite method supporting multiple versions (version 2 of the plug-in)

```
FooStuff::ReadWrite(IPMStream * stream, ImplementationID
implementation)
{
  uchar version = 0x02; //Always *write* version 2 data
  stream->XferByte(version);
  if (version == 0x01)
  {

    stream->XferByte(fOne);
    stream->XferByte(fTwo);
  }
  else
  {
    stream->XferByte(fOne);
    stream->XferByte(fTwo);
    stream->XferInt16(fThree);
  }
}
```

Notice the code above still does the work for both reading and writing all of the data for this implementation. It would, of course, be possible to check whether the stream is a reading or writing stream, and then to proceed based on this information - but the code above is actually simpler, and accomplishes the same thing. If the stream is a ReadStream, then version is initialized as 0x02, but it is immediately replaced by the contents of the first byte in the stream, and the rest of the stream is processed according to the version number found. If this plug-in should encounter data claiming a version number of greater than 2, then only the data it understands (processed by the else-clause) would be read. This method allows the version 2 plug-in to work with data from both versions before it and after. Each new version of the plug-in using this methodology must preserve the portion of the stream previous versions created and only add new information to the end.

When using this approach the plug-in's "data version number"will not change between versions of the plug-in. The data version number should only change if a data converter is being supplied to convert the data from one version to another.

6.8. Summary

This chapter outlined how persistence is implemented in the application and how it can be used in plug-ins to store object data. The application's databases are discussed, and how objects in those databases are used and manipulated.

6.9. Review

You should be able to answer these questions:

1. How does the application store its data? (6.3.2., page 174)
2. How is an object made persistent? (6.4.2., page 181)
3. How is a persistent object referenced? (6.4.1.3., page 180)
4. What is a stream? (6.5., page 183)
5. How do I create a new stream? (6.5.3., page 184)

6.10. References

Adobe InDesign SDK. Technical Note #10021, Schema-based Data Conversion. See `Adobe InDesign SDK/Documentation/Documentation/DataConversion.pdf`.

7.

Service Providers

7.0. Overview

This chapter describes the service provider architecture of Adobe InDesign and shows how to use it.

7.1. Goals

The questions this chapter answers are:

1. What are the major components of the service provider architecture?
2. What is the interaction between a service provider and the application?
3. How do you implement a service provider for your plug-in?

7.2. Chapter-at-a-glance

"7.3.Architecture" on page 210 defines the service provider mechanism and describes the interaction between a service provider and the application.

"7.4.Implementation details" on page 212 lists the types of service providers and discusses some of the interfaces used to implement them.

"7.5.Recipes for common service providers" on page 227 provides sample code for selected service providers.

"7.6.Summary" on page 236 recaps everything presented in this chapter.

table 7.2.a. version history

Rev	Date	Author	Notes
2.0	23-Oct-02	Lee Huang	Update content for InDesgn 2.x API
0.1	1-Jan-00	Rodney Cook	First Draft

"7.7.Review" on page 236 presents some questions to determine whether you have assimilated the information adequately to progress.

"7.8.References" on page 236 cites sources of additional information.

7.3. Architecture

The service provider architecture supplies a mechanism by which functionality (a service) created in one plug-in can be made readily available to all plug-ins at runtime.

7.3.1. What is a service provider

The feature distinguishing a boss as a service provider is it does not just provide functionality, but it follows InDesign procedures for categorizing, storing, finding and implementing this functionality.

As a service provider, a boss registers at startup as providing a category of functionality. This information is recorded in a central location. At runtime, a plug-in needing a particular type of functionality (for example, the ability to import and place a TIFF) can quickly look to this central location to see whether the service it needs is available.

Briefly, the components of the service provider mechanism are:

- the categories of service providers are specified by service IDs (ServiceID)
- the central location is the service registry (IK2ServiceRegistry)
- the services identified by service ID are provided by the service provider (IK2ServiceProvider).
- the controlling mechanism is the service manager (IK2ServiceMgr)

In the following sections, the components of the service provider mechanism are discussed in detail

7.3.2. What is the service registry?

The application service registry provides a globally accessible container for any boss object registered as providing a service (for example, an import filter), through a service provider (IK2ServiceProvider).

During startup of the application, the service registry automatically finds and registers all services. This is done by iterating through the object model and registering every boss having an IK2ServiceProvider interface.

7.3.3. What is a service ID?

ServiceIDs have the same form as all other application ID-space values (ClassIDs, IIDs, etc.). A ServiceID is unique to a type of service (for example, kTextEngineService), not to a particular service provider. There can be multiple objects providing the same type of service.

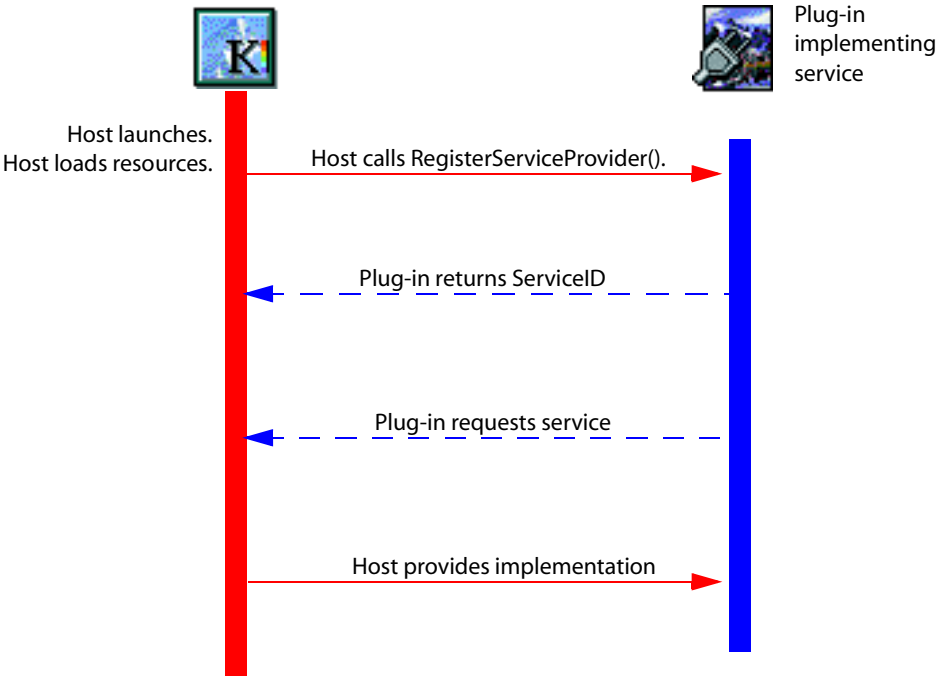
7.3.4. Interaction between service provider and application

The session has an IK2ServiceRegistry interface, which gives access to all service provider bosses. At startup, each service provider is registered with the service registry using a call iterating through the object model and collects these service providers into a list.

Each IK2ServiceProvider interface is instantiated to determine what ServiceID the boss supports, whether it should be the default provider, and whether the service provider should be instantiated once per session and shared by subsequent request or whether a new instantiation should be created for each request.

Nothing further happens then until a service user asks for either a particular service or the default service. Then, the service manager retrieves the boss for the requested service.

figure 7.3.4.a. life cycle diagram



7.4. Implementation details

This section lists the types of service providers and discusses some of the interfaces used to implement them.

7.4.1. Types of service providers

SnipInspectServiceProviders.cpp generate a list of service IDs supported by InDesign. It also output useful information like the name of the service provider boss, interfaces on the boss, instantiation policy.

Listed below are service IDs used by InDesign. Indented below each service ID are the implementation IDs for each service provider returning the service ID.

figure 7.4.1.a. service IDs and the implementation IDs returning them.

```
kActionFilterService
Used where...
kActionFilterProviderImpl

kActionRegisterService
```

```
Used where...
kActionRegisterProviderImpl

kAddEmbedUndoRedoSignalResponderService
Used where...
kAddEmbedUndoRedoSignalRespServiceImpl

kAddExtraLinkUndoRedoSignalResponderService
Used where...
kAddExtraLinkUndoRedoSignalRespServiceImpl

kAddLinkUndoRedoSignalResponderService
Used where...
kAddLinkUndoRedoSignalRespServiceImpl

kAddLinksUndoRedoSignalResponderService
Used where...
kAddLinksUndoRedoSignalRespServiceImpl

kAfterAddEmbedSignalResponderService
Used where...
kAfterAddEmbedSignalRespServiceImpl

kAfterAddExtraLinkSignalResponderService
Used where...
kAfterAddExtraLinkSignalRespServiceImpl

kAfterAddLinkSignalResponderService
Used where...
kAfterAddLinkSignalRespServiceImpl

kAfterAddLinksSignalResponderService
Used where...
kAfterAddLinksSignalRespServiceImpl

kAfterAttachDataLinkSignalResponderService
Used where...
kAfterAttachDataLinkSignalRespServiceImpl

kAfterCloseDocSignalResponderService
Used where...
kAfterCloseDocSignalRespServiceImpl

kAfterMoveLinkSignalResponderService
Used where...
kAfterMoveLinkSignalRespServiceImpl

kAfterNewDocSignalResponderService
Used where...
kAfterNewDocSignalRespServiceImpl
```

```
kAfterOpenDocSignalResponderService
Used where...
kAfterOpenDocSignalRespServiceImpl, kMetaDataResponderImpl

kAfterRefreshLinkSignalResponderService
Used where...
kAfterRefreshLinkSignalRespServiceImpl

kAfterRemoveEmbedSignalResponderService
Used where...
kAfterRemoveEmbedSignalRespServiceImpl

kAfterRemoveLinksSignalResponderService
Used where...
kAfterRemoveLinksSignalRespServiceImpl

kAfterRestoreLinkSignalResponderService
Used where...
kAfterRestoreLinkSignalRespServiceImpl,
kXMLLinksChangedResponderImpl

kAfterRevertDocSignalResponderService
Used where...
kAfterRevertDocSignalRespServiceImpl

kAfterSaveACopyDocSignalResponderService
Used where...
kAfterSaveACopyDocSignalRespServiceImpl

kAfterSaveAsDocSignalResponderService
Used where...
kAfterSaveAsDocSignalRespServiceImpl

kAfterSaveDocSignalResponderService
Used where...
kAfterSaveDocSignalRespServiceImpl

kAfterSetLinkURLSignalResponderService
Used where...
kAfterSetLinkURLSignalRespServiceImpl,
kXMLLinksChangedResponderImpl,
kXMLWFSignalRespServiceImpl

kAfterUpdateLinkSignalResponderService
Used where...
kAfterUpdateLinkSignalRespServiceImpl

kAlertHandlerService
Used where...
```

```
kCAlertHandlerProviderImpl

kAppStartupShutdownService
Used where...
kCStartupShutdownProviderImpl, kDrawServiceImpl,
kServiceRegistryImpl, kIMEServiceProvider,
kACEStartupServiceImpl, kGradGfxStateServiceProviderImpl,
kGraphicStateServiceProviderImpl, kAutoLayoutServiceProviderImpl,
kLibraryPanelMgrSSServiceImpl, kXPPrintSetupServiceImpl

kApplyMasterSignalResponderService
Used where...
kApplyMasterSignalRespServiceImpl

kAttachDataLinkUndoRedoSignalResponderService
Used where...
kAttachDataLinkUndoRedoSignalRespServiceImpl

kBeforeAddEmbedSignalResponderService
Used where...
kBeforeAddEmbedSignalRespServiceImpl

kBeforeAddExtraLinkSignalResponderService
Used where...
kBeforeAddExtraLinkSignalRespServiceImpl

kBeforeAddLinkSignalResponderService
Used where...
kBeforeAddLinkSignalRespServiceImpl

kBeforeAddLinksSignalResponderService
Used where...
kBeforeAddLinksSignalRespServiceImpl

kBeforeAttachDataLinkSignalResponderService
Used where...
kBeforeAttachDataLinkSignalRespServiceImpl

kBeforeCloseDocSignalResponderService
Used where...
kBeforeCloseDocSignalRespServiceImpl, kMetaDataResponderImpl

kBeforeMoveLinkSignalResponderService
Used where...
kBeforeMoveLinkSignalRespServiceImpl

kBeforeNewDocSignalResponderService
Used where...
kBeforeNewDocSignalRespServiceImpl, kWFOpenDocResponderImpl
```

```
kBeforeOpenDocSignalResponderService
Used where...
kBeforeOpenDocSignalRespServiceImpl, kWFOpenDocResponderImpl

kBeforeRefreshLinkSignalResponderService
Used where...
kBeforeRefreshLinkSignalRespServiceImpl

kBeforeRemoveEmbedSignalResponderService
Used where...
kBeforeRemoveEmbedSignalRespServiceImpl

kBeforeRemoveLinksSignalResponderService
Used where...
kBeforeRemoveLinksSignalRespServiceImpl

kBeforeRestoreLinkSignalResponderService
Used where...
kBeforeRestoreLinkSignalRespServiceImpl

kBeforeRevertDocSignalResponderService
Used where...
kBeforeRevertDocSignalRespServiceImpl

kBeforeSaveACopyDocSignalResponderService
Used where...
kCompFontSaveACopyDocResponderImpl,
kBeforeSaveACopyDocSignalRespServiceImpl,
kMetaDataResponderImpl

kBeforeSaveAsDocSignalResponderService
Used where...
kBeforeSaveAsDocSignalRespServiceImpl, kMetaDataResponderImpl

kBeforeSaveDocSignalResponderService
Used where...
kBeforeSaveDocSignalRespServiceImpl, kMetaDataResponderImpl

kBeforeSetLinkURLSignalResponderService
Used where...
kBeforeSetLinkURLSignalRespServiceImpl

kBeforeUpdateLinkSignalResponderService
Used where...
kBeforeUpdateLinkSignalRespServiceImpl

kBeginXReferenceSessionRespService
Used where...
kBeginStyleRefConvSessionRespServiceImpl
```

```
kCMSService
Used where...
kACECMSManagerServiceImpl

kCMSStartupSignalRespService
Used where...
kCMSPrintServiceImpl

kColorPickerPanelService
Used where...
kColorPickerPanelImpl, kColorPickerWidgetServiceImpl,
kLabColorPickerWidgetService

kColorSpaceMgrService
Used where...
kACEColorSpaceMgrServiceImpl

kContentIteratorRegisterService
Used where...
kContentIteratorRegisterServiceImpl

kConversionService
Used where...
kConversionServiceImpl

kDUDCopyConverterService
Used where...
kDUDCopyConverterProviderImpl

kDeleteCleanupService
Used where...
kDeleteCleanupProviderImpl

kDeleteParaStyleRespService
Used where...
kDeleteParaStyleRespServiceImpl

kDeleteStoryRespService
Used where...
kDeleteStoryRespServiceImpl

kDeleteTextRespService
Used where...
kDeleteTextRespServiceImpl

kDocIterationService
Used where...
kDocIterationServiceImpl

kDrawEventService
```

```
Used where...
kCJKGridPrintingDrawServiceImpl, kCJKLayoutGridDrawServiceImpl,
kColorMapDrwEvtServiceImpl, kHyperlinkDrawEventServiceImpl,
kPreviewNonPrintDrawServiceImpl, kReferencePointDrawServiceImpl,
kMasterPageDrawEventServiceImpl, kMasterPageHitTestServiceImpl,
kMasterPageInvalServiceImpl, kMasterPageIterateServiceImpl,
kColumnGuideHitTestServiceImpl, kPageShapeDrawServiceImpl,
kTaggedFramesDrawServiceImpl, kFrameThreadDrawServiceImpl,
kXPDrwEvtServiceImpl

kDuplicateSpreadSignalResponderService
Used where...
kDuplicateSpreadSignalRespServiceImpl

kDuringNewDocSignalResponderService
Used where...
kDuringNewDocSignalRespServiceImpl, kAutoLayoutDocResponderImpl,
kMetaDataResponderImpl, kHyphExceptionDocResponderImpl,
kScotchRulesNewDocResponderImpl, kTOCNewDocResponderImpl,
kWFOpenDocResponderImpl

kDuringNewScrapDocSignalResponderService
Used where...
kDuringNewScrapDocSignalRespServiceImpl

kDuringOpenDocSignalResponderService
Used where...
kDuringOpenDocSignalRespServiceImpl, kAutoLayoutDocResponderImpl,
kHyphExceptionDocResponderImpl, kScotchRulesNewDocResponderImpl,
kWFOpenDocResponderImpl

kDuringSaveACopyDocSignalResponderService
Used where...
kDuringSaveACopyDocSignalRespServiceImpl

kEasterEggService
Used where...
kSVGExportTestMenuImpl, kMandelbrotEggImpl,
kTextWalkerServiceProviderImpl

kEdgeAlignmentService
Used where...
kKFKerningOnTheFlyImpl, kPairKernOffServiceImpl

kEditCmdPostProcessService
Used where...
kTextPreProcessService

kEditCmdPreProcessService
Used where...
```

```
kPageNumEvenOddnessChangeResponderImpl

kEncodingConverterService
Used where...
kEuropeanEncodingMacToWinServiceProviderImpl,
kEuropeanEncodingWinToMacServiceProviderImpl

kEndPDFDocumentSignalResponderService
Used where...
kEndPDFDocumentSignalResponderServiceImpl

kEndPDFPageSignalResponderService
Used where...
kEndPDFPageSignalResponderServiceImpl

kEndXReferenceSessionRespService
Used where...
kEndStyleRefConvSessionRespServiceImpl

kErrorStringService
Used where...
kErrorStringProviderImpl

kExportBookService
Used where...
kExportBookServiceImpl

kExportProviderService
Used where...
kExportServiceImpl

kFindChangeParaDlgService
Used where...
kFindChangeParaDlgService

kGenStlEdtEditorService
Used where...
kRomanOnlyPairKernServiceImpl

kGenericDataLinkService
Used where...
kIndexDataLinkProviderImpl, kIndexDataLinkServiceImpl,
kTOCDataLinkProviderImpl, kTOCDataLinkServiceImpl

kGlobalTextAdornmentService
Used where...
kStripCharServiceProviderImpl

kIDataLinkService
Used where...
```

```
kDataLinkServiceImpl

kISuiteRegisterService
Used where...
kCSuiteRegisterProviderImpl

kImageReadFormatService
Used where...
kDIBImageReadFormatServiceImpl, kGIFImageReadFormatServiceImpl,
kJPEGImageReadFormatServiceImpl, kPCXImageReadFormatServiceImpl,
kPNGImageReadFormatService, kPSImageReadFormatService,
kSCTImageReadFormatServiceImpl, kTIFFImageReadFormatServiceImpl,
kDfltImageReadFormatService

kImageWriteFormatService
Used where...
kGIFImageWriteFormatServiceImpl, kJPEGImageWriteFormatServiceImpl,
kSCTImageWriteFormatServiceImpl, kTIFFImageWriteFormatServiceImpl

kImportManagerService
Used where...
kImportMgrServiceImpl

kImportProviderService
Used where...
kTaggedTextImportServiceProvider, kMultiLinkPlaceServiceImpl,
kImportServiceImpl, kDCSPlaceServiceImpl, kEPSPlaceServiceImpl

kIndexingHeaderSetHandlerService
Used where...
kIndexDataLinkServiceImpl

kKerningOnTheFlyService
Used where...
kKFPairKernServiceImpl

kKitRegisterService
Used where...
kKitRegisterProviderImpl

kLayoutActionService
Used where...
kLayoutActionProviderImpl

kLayoutDDSrcContentHelperService
Used where...
kLayoutDDSrcHelperProviderImpl

kLayoutDDTargetFlavorHelperService
Used where...
```

```
kLayoutDDTargHelperProviderImpl

kLibraryItemGridDDTargetFlavorHelperService
Used where...
kLibraryItemGridDDTHelperProviderImpl

kLibraryNewButtonDDTargetFlavorHelperService
Used where...
kLibraryNewButtonDDTHelperProviderImpl

kLibraryServiceID
Used where...
kLibraryServiceProviderImpl

kLinguisticManagerService
Used where...
kLinguisticMgrServiceImpl

kLinguisticService
Used where...
kCJKLinguisticProviderImpl, kLinguisticMgrImpl,
kLinguisticServiceProviderImpl, kProxServiceProvider

kLinksChangedSignalService
Used where...
kLinksChangedSignalServiceImpl, kXMLLinksChangedResponderImpl

kMangleObjectServiceID
Used where...
kMangleObjectServiceProviderImpl

kMenuFilterService
Used where...
kMenuFilterProviderImpl

kMenuRegisterService
Used where...
kMenuRegisterProviderImpl

kMergeStoriesSignalService
Used where...
kDeleteTextRespServiceImpl

kMetaDataOpsService
Used where...
kMetaDataOpsProviderImpl, kMetaDataResponderImpl

kMoveLinkUndoRedoSignalResponderService
Used where...
kMoveLinkUndoRedoSignalRespServiceImpl
```

```
kNewPISignalResponderService
Used where...
kNewPISignalRespServiceImpl

kNewStorySignalResponderService
Used where...
kJSingleServiceImpl, kNewStorySignalRespServiceImpl

kNewWorkspaceSignalResponderService
Used where...
kNewWorkspaceSigRespServiceImpl

kOpenLayoutSignalServiceID
Used where...
kLayoutSelectFilterServiceImpl

kOpenManagerService
Used where...
kOpenMgrServiceImpl

kOpenProviderService
Used where...
kOpenServiceImpl

kPageItemDDTargetFlavorHelperService
Used where...
kPageItemDDTargetHelperProviderImpl

kPageItemDataExchHandlerHelperService
Used where...
kPageItemDataExchHandlerHelperProviderImpl

kPageItemScrapSuitePasteHelperService
Used where...
kPageItemScrapSuitePasteHelperProviderImpl

kPageNumEvenOddnessChangeSignalResponderService
Used where...
kNewStorySignalRespServiceImpl

kPairKerningService
Used where...
kTextAttrPairKernMethodBossImpExpImpl,
kTIFFImageWriteFormatServiceImpl,
kIndexingHSHandlerServiceImpl,
kGlobalTextAdornmentServiceImpl

kPaletteFactoryService
Used where...
```

```
kFloatingTabPaltFactoryServImpl, kPaletteFactoryServiceImpl

kPaletteMgrService
Used where...
kBookPanelPaletteServiceProviderImpl,
kDTTPaletteServiceProviderImpl

kPanelRegisterService
Used where...
kCPanelRegisterProviderImpl

kPathCornerService
Used where...
kPathCornerServiceProviderImpl

kPathEndStrokerService
Used where...
kPathEndStrokerServiceProviderImpl

kPathStrokerService
Used where...
kPathStrokerServiceProviderImpl

kPhase2ConversionSignalResponderService
Used where...
kPhase2ConvSignalRespServiceImpl

kPlaceGunServiceID
Used where...
kPlaceGunServiceImpl

kPrintInsertPSProcService
Used where...
kInsertPSProcServiceImpl

kPrintSetupService
Used where...
kCMSPrintServiceImpl, kPrintGradientSetupServiceImpl,
kThumbnailServiceImpl, kPreflightButtonServiceImpl,
kXPDrwEvtServiceImpl

kRasterPortSetupService
Used where...
kACERasterPortSetupServiceImpl

kReferenceConverterService
Used where...
kReferenceConverterProviderImpl

kRemoveEmbedUndoRedoSignalResponderService
```

```
Used where...
kRemoveEmbedUndoRedoSignalRespServiceImpl

kRemoveLinksUndoRedoSignalResponderService
Used where...
kRemoveLinksUndoRedoSignalRespServiceImpl

kRenderingObjectService
Used where...
kRenderClassProviderImpl

kRestoreLinkUndoRedoSignalResponderService
Used where...
kRestoreLinkUndoRedoSignalRespServiceImpl

kScriptMgrProviderService
Used where...
kScriptManagerServiceImpl

kScriptProviderService
Used where...
kScriptServiceImpl

kSelectionFilterService
Used where...
kLayoutSelectFilterServiceImpl

kSelectionService
Used where...
kSelectionServiceProviderImpl

kService_PageSizes
Used where...
kPageSizesService

kService_SectionStyles
Used where...
kSectionStylesService

kService_UnitOfMeasure
Used where...
kAPUnitOfMeasureServiceImpl, kHaUnitOfMeasureServiceImpl,
kQUnitOfMeasureServiceImpl, kDfltUnitOfMeasureServiceImpl,
kUnitOfMeasureService, kCustomUnitOfMeasureServiceImpl

kSetLinkURLUndoRedoSignalResponderService
Used where...
kSetLinkURLUndoRedoSignalRespServiceImpl

kShortcutContextService
```

```
Used where...
kShortcutContextProviderImpl

kShutdownNotificationService
Used where...
kShutdownNotificationProviderImpl

kSnapToService
Used where...
kSnapToServiceProviderImpl

kStartPDFDocumentSignalResponderService
Used where...
kStartPDFDocumentSignalResponderServiceImpl

kStartPDFPageSignalResponderService
Used where...
kStartPDFPageSignalResponderServiceImpl

kStringRegisterService
Used where...
kCStringRegisterProviderImpl

kStripCharService
Used where...
kStripCharServiceProviderImpl

kStyleSyncService
Used where...
kStyleSyncProviderImpl

kSysFileDataExchHandlerHelperService
Used where...
kSysFileDataExchHandlerHelperProviderImpl

kTableDataExchHandlerHelperService
Used where...
kTableDataExchHandlerHelperProviderImpl

kTableScrapSuitePasteHelperService
Used where...
kTableScrapSuitePasteHelperProviderImpl

kTablesDDTargetFlavorHelperService
Used where...
kTablesDDTargetHelperProviderImpl

kTextDataExchHandlerHelperService
Used where...
kTextDataExchHandlerHelperProviderImpl
```

```
kTextEngineService
Used where...
kTextAttrComposerBossImpExpImpl, kTCSimpleEggServiceImpl

kTextOffscreenService
Used where...
kTextOffscreenServiceImpl

kTextScrapSuitePasteHelperService
Used where...
kTextScrapSuitePasteHelperProviderImpl

kTextWalkerService
Used where...
kTextOffscreenServiceImpl

kTipRegisterService
Used where...
kTipRegisterProviderImpl

kToolRegisterService
Used where...
kCToolRegisterProviderImpl

kTrackerRegisterService
Used where...
kCTrackerRegisterProviderImpl

kUpdateLinkUndoRedoSignalResponderService
Used where...
kUpdateLinkUndoRedoSignalRespServiceImpl

kUserEditTextCmdResponder
Used where...
kUserEditTextCmdRespServiceImpl

kWFServiceProvider
Used where...
kScriptServiceImpl, kWFOpenDocResponderImpl

kXMLParserService
Used where...
kXMLParserServiceImpl
```

7.4.2. Methods of IK2ServiceProvider

The methods of IK2ServiceProvider are documented in IK2ServiceProvider.h in the SDK.

7.4.3. Methods of IK2ServiceRegistry

The methods of IK2ServiceRegistry are documented in IK2ServiceRegistry.h.

7.4.4. Getting to a service provider

There are a couple ways to get to a service provider via the `IK2ServiceRegistry`, which is part of the session boss that you can access through the `gSession`.

```
InterfacePtr<IK2ServiceRegistry> sRegistry(gSession, UseDefaultIID());
```

Once you have the pointer to `IK2ServiceRegistry`, you can find a service provider by

1. iterate thru all service providers of a certain service ID via the method `IK2ServiceRegistry::QueryNthServiceProvider()`. Usually there is some companion interface aggregated in the same boss that you can use to narrow down the available providers. For example, the service provider that supports `kImportProviderService` will aggregate the interface `IImportProvider`, which has a method called `CanImportThisStream`() to let you find a provider that supports the type of file.
2. find a specific service provider using service ID and class ID via the method `IK2ServiceRegistry::QueryServiceProviderByClassID()`.

Note that when you use the above method 2, it implies your code is coupled with some class ID across different components, and you should be aware that Class ID can be changed or removed in the future. However, there is some usage in InDesign API does require the use of method 2, for example, kSelectableDialogBoss is implemented as a service provider with service ID kSelectableDialogServiceImpl (with the implementation ID doubled as service ID), if you are implementing your own selectable dialog based on kSelectableDialogBoss, you will need to use method 2 if you are indeed accessing the dialog boss through the `IK2ServiceRegistry`.

7.5. Recipes for common service providers

This section demonstrates common uses and implementations of service providers. Developers can use this material as an aid to determining whether they can use an existing service provider or must create their own service provider.

The following code segments are taken from sample plug-ins located in the InDesign SDK.

7.5.1. Implementing string register and panel register service providers

The ResizablePanel plug-in demonstrates the use of InDesign APIs for creating two resizable panels within one plug-in; one of which incorporates splitter and scroll bars.

Here is an example from the ResizablePanel plug-in of how an existing service provider implementation is used. ResizablePanel uses the supplied CPanelRegisterProvider and CStringRegisterProvider implementations, as shown in the code fragment below.

Figure 7.5.1.a. using default implementations of IK2ServiceProvider

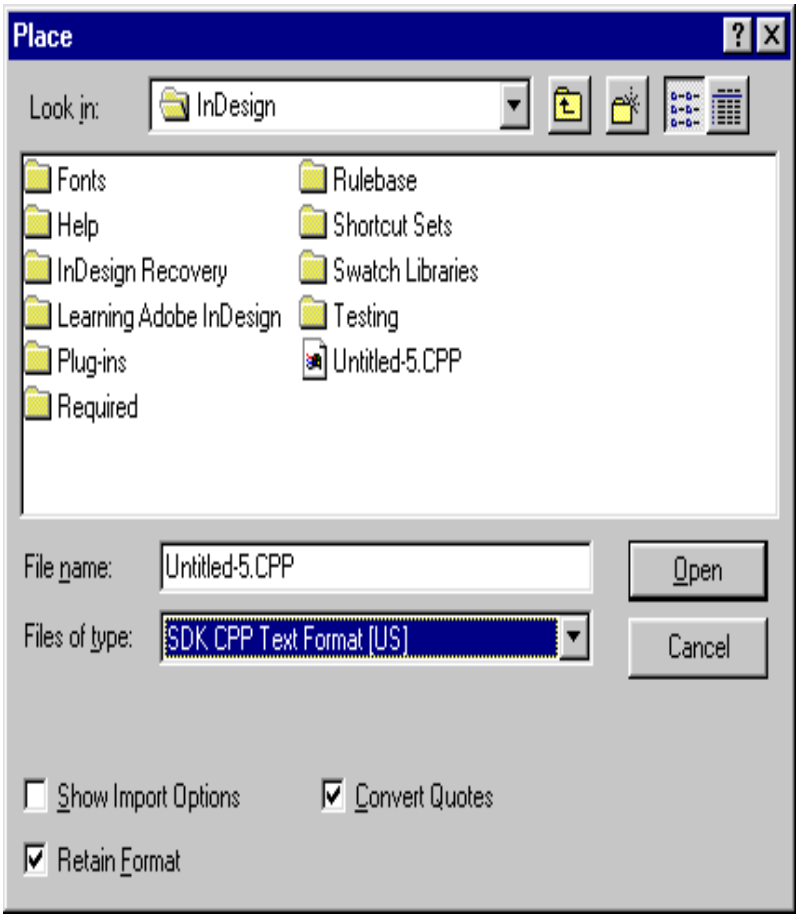
```
/**
This boss class registers all the panel for this plug-in.
*/
Class
{
kRezPnlPanelRegisterBoss,
kInvalidClass,
{
/**
Register panels with the application.
*/
IID_IPANELREGISTER, kAutoPanelRegisterImpl,
/**
Identify this boss as a panel register service.
Implementation provided by the API.
*/
IID_IK2SERVICEPROVIDER, kCPanelRegisterProviderImpl,
}
},

/**
 This boss class registers all the strings for this plug-in.
*/
Class
{
kRezPnlStringRegisterBoss,
kInvalidClass,
{
/**
Register string with the application.
Implementation provided by the API.
*/
IID_ISTRINGREGISTER, kAutoStringRegisterImpl,
/**
Identify this boss as a string register service.
Implementation provided by the API.
```

```
*/
IID_IK2SERVICEPROVIDER, kCStringRegisterProviderImpl,
}
},
```

See RezPnl.fr for the string and panel definitions.

7.5.2. Implementing an import filter service provider

The TextImportFilter plug-in is a simple filter allowing .cpp files to be placed into the InDesign application. The filter places .cpp files so they won't interfere with the application's text-only import filter. The plug-in is provided as an example implementation of IImportProvider.



Here is an example from the TextImportFilter plug-in on how an existing service provider implementation is used. TextImportFilter uses the supplied ImportService implementation, as shown below.

Figure 7.5.2.a. using a default implementation of IK2ServiceProvider

```
Class
{
kTxtImpFilterBoss,
kInvalidClass,
{
/**
Register import provider with application.
Implementation provided by the API.
*/
IID_IK2SERVICEPROVIDER, kImportServiceImpl,
/**
Identify this boss as an import provider.
Implementation provided in this sample in TxtImpFilter.cpp.
*/
IID_IIMPORTPROVIDER, kTxtImpFilterImpl,

// .. other interfaces

}
},
```

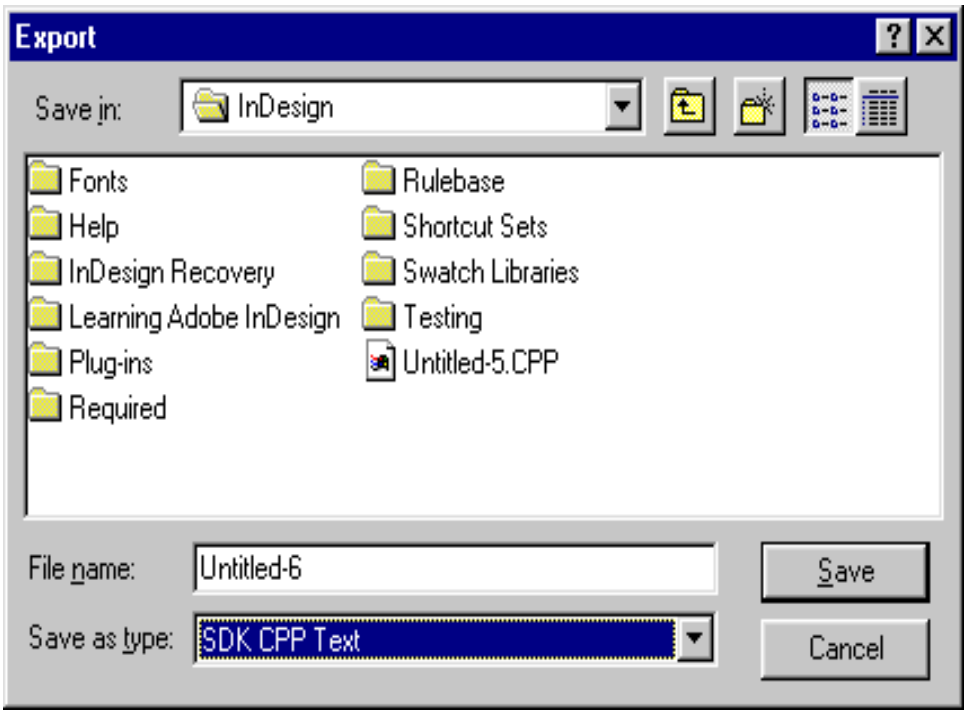
TextImportFilter supplies a full implementation for the IImportProvider interface, which defines an import provider importing (placing) text or graphics of a particular format into a document. The provider is aggregated, along with IK2ServiceProvider, by a service boss (for example, a filter). The service furnishes service IDs through IK2ServiceProvider, under the guidance of the service manager (IK2ServiceMgr).

IImportProvider identifies the formats it can import, presents any preferences UI, and actually imports text or graphics. If the service is an image import filter for a particular format (for example, TIFF), your code must include an image format reader boss aggregating IImageReadFormat and IImageReadFormatInfo. TxtImpFilter.cpp from the TextImportFilter provides an example of IImportProvider implementation.

CHMLImportFilter sample in the SDK also shows how to implemnt a kOpenProviderService based service provider.

7.5.3. Implementing an export filter service provider

The Text Export Filter is a filter registering the format, "SDK Text only" in the Export dialog's list of formats. If this format is chosen for a range of selected text, the filter exports plain text.



The following resource definition shows how the export service boss is defined.

Figure 7.5.3.a. resources

```
/**
 This boss class provides the export filter provider.
*/
Class
{
kTxtExpFilterBoss,
        kInvalidClass,
        {
/**
Register our text export filter with the export registry.
Implementation provided by the API.
*/
            IID_IK2SERVICEPROVIDER, kExportServiceImpl,
/**
```

```
Identify this boss as an export provider.
Implementation provided in this sample in TxtExpFilter.cpp.
*/
            IID_IEXPORTPROVIDER, kTxtExpFilterImpl,
// ... other interface
}
},
```

The default kExportServiceImpl is used to provide default implementation for IK2ServiceProvider, it identifies this boss as a service provider that provides service along with kExportProviderService ID. TxtExpFilter supplies a full implementation for the IExportProvider interface, which defines an export provider exporting text or graphics of a particular format from a document. The provider is aggregated, along with IK2ServiceProvider, by a service boss (for example, a shape support boss). The service furnishes service IDs through IK2ServiceProvider, under the guidance of the service manager (IK2ServiceMgr).

IExportProvider identifies the formats it can export, presents any preferences UI, and actually exports text or graphics. If the service is an export filter for a particular format (for example, GIF), your code must include an image format writer boss aggregating IImageWriteFormat, IImageWriteFormatInfo. TxtExpFilter.cpp from the TextExportFilter provides an example of IExportProvider implementation.

7.5.4. Implementing a scripting service provider

Here is an example from the CustomPrefsScript plug-in, demonstrating how to implement a new script object and how to add events and properties to application-supplied script objects.

Figure 7.5.4.a. resource

```
/** This boss class aggregates interfaces related
   to handling events or properties on a scripting object.
*/
Class
{
kCPScrScriptProviderBoss,
kInvalidClass,
{
/** Identifies this boss as a script service.
         Implemented by the API.
         */
IID_IK2SERVICEPROVIDER, kScriptServiceImpl,
/** Handles one or more specific events or properties
```

```
            on a specific exposed scripting object.
            */
    IID_ISCRIPTPROVIDER, kCPScrScriptProviderImpl,
    #ifdef MACINTOSH
    /** On Macintosh ONLY: Holds an AEDesc of type typeAETE
            representing an aete resource. It is added to a script
            manager that implements AppleScript.
            */
    IID_IAETE, kCPScrAETEImpl,
    #endif
    #ifdef WINDOWS
    /** On Windows ONLY: Added to a script manager that
            implements OLE Automation and is used to set and get
            OLE-specific information.
    Implemented by the API.
            */
    IID_IOLETYPELIB, kOLETypeLibImpl,
    /** On Windows ONLY: Holds an ITypeInfo interface which
            holds Visual Basic type information for an object.
    Implemented by the API.
            */
    IID_IOLETYPEINFO, kOLETypeInfoImpl,
    #endif
    }
    },
```

CustomPrefsScript needs to supply an implementation for the IScriptProvider interfaces. Here, default implementations can be used to help implement our own. By deriving from RepresentScriptProvider, CustomPrefsScript needs only implement certain methods as shown in the CPScrScriptProvider.h.

Which of the methods needing implementation is determined by whether the script provider creates a script object and whether events and properties are created.

7.5.5. Implementing a startup/shutdown service provider

The PanelTreeView plug-in displays a tree view widget that reflects the contents of an OS folder set by the user. Since the folder contents maybe changed anytime by the user, PanelTreeView installed an IIdleTask during application start up so the application will notify the plug-in perodically so the plug-in can check the contents of the folder for updates. In order to install the IIdleTask at application start up time, PanelTreeView implemented a kPnlTrvStartupShutdownBoss, the purpose of this boss is to tell the application

that this plug-in would like to get a chance to do something while the application is starting up or shuttong down.

Here, an existing implementation of IK2ServiceProvider is used. PanelTreeView uses the supplied CStartupShutdownProvider implementation, as shown below. The implementation of CStartupShutdownProvider identifies kPnlTrvStartupShutdownBoss as a service provider who will participate in the event when kAppStartupShutdownService is being broadcasted by the service manager.

figure 7.5.5.a.

```
Class
{
kPnlTrvStartupShutdownBoss,
kInvalidClass,
 {
IID_IAPPSTARTUPSHUTDOWN, kPnlTrvStartupShutdownImpl,
IID_IK2SERVICEPROVIDER, kCStartupShutdownProviderImpl,
 }
},
```

PanelTreeView supplies a full implementation for the IStartupShutdownService interface, which defines code needing to be run when InDesign starts up and/or shuts down. A service provider registers for the kAppStartupShutdownService service ID (defined in ShuksanID.h). They must provide the IID_IAPPSTARTUPSHUTDOWN interface, which contains implementations of the Startup() and Shutdown() methods.

The PnlTrvStartupShutdown.cpp from the PanelTreeView sample provides an example of IStartupShutdownService implementation.

7.5.6. Implementing a responder service provider

The DocWatch plug-in shows how to catch document file actions using a responder. When the responder is invoked through the plug-in menu, Alert boxes will appear at each stage of a document file action, such as new, open, close, etc.

The responder is implemented in a single boss, kDocWchResponderServiceBoss, as shown below. Here, DocWatch provides an implementation of IK2ServiceProvider, kDocWchServiceProviderImpl, with

the help of CServiceProvider. In this implementation, DocWchServiceProvider registers as providing the service of responding to a group of document file action signals such as kBeforeNewDocSignalResponderService.

Figure 7.5.6.a.

```
/**
This boss provides the service of responding to document file actions.
It has two interfaces: one that tells InDesign what kind of service is
provided, and a second to provide the service.
*/
Class
{
kDocWchResponderServiceBoss,
kInvalidClass,
{
/**
An impl. of this plug-in to identify this boss as providing a
responder service for multiple document actions, such as for doc open,
close, etc.
If only one service was needed, then we'd reuse an API-defined
implementation ID
listed in DocumentID.h.
*/
IID_IK2SERVICEPROVIDER,kDocWchServiceProviderImpl,
/**
An impl. of this plug-in to perform the responder service.  This
implementation
will deliver every service promised by the IK2ServiceProvider
implementation.
*/
IID_IRESPONDER,kDocWchResponderImpl,
}
},
```

DocWatch needs only supply an implementation for the IResponder interface. Here too, helper implementations can be used. By deriving from CResponder, DocWatch needs only implement certain methods shown in the DocWchResponder.cpp. The method Respond of IResponder provides the plug-in a chance to respond to the signals it registers in the kDocWchServiceProviderImpl. In the sample's case, it pops up a dialog showing what kind of signal has just arrived. In summary, you can respond to the signals that were stated in your implementation of IK2ServiceProvider of your responder service provider boss, since those signals will be sent along the IResponder.

7.6. Summary

This chapter has described the Adobe InDesign service provider architecture. Implementation issues, including the basics of either using, adapting, or creating a service provider for your plug-in are also covered.

7.7. Review

You should be able to answer these questions:

1. What is a service provider?
2. What is the purpose of the service registry?
3. What do you need to implement if creating a service provider?

7.8. References

- Adobe InDesign SDK. *InDesign Command Reference*, 2000. See **Adobe InDesign SDK/Documentation/CommandReference.pdf**.

8. Tools

8.0. Overview

The tools palette can be customized to add new tools that manipulate the objects in a document. This chapter describes how tools work and how to program your own tools and add them to the toolbox.

8.1. Goals

The questions this chapter answers are:

1. What is a tool?
2. What is a tracker?
3. What is the toolbox?
4. What is the layout view?
5. How do tools work?
6. How do I track the user's mouse gestures?
7. How do I implement a new tool?
8. What building blocks does the API provide to help me?

8.2. Chapter-at-a-glance

"8.3.Key concepts" on page 238 explains what tools do and the architecture that surrounds them.

"8.4.Custom tools" on page 251 explains the objects that constitute a tool, describes how they collaborate, presents the resources needed to describe a tool's user interface and describes the implementation classes the API provides and on which new tools are built.

table 8.1.a. version history

Rev	Date	Author	Notes
2.1	21-Oct-2002	Seoras Ashby	Revised based on feedback from Lee Huang.
2.0	14-Oct-2002	SeorasAshby	Update content for InDesgn 2.x API and revise .
0.3	09-Apr-1999	Seoras Ashby	Revised based on Andy's edit and Adrian's feedback

"8.5.Sample code" on page 265 directs the reader to relevant sample code on the SDK.

"8.6.Frequently asked questions(FAQs)" on page 265 provides answers to some often asked questions.

"8.7.Summary" on page 268 summarizes the material presented in this chapter.

"8.8.Review" on page 268 provides a set of questions to test the user's understanding of tools.

"8.9.Exercises" on page 269 provides some tasks the reader could undertake to gain practical experience of tools.

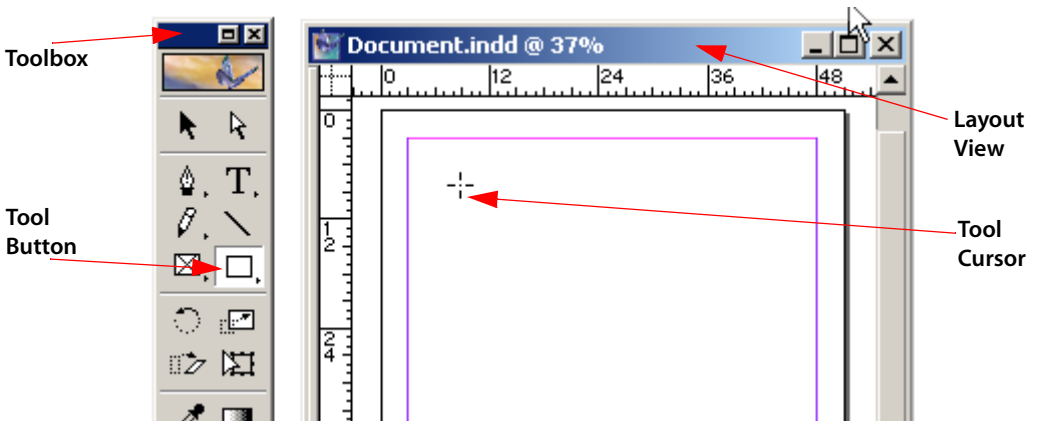
"8.10.References" on page 270 provides further pertinent reading material.

8.3. Key concepts

8.3.1. The toolbox and the layout view

Tools are presented via a palette called the **toolbox**. Document content is presented in the **layout view**. Tools create and manipulate document objects via keyboard and mouse events in the layout view. The general arrangement is illustrated in figure 8.3.1.a.

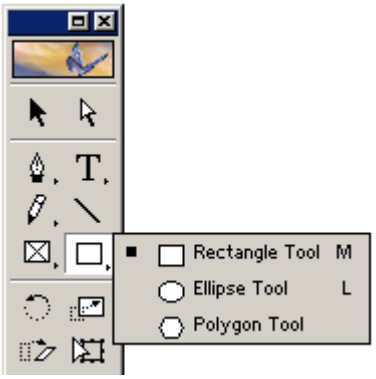
figure 8.3.1.a. The toolbox and the layout view



The layout view is a widget in which a document is presented and edited by the user. It implemented by boss class kLayoutWidgetBoss. The layout view is

concise way of saying "the IControlView interface on boss object kLayoutWidgetBoss". Tools commonly use interfaces on kLayoutWidgetBoss to discover the context they are working in. For example the spread being manipulated can be found via ILayoutControlData and hit testing can be done using ILayoutControlViewHelper. The toolbox contains a tool button icon for each tool and, optionally, a hidden tools panel containing other tools as shown in figure 8.3.1.b.

figure 8.3.1.b. Hidden tools panel



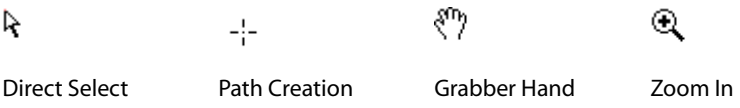
8.3.2. Tools

Tools (see interface ITool) provide a button icon in the toolbox and, optionally, a keyboard shortcut. They can provide a **cursor** as a visual cue to the user of the active tool and a **tool tip** to help the user understand the purpose of the tool. To track mouse gestures when the tool is being used tools provide a **tracker**.

8.3.3. Cursors

Cursors (see interface ICursorProvider) provide a visual cue to the user of the active tool. Tools wishing to provide their own cursor must become **cursor providers**. Cursor providers set the mouse cursor and provide context-sensitive cursors for different areas of the screen.

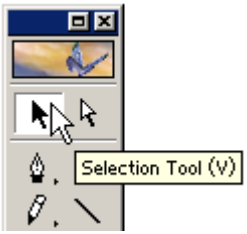
figure 8.3.3.a. Cursors



8.3.4. Tool tips

Tool tips (see interface ITip) reveal a string with the name of the tool and its keyboard shortcut when the mouse pointer is over the tool icon in the toolbox. The strings displayed are declared as ODFRez string resources in the plug-in's .fr file. The mechanics of the registration process will be explained later. Once the appropriate strings are registered the revealing of the tool tip is taken care of automatically by the application.

figure 8.3.4.a. Tool tip



8.3.5. Trackers

Trackers (see interface ITracker) monitor mouse movement while an object is being manipulated by a tool and can provide visual feedback to the user. They makes the changes to the objects being manipulated using commands. A tool may have one or more trackers but only a single tracker will be active at a time.

8.3.6. The tracker factory, tracking and event handling

The tracker factory (see interface ITrackerFactory) allows the introduction of new trackers. It is used to manufacture the tracker required for a particular context. ITrackerFactory is aggregated on the session boss, kSessionBoss. The tracker factory maintains a table associating a tracker with a given widget and tool by ClassID. When the tool is used in the context of the widget the associated tracker is created and receives control. Trackers for tools that appear in the toolbox register themselves as being associated with the layout widget, kLayoutWidgetBoss. The code shown in figure 8.3.6.a. adds the highlighted entry to the tracker factory.

figure 8.3.6.a. Line tracker registration in the tracker factory

```
void LineTrackerRegister::Register(ITrackerFactory *factory)
{
  factory->InstallTracker(kLayoutWidgetBoss,
       kLineToolBoss,
       kLineTrackerBoss);
}
```

Widget ClassID	Tool ClassID	Tracker ClassID
kLayoutWidgetBoss	kPointerToolBoss	kPointerTrackerBoss
kLayoutWidgetBoss	kRectFrameToolBoss	kRectangleFrameTrackerBoss
kLayoutWidgetBoss	kRectToolBoss	kRectangleTrackerBoss
kLayoutWidgetBoss	kGrabberHandToolBoss	kGrabberHandTrackerBoss
kLayoutWidgetBoss	kZoomToolBoss	kZoomToolTrackerBoss
kLayoutWidgetBoss	**kLineToolBoss**	**kLineTrackerBoss**

The framework maintains an event handler stack it uses to dispatch events (mouse, keyboard and system events). Many event handlers (see interface IEventHandler) are associated with a widget. The widget having the user interface focus will be on top of the stack and will receive and process events.

When a mouse down occurs in a layout view and the active tool is kLineToolBoss the layout view's event handler asks the tracker factory to manufacture the tracker for this context by making the call below which creates kLineTrackerBoss and return its ITracker interface.

```
ITrackerFactory::QueryTracker(kLayoutWidgetBoss, kLineToolBoss)
```

The tracker is then focussed on the layout view and then asked to begin tracking. A simplified version of the layout event handler code involved is shown in figure 8.3.6.b.

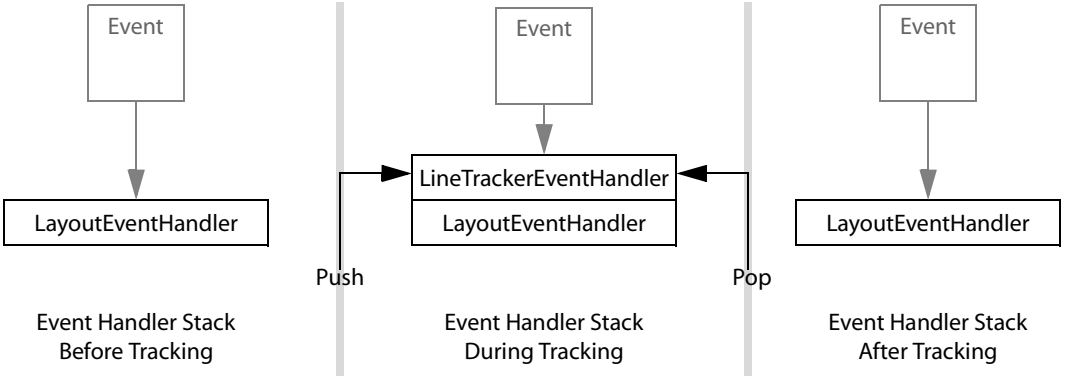
figure 8.3.6.b. Layout event handler

```
bool16 LayoutEventHandler::LButtonDn(IEvent* e)
{
  ITracker* theTracker = nil;
  InterfacePtr<ITrackerFactory> factory(gSession,IID_ITRACKERFACTORY);
  InterfacePtr<ITool> theTool(Utils<IToolboxUtils>()-
  >QueryActiveTool());
  if(theTool)
  {
    ClassID contextID = ::GetClass(this);
    ClassID toolID = ::GetClass(theTool);
    theTracker = factory->QueryTracker(contextID, toolID);
  }
  if (theTracker != nil)
  {
```

```
        InterfacePtr<IControlView> pControlView(this, IID_ICONTROLVIEW);
        theTracker->Set(pControlView);
        if (!theTracker->BeginTracking(e))
            theTracker->Release();
    }
}
```

To follow mouse movement a tracker must handle events for the duration of the tracking process. To do this the tracker pushes its event handler interface onto the stack when tracking begins and pops when tracking ends. For example when the line tool is used to drag the end points of a line its tracker pushes and pops its event handler as shown in figure 8.3.6.c.

figure 8.3.6.c. Event dispatching



All tracker boss classes that want to follow the mouse as it is dragged aggregate an IEventHandler interface. When the LayoutEventHandler receives a mouse down event it calls the tracker's ITracker::BeginTracking method which is normally implemented by CTracker::BeginTracking. If the mouse is to be tracked this method calls CTracker::EnableTracking which calls CTracker::PushEventHandler to push the tracker's event handler (interface IEventHandler) onto the event handler stack using IEventDispatcher::Push. Please examine the implementation source code for CTracker.cpp on the SDK for further details.

8.3.7. Beyond the toolbox

Tools do not have to appear in the toolbox. For example the place tool is activated after selecting a file using the **File»Place** menu. Trackers are also used extensively in mouse dragging features such in the user interface. Examples of this are setting the layout zero point and dragging guides from rulers.

8.3.8. Drawing and sprites

To provide visual feedback while an object is undergoing manipulation a tracker can draw to the screen.

Page items can be hard to draw when they are being changed dynamically. To ensure objects are drawn on screen smoothly and efficiently without flickering the application provides a **sprite** API. A sprite (see interface ISprite) is a graphic object that can be moved around on screen causing no disturbance to the background.

8.3.9. Documents, page items and commands

Tools allow the manipulation of documents by the user. Please refer to the "Document Structure" and "Page Items" chapters for more information on how documents are organized and how page items are arranged. Tools use commands to make changes to a document.

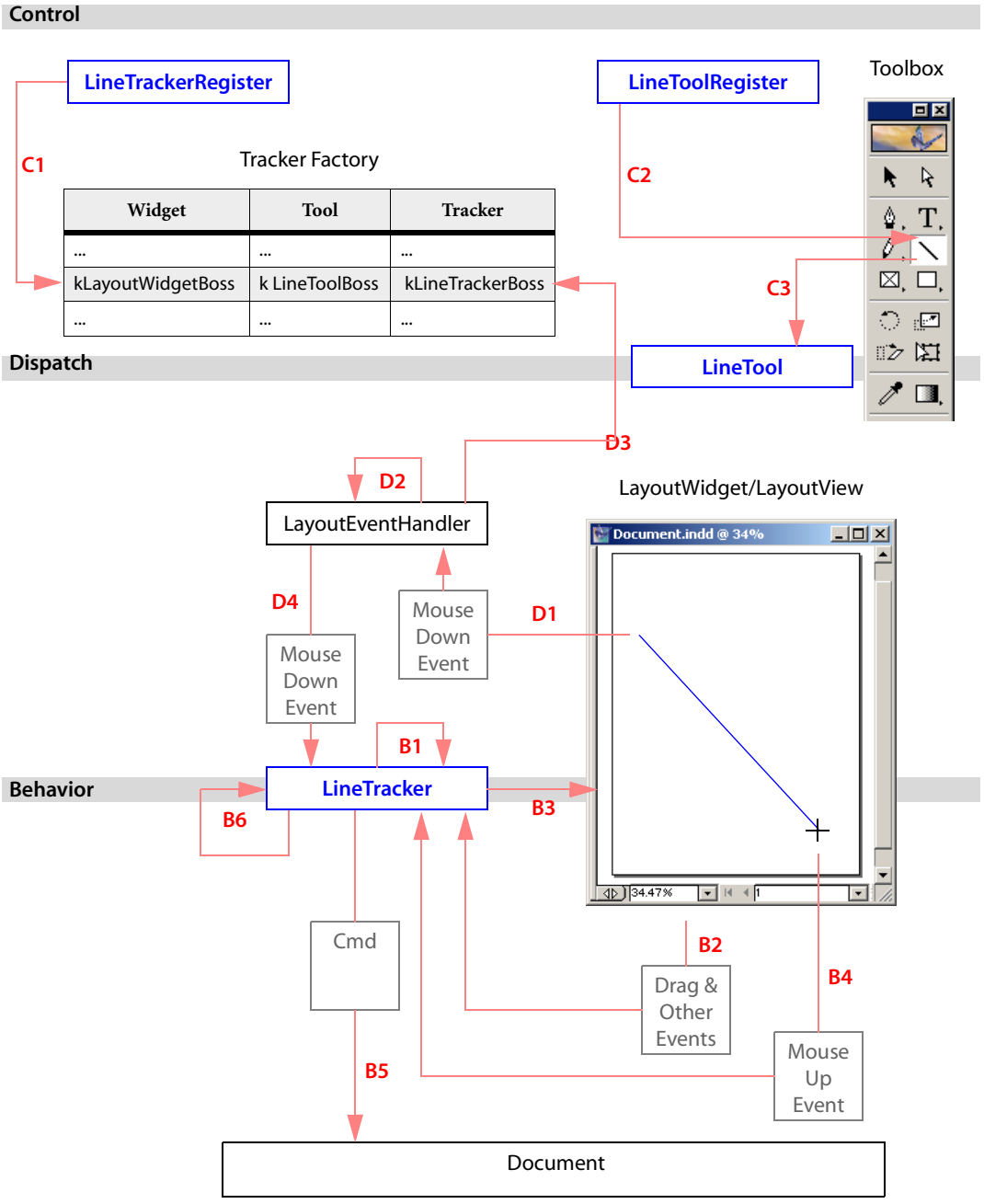
8.3.10. Line tool use scenario

To show how the objects in a tool collaborate a scenario describing the line tool is given below.

The scenario is divided into three sections: control; dispatch and behavior. Control is concerned with the registration of the tool with the application and the mechanism allowing the user to select the tool. Dispatch is concerned with how the application launches active use of the tool. Behavior is concerned with what the tool does to create a line. Some of the objects mentioned have not yet been introduced however they will be described later in this chapter.

Figure 8.3.10.a shows how the line tool registers with the application and is used to create a line between two points in a document. A legend explaining the steps in each section is shown in figure 8.3.10.b.

figure 8.3.10.a. Line tool scenario



Legend: See figure 8.3.10.b. for an explanation of labelled steps C, D and B

figure 8.3.10.b. Legend for the line tool scenario

Control
C1) The tool's tracker is registered with the application's tracker factory.
C2) The tool is registered with the application and its tool button icon in the toolbox is initialized.
C3) The user clicks the tool's button icon (kLineToolBoss becomes the active tool).

Dispatch
D1) The user clicks in the layout view (a mouse down event is passed to the LayoutEventHandler).
D2) The LayoutEventHandler looks at the active tool (kLineToolBoss) and the context of the event (mouse down over an empty page area). The association identifies the tracker that should be created for the context (kLineTrackerBoss).
D3) The appropriate tracker is manufactured via the tracker factory.
D4) The tracker is asked to begin tracking the mouse from the original mouse down event.

Behavior
B1) The tracker pushes its own event handler onto the application's event handler stack so that it can receive events and track the mouse.
B2) The user drags the mouse (events are passed into the tracker).
B3) The tracker provides appropriate dynamic visual feedback to the user of the tool behavior (a line is drawn between the location of the original mouse down event and the current mouse position).
B4) The user releases the mouse (a mouse up event is passed into the tracker).
B5) The tracker implements an appropriate action (creation of a page item describing the line between start and end points) using a command.
B6) The tracker pops its event handler from the application's event handler stack and tracking is complete.

The scenario described above is typical of a tool that creates items. The item itself is created by the tracker using a command once the user releases the mouse button. However other categories of tool may dynamically execute commands while tracking the mouse. For example the pointer tool dynamically executes commands when moving or resizing items.

8.3.11. Trackers with multiple behaviors

If a tracker needs to exhibit more than one behavior it can create another tracker dependent on the context. The selection tool for example exhibits multiple behaviors. When it is active and a mouse down occurs in a layout view the pointer tracker (kPointerTrackerBoss) is created. The pointer tracker considers the context of the click then creates and dispatches control to another tracker. Once the pointer tracker has examined the context and created an appropriate tracker its job is done. The trackers used by kPointerTrackerBoss to move and resize page items are illustrated in figure 8.3.11.a. The IDs under which they are registered in the tracker factory are shown in figure 8.3.11.b. Note the figures do not show all the behaviors of kPointerTrackerBoss.

figure 8.3.11.a. Pointer tracker move and resize behavior

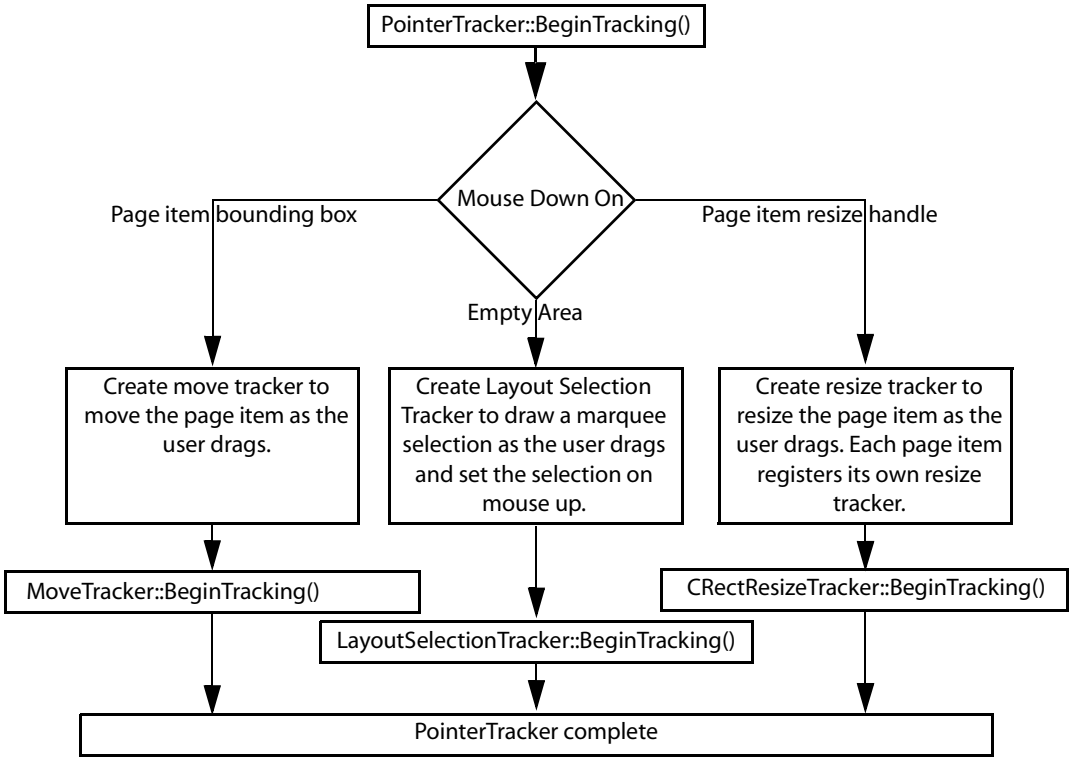


figure 8.3.11.b. Trackers used by pointer tracker to move and resize page items

Widget ClassID	Tool ClassID	Tracker ClassID[a]
kLayoutWidgetBoss	kPointerToolBoss	kPointerTrackerBoss

Widget ClassID	Tool ClassID	Tracker ClassID[a]
kPageItemBoss	kMoveToolBoss	kMoveTrackerBoss
kLayoutWidgetBoss	kLayoutSelectionToolImpl	kLayoutSelectionTrackerBoss
kPlacedPDFItemBoss	[b]kResizeToolBoss	kBBoxResizeTrackerBoss
kEPSItem	kResizeToolBoss	kBBoxResizeTrackerBoss
kEPSTextItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kDCSItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kWMFItem	kResizeToolBoss	kBBoxResizeTrackerBoss
kPICTItem	kResizeToolBoss	kBBoxResizeTrackerBoss
kGroupItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kImageItem	kResizeToolBoss	kBBoxResizeTrackerBoss
kSplineItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kFrameItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kFrameItemBoss	kILGMoveToolImpl	kILGMoveTrackerBoss

a. Note the figures above do not show all kPointerTrackerBoss behaviors. For example text frame link tracking via in and out port handles (kPrePlaceTrackerBoss), tracking when the layer on which the item lies is locked (kLockTrackerBoss), tracking of text on a path handle manipulation (kTOPResizeTrackerBoss, kTOPMoveTrackerBoss) and others are not shown.

b. Note that the each page item can registers its own resize tracker though as you can see they all use the same one.

8.3.12. The tool manager

Tools are managed by the tool manager, kToolManagerBoss. You can navigate to the IToolManager interface as shown below:

```
InterfacePtr<IApplication> app(gSession->QueryApplication());
InterfacePtr<IToolManager> toolMgr(app->QueryToolManager());
```

8.3.13. Toolbox utilities

Interface IToolBoxUtils provides a facade which should, in most situations, save you from having to program to the IToolManager interface. It's a utility interface on kUtilsBoss accessed in the standard way. For example the code below queries the active tool of type `kPointerToolBoss`. The tool type in this context identifies a group of tools within which only one tool can be active:

```
const ClassID toolType = kPointerToolBoss;
InterfacePtr<ITool> currentTool(
Utils<IToolBoxUtils>()->QueryActiveTool(toolType));
```

8.3.14. Tool type

Tools are categorized as belonging to one or more of the categories given by ITool::ToolType. This identifies what the tool does and how the selection in the layout view reacts when that tool becomes active (see interface IToolChangeSuite). Tools identify this type in their CTool constructor via parameter toolInfo.

ITool::ToolType can easily be confused the `ClassID` parameter called toolType defined by the tool's ToolDef statement (see "ToolDef ODFRez type" on page 257) and used by ITool::GetToolType and other APIs. This ClassID is used to identify a group of mutually exclusive tools, i.e. only one tool of a given tool type can be selected in the toolbox at any one time.

To illustrate the distinction between these two different "tool types" their values have been tabulated below in figure 8.3.14.

figure 8.3.14.a. Tool categories (see ITool::ToolType)

Tool	Tool Boss	ITool::ToolType	ClassID toolType
Selection	kPointerToolBoss	kLayoutSelectionTool	kPointerToolBoss
Direct Selection	kDirectSelectToolBoss	kLayoutSelectionTool kPathManipulationTool	kPointerToolBoss
Pen	kSplinePenToolBoss	kLayoutCreationTool kLayoutManipulationTool kPathManipulationTool	kPointerToolBoss
Add Anchor Point	kSplineAddPointToolBoss	kLayoutManipulationTool kPathManipulationTool	kPointerToolBoss
Delete Anchor	kSplineRemovePointToolBoss	kLayoutManipulationTool kPathManipulationTool	kPointerToolBoss
Convert Direction	kSplineDirectionToolBoss	kLayoutManipulationTool kPathManipulationTool	kPointerToolBoss
Type	kIBeamToolBoss	kTextSelectionTool kTableSelectionTool kTextManipulationTool kTableManipulationTool kTextCreationTool kTableCreationTool	kPointerToolBoss

figure 8.3.14.a. Tool categories (see ITool::ToolType) (continued)

Tool	Tool Boss	ITool::ToolType	ClassID toolType
Horizontal text on a path	kTOPHorzToolBoss	kTextSelectionTool kTableSelectionTool kTextManipulationTool kTableManipulationTool kTextCreationTool kTableCreationTool	kPointerToolBoss
Vertical text on a path (available under the Japanese feature set)	kTOPVertToolBoss	kTextSelectionTool kTableSelectionTool kTextManipulationTool kTableManipulationTool kTextCreationTool kTableCreationTool	kPointerToolBoss
Pencil	kPencilToolBoss	kLayoutCreationTool kLayoutManipulationTool kPathManipulationTool	kPointerToolBoss
Smooth	kSmoothToolBoss	kLayoutCreationTool kLayoutManipulationTool kPathManipulationTool	kPointerToolBoss
Erase	kEraseToolBoss	kLayoutCreationTool kLayoutManipulationTool kPathManipulationTool	kPointerToolBoss
Line	kLineToolBoss	kLayoutCreationTool	kPointerToolBoss
Rectangle	kRectToolBoss	kLayoutCreationTool	kPointerToolBoss
Rectangle Frame	kRectFrameToolBoss	kLayoutCreationTool	kPointerToolBoss
Oval	kOvalToolBoss	kLayoutCreationTool	kPointerToolBoss
Oval Frame	kOvalFrameToolBoss	kLayoutCreationTool	kPointerToolBoss
Regular Polygon	kRegPolyToolBoss	kLayoutCreationTool	kPointerToolBoss
Regular Polygon Frame	kRegPolyFrameToolBoss	kLayoutCreationTool	kPointerToolBoss
Horizontal frame grid (available under the Japanese feature set)	private	kLayoutCreationTool	kPointerToolBoss

figure 8.3.14.a. Tool categories (see ITool::ToolType) (continued)

Tool	Tool Boss	ITool::ToolType	ClassID toolType
Vertical frame grid (available under the Japanese feature set)	private	kLayoutCreationTool	kPointerToolBoss
Place	kPlaceToolBoss	kNone The place tool creates page items and is in theory a layout creation tool but because it does not appear in the toolbox it has no category as such.	not applicable
Rotate	kRotateToolBoss	kLayoutSelectionTool kLayoutManipulationTool	kPointerToolBoss
Scale	kScaleToolBoss	kLayoutSelectionTool kLayoutManipulationTool	kPointerToolBoss
Shear	kShearToolBoss	kLayoutSelectionTool kLayoutManipulationTool	kPointerToolBoss
Free transform tool	kFreeTransformToolBoss	kLayoutManipulationTool	kPointerToolBoss
Eye dropper	private	kLayoutManipulationTool kTextManipulationTool kTableManipulationTool	kPointerToolBoss
Gradient	kGradientToolBoss	kLayoutManipulationTool kTextManipulationTool kTableManipulationTool	kPointerToolBoss
Scissors	kScissorsToolBoss	kLayoutManipulationTool kPathManipulationTool	kPointerToolBoss
Zoom	kZoomToolBoss	kViewModificationTool	kPointerToolBoss
Hand	kGrabberHandToolBoss	kViewModificationTool	kPointerToolBoss
Fill stroke	kStrokeFillProxyToolBoss	kNone	
Apply color	kBoss_ApplyCurrentColorTool	kNone	kBoss_ClearFillStrokeTool
Apply gradient	kBoss_ApplyCurrentGradientTool	kNone	kBoss_ClearFillStrokeTool
Apply none	kBoss_ClearFillStrokeTool	kNone	kBoss_ClearFillStrokeTool
Normal view mode	kNormalViewModeToolBoss	kNone	kNormalViewModeToolBoss

figure 8.3.14.a. Tool categories (see ITool::ToolType) (continued)

Tool	Tool Boss	ITool::ToolType	ClassID toolType
Preview mode	kPreviewModeToolBoss	kNone	kNormalViewModeToolBoss

8.4. Custom tools

8.4.1. Introduction

This section describes the boss classes, interfaces and resources you need to implement to add a new tool. The APIs using which custom tools are built are catalogued and described.

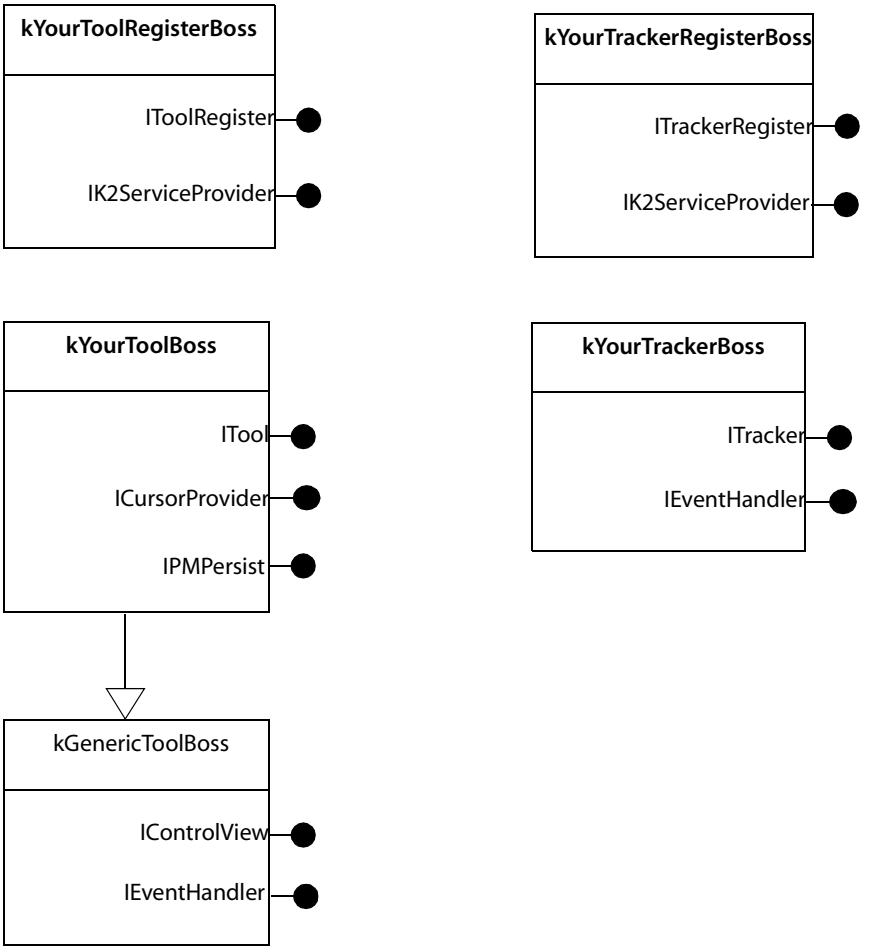
Plug-ins that implement tools typically provide:

1. A tool register boss class.
2. A tracker register boss class.
3. A tool boss class per tool.
4. A tracker boss class per tool.
5. Resources controlling how the tool is displayed.

8.4.2. Class diagram

The classes typically found in a custom tool are shown in figure 8.4.2.a:

figure 8.4.2.a. Custom tool class diagram



kYourToolRegisterBoss registers the plug-in's tool with the tool manager using the **IToolRegister** interface. If your tool does not appear in the toolbox don't implement this boss class.

kYourTrackerRegisterBoss registers the plug-in's tracker(s) with the tracker factory using the **ITrackerRegister** interface.

kYourToolBoss allows the tool manager to control the tool using the **ITool** interface. It specifies information about a tool, gets called when the tool is selected and deselected by the user and when a tool options dialog should be

popped. **ICursorProvider** allows the tool to customize the cursor when the tool is active. **IPMPersist** allows information such as the tool's name and icon to be saved persistently. **kGenericToolBoss** is the parent boss class for toolbox tools. The control view it provides displays the tool's buttons and its event handler handles clicks on the tool's buttons in the toolbox.

kYourTrackerBoss responds to mouse gestures in the layout view when your tool is being used. You will have at least one tracker boss for each tool in your plug-in. The interfaces on a tracker boss class collaborate to provide the active behavior of the tool. **ITracker** is the interface to which control is passed so the mouse can be tracked. It manages and controls the other interfaces on the boss object. The tracker pushes its event handler to the top of the event handler stack when tracking begins. During tracking **IEventHandler** forwards events into the ITracker interface. When tracking ends the event handler is popped from the stack and the tracker is finished. Standard tracker event handler implementations are provided by the API. It is common for tracker boss classes to have other interfaces particular to their needs. For example trackers that create splines aggregate **ISprite** and **IPathGeometry**. However if a tracker only needs to handle a single mouse click it does not require an IEventHandler.

8.4.3. Partial implementation classes

The API provides helper classes that partially implement interfaces relevant to building tools.

figure 8.4.3.a. Partial implementation classes

Interface	Class	Description
IToolRegister	none	Normally the default implementation kAutoToolRegisterImpl is used.
ITrackerRegister	none	Implemented by all tools to install the tool's trackers in the tracker factory using ClassIDs you choose. Use IDs meaningful to your context. See "The tracker factory, tracking and event handling" on page 240.

figure 8.4.3.a. Partial implementation classes

Interface	Class	Description
ITool	CTool	Implemented by all tools. A couple of the methods are worthy of note. Override IsCreationTool to return kTrue if your tool creates or modify items. Your tool will not be allowed to be activated when the active layer is locked or the document is read only. Also IToolboxUtils::QueryMostRecentCreationTool may return your tool. The CTool implementation returns the flag set in the constructor. Override IsSelectionTool to return kTrue if you implement a tool that selects objects. IToolboxUtils::QueryMostRecentSelectionTool may return your tool. The CTool implementation returns the flag set by the constructor. Override IsTextTool to return kTrue if the text editor should not be deactivated when your tool is selected. Tools like Zoom and Grabber Hand also use this ability so they can be used without deactivating the text editor.
ICursorProvider	CToolCursorProvider	Implement if you want your own cursor.

figure 8.4.3.a. Partial implementation classes

Interface	Class	Description
ITracker	CTracker[a]	Implemented by all tools. Override DoBeginTracking to start tracking the mouse. Handle the mouse click and return kFalse if you don't want to continue. Return kTrue to track the mouse which will result in CTracker pushing your tracker's IEventHandler interface onto the event handler stack. Override ContinueTracking to be called repeatedly even when the mouse is not moving. Override DoEndTracking to tidy up and end tracking. The standard tracker event handler (CTrackerEventHandler/ kCTrackerEventHandlerImpl) will pop your tracker's IEventHandler from the event handler stack. So you only need to do this yourself if you have specialized this implementation.
ITracker	CPathCreationTracker[b]	The base for a tracker that creates new path based page items. Your tracker boss class must aggregate an IPathGeometry interface and an ISprite interface to use this class. CPathCreationTracker repeatedly calls your MakePath method so you can define the points making up your path(s). The path is stored in an IPathGeometry interface. CPathCreationTracker uses the ISprite interface to draw the path to the screen as the mouse is dragged. On mouse up it processes commands to create your page item.
ITracker	CLayoutTracker[c]	See CLayoutTracker.cpp

figure 8.4.3.a. Partial implementation classes

Interface	Class	Description
IEventHandler	CTrackerEventHandler[d]	The default implementation, kCTrackerEventHandlerImpl, should normally be used. Specialize CTrackerEventHandler only if absolutely necessary.

a. The C++ source code for this implementation is provided on the SDK.
b. The C++ source code for this implementation is provided on the SDK.
c. The C++ source code for this implementation is provided on the SDK.
d. The C++ source code for this implementation is provided on the SDK.

8.4.4. Default implementations

The API provides default implementations that completely implement some interfaces involved in building tools. If these meet your needs you can re-use them in your boss class definition and avoid writing the C++ code.

figure 8.4.4.a. Default implementations

Interface	ImplementationID	Description
IToolRegister	kAutoToolRegisterImpl	Reads the resource definition for your tool and instantiates your tool in the application's toolbox.
IK2ServiceProvider	kCToolRegisterProviderImpl	Causes a boss class to be recognized as a tool register service.
IK2ServiceProvider	kCTrackerRegisterProviderImpl	Causes a boss class to be recognized as a tracker register service.
IEventHandler	kCTrackerEventHandlerImpl	Standard tracker event handler implementation that forwards events into an ITracker.

figure 8.4.4.a. Default implementations

Interface	ImplementationID	Description
ICursorProvider	kCreationCursorProviderImpl kDirectSelectCursorProviderImpl kRotateCursorProviderImpl kGrabberHandCursorProviderImpl kScaleCursorProviderImpl kShearCursorProviderImpl kCreationCursorProviderImpl kSplineAddCursorProviderImpl kSplineRemoveCursorProviderImpl kSplineDirectionCursorProviderImpl kScissorsCursorProviderImpl kHorizontalIBeamCrsrProviderImpl kVerticalIBeamCrsrProviderImpl kZoomToolCursorProviderImpl kSelectCursorProviderImpl kPlaceGunCursorProviderImpl kSplineCreationCursorProviderImpl kPencilCursorProviderImpl kSmoothCursorProviderImpl kEraseCursorProviderImpl kTOPHorzToolCursorProviderImpl kTOPVertToolCursorProviderImpl	Cursors provided by the application's tools.
ISprite	kNoHandleSpriteImpl kGradientToolSprite kFreeTransformSpriteImpl kCSpriteImpl kNoHandleAndCrossSpriteImpl kLayoutSpriteImpl kPencilSpriteImpl kStandOffSpriteImpl kTableResizeSpriteImpl kTextOffscreenSpriteImpl	Used by trackers to draw to the screen as the user drags the mouse.
IPathGeometry	kPathGeometryImpl	Used by path creation trackers to describe the path points of the spline.

8.4.5. ToolDef ODFRez type

ODFRez provides a type called ToolDef that controls how a tool is displayed within the toolbox. The order in which tools are displayed, the way in which they are grouped and other properties are controlled using it as shown in figure 8.4.5.a.. A sample ToolDef resource data statement is given in figure 8.4.5.b.

figure 8.4.5.a. Tool display in the toolbox

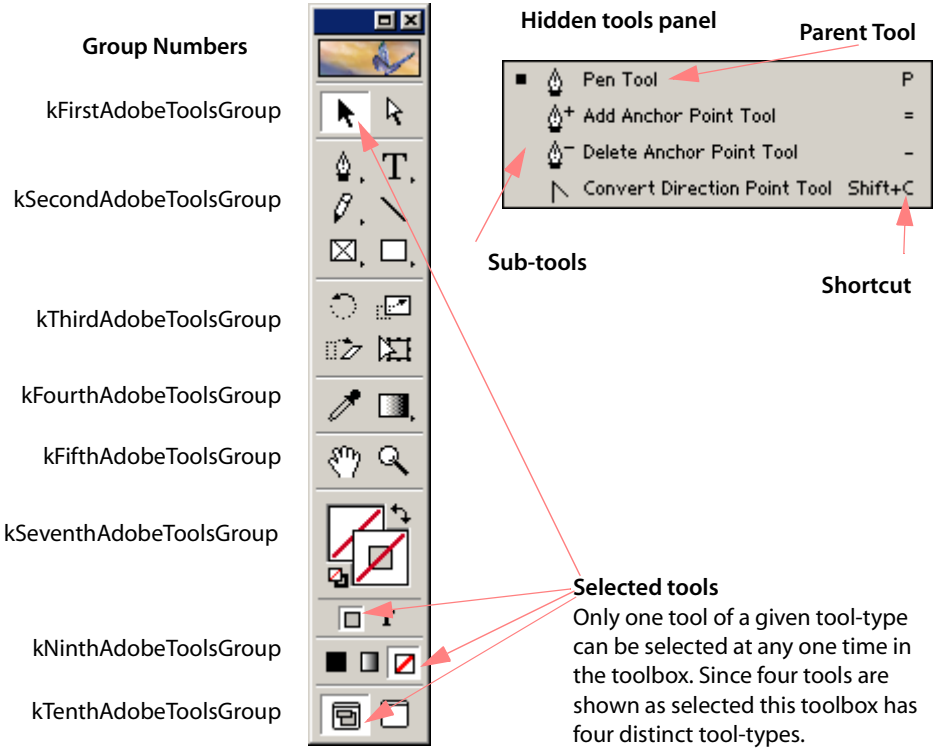


figure 8.4.5.b. Sample ToolDef resource statement

```
#ifdef __ODFRC__

resource ToolDef (135)
{
  // 1) Tool ClassID; your tool's boss class.
  kYourToolBoss,
  // 2) Tool-type ClassID; your tool's tool-type. Tools of a given tool-type are
  // mutually exclusive, only one tool of a given tool-type can be selected at any
  // one time in the toolbox. The majority of tools (selection, creation,
  // transformation) set this to kPointerToolBoss. See "Tool type" on page 248 for
  // further documentation.
  kPointerToolBoss,
  // 3) Parent tool ClassID; if your tool is to be displayed by default in the main
  // toolbox this should be kDoesNotApply. Otherwise your tool is a sub-tool that is
```

```
    // displayed in a hidden tools panel. A sub-tool specifies the ClassID of its parent
    // tool boss class in whose hidden tools panel the sub-tool is to be displayed.
    kDoesNotApply,
    // 4) Group number (See ToolboxDefs.h); the group number or kDoesNotApply.
    // Grouped tools appear together in the toolbox within a bordered area.
    kSixthAdobeToolsGroup,
    // 5) Tool number (See ToolboxDefs.h); the tool number that determines the
    // order of tools within a group or kDoesNotApply. If two or more tools give the
    same group number and tool number, their positioning will be arbitrary.
    kFirstAdobeTool,
    // 6) Sub-tool number; the sub-tool number that determines the order of
    // sub-tools in a hidden tools panel or kDoesNotApply.
    kDoesNotApply,
    // 7) ActionID; ID from your plug-in's ID space that can be used to assign a
    shortcut to your tool or kInvalidActionID if don't want your tool to support a
    shortcut. Sub-tools get the shortcut for their parent's tool. If tools have the same
    shortcut, using that shortcut will cyclically select the tools with that shortcut. If
    you use kInvalidActionID the keyboard shortcut editor won't be able to assign a
    shortcut for your tool.
    kYourToolActionID,
    // 8) Icon Identity; the icon PMSysRsrcID determines the icon bitmap used for
    // the tool's button. The resourceID for the icon and the ID for the plug-in are
    // required to specify the icon resource.
    kIconMyTool, kMyPluginID
}; // End, ToolDef.
```

ToolDef resources are localizable, so you can define different resources for different locales, and have a tool show up in a different place, or with a different icon. An example of the use of tool localization would be a currency stamp tool. A tool icon could be provided for each locale (e.g., dollar, yen) and the icon for the current locale would be shown in the toolbox. To localize your ToolDef resources add a locale index to your plug-in's .fr file and define a ToolDef resource in the .fr file for each specific locale:

figure 8.4.5.c. ToolDef localization

```
resource LocaleIndex (kYourToolsRsrcID)
{
  kToolRsrcType,
  {
    k_enUS, kShapeSelectorToolsRsrcID + index_enUS
    k_jaJP, kShapeSelectorToolsRsrcID + index_jaJP
  }
```

```
}
```

8.4.6. Icons and Cursors

Icons and cursors are created in their native platform resource form.

Macintosh icons need resources of type icl4, icl8 and ICN#. Cursors need resources of type CURS.

Windows icons need an icon bitmap **.ico** file and an ICON resource declaration in your plug-in project's **.rc** file. Cursors need a cursor bitmap **.cur** file and a CURSOR resource declaration in your plug-in project's **.rc** file.

figure 8.4.6.a. Windows .rc file for icons and cursors

```
#include "YourTool.r"
135 ICON "YourIcon.ico"
6001 CURSOR  DISCARDABLE  "YourCursor.cur"
```

Tool button icons come in two sizes, standard and mini. Normally you will use the standard size, `kStandardToolRect`. CTool specifies the widget rects involved and in your CTool::Init implemention you control the size to be used by calling CTool::InitWidget passing in the mini tool rects:

figure 8.4.6.b. CTool Tool Widget Rects

```
const PMRect kStandardToolRect(0,0,26,22 );
const PMRect kMiniToolRect(0,0, 18,18);
const PMRect kMiddleMiniToolRect(0,0,17,18);
```

8.4.7. InDesign's trackers

The API provides many trackers and you may wish to dispatch control to one of them. These can be generally divided into trackers used by tools to manipulate document content (show in figure 8.4.7.a) and trackers used by user interface widgets to manipulate controls (shown in figure 8.4.7.b). The ClassID's needed by ITrackerFactory to make one of these trackers are given below.

figure 8.4.7.a. Tool related trackers

Widget ClassID	Tool ClassID	Tracker ClassID
kDCSItemBoss	kPathResizeToolBoss	kSplinePathResizeTrackerBoss
kDCSItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kDCSItemBoss	kScissorsToolBoss	kSplineScissorsTrackerBoss
kDCSItemBoss	kSplineAddPointToolBoss	kSplineAddPointTrackerBoss

figure 8.4.7.a. Tool related trackers

Widget ClassID	Tool ClassID	Tracker ClassID
kDCSItemBoss	kSplineDirectionToolBoss	kSplineDirectionTrackerBoss
kDCSItemBoss	kSplineRemovePointToolBoss	kSplineRemovePointTrackerBoss
kEPSItem	kPathResizeToolBoss	kSplinePathResizeTrackerBoss
kEPSItem	kResizeToolBoss	kBBoxResizeTrackerBoss
kEPSItem	kScissorsToolBoss	kSplineScissorsTrackerBoss
kEPSItem	kSplineAddPointToolBoss	kSplineAddPointTrackerBoss
kEPSItem	kSplineDirectionToolBoss	kSplineDirectionTrackerBoss
kEPSItem	kSplineRemovePointToolBoss	kSplineRemovePointTrackerBoss
kEPSTextItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kFrameItemBoss	kILGMoveToolImpl	kILGMoveTrackerBoss
kFrameItemBoss	kILGRotateToolImpl	kILGRotateTrackerBoss
kFrameItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kGenericToolBoss	kPrePlaceToolBoss	kPrePlaceTrackerBoss
kGroupItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kGuideItemBoss	kMoveToolBoss	kGuideMoveTrackerBoss
kHorzRulerWidgetBoss	kGuideToolImpl	kGuideCreationTrackerBoss
kIBeamToolBoss	kFrameToolBoss	kFrameTrackerBoss
kIBeamToolBoss	kTextSelectionToolBoss	kTextSelectionTrackerBoss
kIBeamToolBoss	kVerticalTextToolBoss	kVerticalFrameTrackerBoss
kImageItem	kPathResizeToolBoss	kSplinePathResizeTrackerBoss
kImageItem	kResizeToolBoss	kBBoxResizeTrackerBoss
kImageItem	kScissorsToolBoss	kSplineScissorsTrackerBoss
kImageItem	kSplineAddPointToolBoss	kSplineAddPointTrackerBoss
kImageItem	kSplineDirectionToolBoss	kSplineDirectionTrackerBoss
kImageItem	kSplineRemovePointToolBoss	kSplineRemovePointTrackerBoss
kLayoutWidgetBoss	kDirectSelectToolBoss	kDirectSelectTrackerBoss
kLayoutWidgetBoss	kEraseToolBoss	kEraseTrackerBoss
kLayoutWidgetBoss	kFreeTransformMoveToolBoss	kFreeTransformMoveTrackerBoss
kLayoutWidgetBoss	kFreeTransformRotateToolBoss	kFreeTransformRotateTrackerBoss
kLayoutWidgetBoss	kFreeTransformScaleToolBoss	kFreeTransformScaleTrackerBoss
kLayoutWidgetBoss	kFreeTransformToolBoss	kFreeTransformTrackerBoss
kLayoutWidgetBoss	kGrabberHandToolBoss	kGrabberHandTrackerBoss
kLayoutWidgetBoss	kGradientToolBoss	kGradientToolTrackerBoss

figure 8.4.7.a. Tool related trackers

Widget ClassID	Tool ClassID	Tracker ClassID
kLayoutWidgetBoss	kGroupSelectToolImpl	kGroupSelectTrackerBoss
kLayoutWidgetBoss	kIBeamToolBoss	kIBeamTrackerBoss
kLayoutWidgetBoss	kLayoutLockToolImpl	kLockTrackerBoss
kLayoutWidgetBoss	kLayoutSelectionToolImpl	kLayoutSelectionTrackerBoss
kLayoutWidgetBoss	kLineToolBoss	kLineTrackerBoss
kLayoutWidgetBoss	kOvalFrameToolBoss	kOvalFrameTrackerBoss
kLayoutWidgetBoss	kOvalToolBoss	kOvalTrackerBoss
kLayoutWidgetBoss	kPencilToolBoss	kPencilCreationTrackerBoss
kLayoutWidgetBoss	kPlaceToolBoss	kPlaceTrackerBoss
kLayoutWidgetBoss	kPointerToolBoss	kPointerTrackerBoss
kLayoutWidgetBoss	kRectFrameToolBoss	kRectangleFrameTrackerBoss
kLayoutWidgetBoss	kRectToolBoss	kRectangleTrackerBoss
kLayoutWidgetBoss	kReferencePointToolImpl	kReferencePointTrackerBoss
kLayoutWidgetBoss	kRegPolyFrameToolBoss	kRegPolyFrameTrackerBoss
kLayoutWidgetBoss	kRegPolyToolBoss	kRegPolyTrackerBoss
kLayoutWidgetBoss	kRotateToolBoss	kRotateTrackerBoss
kLayoutWidgetBoss	kScaleToolBoss	kScaleTrackerBoss
kLayoutWidgetBoss	kScissorsToolBoss	kScissorsTrackerBoss
kLayoutWidgetBoss	kShearToolBoss	kShearTrackerBoss
kLayoutWidgetBoss	kSmoothToolBoss	kSmoothTrackerBoss);"
kLayoutWidgetBoss	kSplineAddPointToolBoss	kAddPointTrackerBoss
kLayoutWidgetBoss	kSplineDirectionToolBoss	kConvertDirectionTrackerBoss
kLayoutWidgetBoss	kSplinePenToolBoss	kSplineCreationTrackerBoss
kLayoutWidgetBoss	kSplineRemovePointToolBoss	kRemovePointTrackerBoss
kLayoutWidgetBoss	kTOPHorzToolBoss	kTOPHorzToolTrackerBoss
kLayoutWidgetBoss	kTOPVertToolBoss	kTOPVertToolTrackerBoss
kLayoutWidgetBoss	kVerticalTextToolBoss	kVerticalTextTrackerBoss
kLayoutWidgetBoss	kZoomToolBoss	kZoomToolTrackerBoss
kMultiColumnItemBoss	kPlaceToolBoss	kPlacePITrackerBoss
kPageBoss	kMoveToolBoss	kColumnGuideTrackerBoss
kPageItemBoss	kMoveToolBoss	kMoveTrackerBoss
kPageItemBoss	kPlaceToolBoss	kPlacePITrackerBoss
kPICTItem	kPathResizeToolBoss	kSplinePathResizeTrackerBoss

figure 8.4.7.a. Tool related trackers

Widget ClassID	Tool ClassID	Tracker ClassID
kPICTItem	kResizeToolBoss	kBBoxResizeTrackerBoss
kPICTItem	kScissorsToolBoss	kSplineScissorsTrackerBoss
kPICTItem	kSplineAddPointToolBoss	kSplineAddPointTrackerBoss
kPICTItem	kSplineDirectionToolBoss	kSplineDirectionTrackerBoss
kPICTItem	kSplineRemovePointToolBoss	kSplineRemovePointTrackerBoss
kPlacedPDFItemBoss	kPathResizeToolBoss	kSplinePathResizeTrackerBoss
kPlacedPDFItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kPlacedPDFItemBoss	kScissorsToolBoss	kSplineScissorsTrackerBoss
kPlacedPDFItemBoss	kSplineAddPointToolBoss	kSplineAddPointTrackerBoss
kPlacedPDFItemBoss	kSplineDirectionToolBoss	kSplineDirectionTrackerBoss
kPlacedPDFItemBoss	kSplineRemovePointToolBoss	kSplineRemovePointTrackerBoss
kSplineItemBoss	kPathResizeToolBoss	kSplinePathResizeTrackerBoss
kSplineItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kSplineItemBoss	kScissorsToolBoss	kSplineScissorsTrackerBoss
kSplineItemBoss	kSplineAddPointToolBoss	kSplineAddPointTrackerBoss
kSplineItemBoss	kSplineDirectionToolBoss	kSplineDirectionTrackerBoss
kSplineItemBoss	kSplineRemovePointToolBoss	kSplineRemovePointTrackerBoss
kSplitterWidgetBoss	kSplitterWidgetBoss	kSplitterTrackerBossMessage
kStandOffPageItemBoss	kMoveToolBoss	kStandOffMoveTrackerBoss
kStandOffPageItemBoss	kPathResizeToolBoss	kStandOffResizeTrackerBoss
kStandOffPageItemBoss	kResizeToolBoss	kStandOffResizeTrackerBoss
kStandOffPageItemBoss	kSplineAddPointToolBoss	kStandOffAddPointTrackerBoss
kStandOffPageItemBoss	kSplineDirectionToolBoss	kStandOffDirectionTrackerBoss
kStandOffPageItemBoss	kSplineRemovePointToolBoss	kStandOffRemovePointTrackerBoss
kTOPSplineItemBoss	kTOPMoveToolBoss	kTOPMoveTrackerBoss
kTOPSplineItemBoss	kTOPResizeToolBoss	kTOPResizeTrackerBoss
kWMFItem	kPathResizeToolBoss	kSplinePathResizeTrackerBoss
kWMFItem	kResizeToolBoss	kBBoxResizeTrackerBoss
kWMFItem	kScissorsToolBoss	kSplineScissorsTrackerBoss
kWMFItem	kSplineAddPointToolBoss	kSplineAddPointTrackerBoss
kWMFItem	kSplineDirectionToolBoss	kSplineDirectionTrackerBoss
kWMFItem	kSplineRemovePointToolBoss	kSplineRemovePointTrackerBoss

figure 8.4.7.b. User interface widget related trackers

Widget ClassID	Tool ClassID	Tracker ClassID
kCmykColorSliderWidgetBoss	kCmykColorSliderWidgetBoss	kCmykColorSliderTrackerBoss
kColorSliderWidgetBoss	kColorSliderWidgetBoss	kColorSliderTrackerBoss
kGradientSliderWidgetBoss	kGradientSliderWidgetBoss	kGradientSliderTrackerBoss
kGroupItemBoss	kResizeToolBoss	kBBoxResizeTrackerBoss
kGuideItemBoss	kMoveToolBoss	kGuideMoveTrackerBoss
kHorzRulerWidgetBoss	kGuideToolImpl	kGuideCreationTrackerBoss
kHorzTabRulerBoss	kTabCreationToolImpl	kTabCreationTrackerBoss
kHorzTabRulerBoss	kTabMoveToolImpl	kTabMoveTrackerBoss
kHorzTextDocRulerBoss	kTabCreationToolImpl	kDocRulerTrackerBoss
kLabColorSliderWidgetBoss	kLabColorSliderWidgetBoss	kLabColorSliderTrackerBoss
kPencilFidelitySliderWidgetBoss	kPencilFidelitySliderWidgetBoss	kPencilSliderTrackerBoss
kPencilSmoothnessSliderWidgetBoss	kPencilSmoothnessSliderWidgetBoss	kPencilSliderTrackerBoss
kPencilWithinSliderWidgetBoss	kPencilWithinSliderWidgetBoss	kPencilSliderTrackerBoss
kRasterSliderCntrlViewBoss	kRasterSliderCntrlViewBoss	kRasterSliderTrackerBoss
kRgbColorSliderWidgetBoss	kRgbColorSliderWidgetBoss	kColorSliderTrackerBoss
kSpectrumWidgetBoss	kSpectrumWidgetBoss	kSpectrumTrackerBoss
kSplitterWidgetBoss	kSplitterWidgetBoss	kSplitterTrackerBossMessage
kStrokeParamsSliderBoss	kStrokeParamsSliderBoss	kStrokeParamsSliderTrackerBoss
kStructureSplitterWidgetBoss	kStructureSplitterWidgetBoss	kXorSplitterTrackerBoss
kThresholdSliderWidgetBoss	kThresholdSliderWidgetBoss	kThresholdSliderTrackerBoss
kTintSliderWidgetBoss	kTintSliderWidgetBoss	kColorSliderTrackerBoss
kToleranceSliderWidgetBoss	kToleranceSliderWidgetBoss	kThresholdSliderTrackerBoss
kTransparencySliderCntrlViewBoss	kTransparencySliderCntrlViewBoss	kXPSliderTrackerBoss
kVectorSliderCntrlViewBoss	kVectorSliderCntrlViewBoss	kVectorSliderTrackerBoss
kVertRulerWidgetBoss	kGuideToolImpl	kGuideCreationTrackerBoss
kVertTabRulerBoss	kTabCreationToolImpl	kTabCreationTrackerBoss
kVertTabRulerBoss	kTabMoveToolImpl	kTabMoveTrackerBoss
kVertTextDocRulerBoss	kTabCreationToolImpl	kDocRulerTrackerBoss
kZeroPointWidgetBoss	kGuideToolImpl	kGuideCreationTrackerBoss
kZeroPointWidgetBoss	kZeroPointToolImpl	kZeroPointTrackerBoss

8.5. Sample code

8.5.1. WaveTool

WaveTool shows how to implement two layout creation tools that track the mouse drag and create spline page items. It also shows how to implement a hidden tools panel.

8.5.2. ShapeSelector

ShapeSelector shows how to implement a layout selection tool that performs a hit test and selects items of similar shape to the clicked item.

8.5.3. Snapshot

Snapshot shows how to implement a layout manipulation tool that creates an image of a clicked spread using the SnapshotUtils API. It also shows how to implement a tool options dialog to specify the image format (JPEG, TIFF etc.) to be used and other parameters.

8.5.4. Dolly tool template

Dolly has a template that generates the boilerplate code for a custom tool that can handle a single button click in the layout view.

8.6. Frequently asked questions(FAQs)

8.6.1. What is the layout view?

See “The toolbox and the layout view” on page 238.

8.6.2. What is the toolbox?

See “The toolbox and the layout view” on page 238.

8.6.3. What is a tool?

See “Tools” on page 239.

8.6.4. What is a tracker?

See “Trackers” on page 240.

8.6.5. Where can I find sample code for tools?

See “Sample code” on page 265.

8.6.6. How do I catch a mouse click or mouse drag on a document?

The answer depends on the experience you want users have. If you want users to recognise you are going to handle the event you'll want a custom cursor in which case implement a custom tool, set your tool as the active tool then handle the mouse in your tracker (See "The toolbox and the layout view" on page 238.). Otherwise you likely wish to handle the event behind the scenes without the user receiving any visual cue. In this case you will use some other stimulus, for example a change in selection, to push an event handler onto the event handler stack. If in doubt which to choose use a tool and tracker, it's the recommended way to catch mouse events in a layout view on a document.

8.6.7. How do I implement a custom tool?

For the theory read "Key concepts" on page 238, for the design read "Custom tools" on page 251, for the code use Dolly's tool template to generate the boilerplate and add the functionality you want. Or study one of the sample tool plug-ins on the SDK and adapt it to your needs (see "Sample code" on page 265).

8.6.8. How do I display a tool options dialogue?

Specialize the DisplayOptions and/or DisplayAltOptions methods in your ITool implementation.

8.6.9. How do I find the spread nearest the mouse position?

When implementing a tracker you need to handle the fact that the user can click on any spread in a layout view and your tracker will need to find which spread has been clicked on. To do this transform the position from the system to pasteboard co-ordinate system then use one of the methods you'll find on IPasteboardUtils as illustrated in figure 8.6.9.a.

figure 8.6.9.a. Finding the spread nearest the mouse location

```
PMPoint currentPoint = Utils<ILayoutUtils>()->
  GlobalToPasteboard(layoutView, where);
InterfacePtr<ISpread> targetSpread(Utils<IPasteboardUtils>()->
  QueryNearestSpread(layoutView, currentPoint));
```

8.6.10. How do I change spreads?

When implementing a tracker you need to handle the fact that the user can click on any spread in a layout view. A layout view caches the current spread in interface ILayoutControlData and your tracker may need to change this if the

spread that has been clicked on is different. Process kSetSpreadCmdBoss to change to another spread.

8.6.11. How do I perform a page item hit test?

ILayoutControlViewHelper provides page item hit testing methods that can be used as illustrated in figure 8.6.11.a.

figure 8.6.11.a. Performing a hit test

```
bool16 HitTest(IControlView* layoutView, const PMPoint& location)
{
  InterfacePtr<ILayoutControlViewHelper> iLVCHelper
  (
    layoutView,
    UseDefaultIID()
  );
  if (iLVCHelper == nil)
    return kFalse;
  InterfacePtr<IGeometry> iPageItem
  (
    static_cast<IGeometry *>
      (
        iLCVHelper->QueryHitTestPageItemNew(location,
        kPtrHitTestHandlerBoss)
      )
  );
  return iPageItem != nil ? kTrue : kFalse;
}
```

8.6.12. How do I set/get the active tool?

IToolBoxUtils provides methods that do this that you can use as illustrated in figure 8.6.12.a.

figure 8.6.12.a. Getting and setting the active tool

```
ClassID toolType = kPointerToolBoss;
InterfacePtr<ITool> currentTool(
  Utils<IToolBoxUtils>()->QueryActiveTool(toolType));
InterfacePtr<ITool> targetTool(
  Utils<IToolBoxUtils>()->QueryTool(kRegPolyToolBoss));
if (targetTool && currentTool != targetTool) {
  Utils<IToolBoxUtils>()->SetActiveTool(targetTool, toolType);
}
```

8.6.13. How do I observe when the active tool changes?

Attach an observer (see interface IObserver) to kToolManagerBoss and in your Update method detect the IID_ITOOLMANAGER protocol for the change kSetToolCmdBoss.

8.6.14. How do I change the toolbox appearance from normal to skinny?

Use kSetToolboxPrefsCmdBoss to change the IToolboxPreferences.

8.6.15. Can I use the default implementations for trackers?

Yes, your tracker can create and dispatch control to one of the trackers supplied by the application. For example to perform a marquee selection you could create and dispatch control to a kLayoutSelectionTrackerBoss. For a complete listing of all the trackers provided by the API see figure 8.4.7.a.

8.7. Summary

Tools manipulate objects in a document by tracking the mouse, providing dynamic user feedback and processing commands. To add a new tool you must write the code for the boss classes, the interface implementations and the resources that make up a tool. The API provides basic building blocks to start from in the form of helper implementations and default implementations. There are several reference tool samples on the SDK that show how these can be used.

8.8. Review

You should be able to answer these questions:

1. Which boss objects would you expect to see in a typical tool? (8.4.2., page 251)
2. Give the purpose of the following interfaces: IToolRegister, ITool, ICursorProvider. (8.4.2., page 251)
3. What does the generic tool boss do for you? (8.4.2., page 251)
4. What is a tracker? (8.3.5., page 240)
5. What is the tracker factory? (8.3.6., page 240)
6. What is the purpose of the IEventHandler interface on a tracker boss class? (8.4.2., page 251)
7. Can a tracker have more than one behavior e.g. move and resize? (8.3.11., page 246)
8. Which IToolboxUtils method is used to set the active tool? (8.6.12., page 267)
9. If you wanted your tool to appear in a hidden tools panel what would you set the parent tool of the ToolDef resource to be? (8.4.5., page 257)

10. Which ToolDef resource controls the grouping of tools in the toolbox? (8.4.5., page 257)
11. Are icons and cursors specified in a cross platform format? (8.4.6., page 260)
12. Which ITool method would you specialize if you wanted to display a tool options dialogue? (8.6.8., page 266)
13. Which ITracker method is called to start tracking the mouse? (figure 8.4.3.a., page 253)
14. Which CPathCreationTracker method would you specialize to identify the path describing the page item to be created? (figure 8.4.3.a., page 253)
15. What would the side effects be of a tool that creates or modifies document content returning kFalse to a call to ITool::IsCreationTool()? (figure 8.4.3.a., page 253)

8.9. Exercises

8.9.1. Exercise 1

Run the WaveTool sample plug-in under the control of the debugger with the following breakpoints set:

- WaveTrackerRegister::Register
- SawWaveTool::Init
- SineWaveTool::Init
- SawWaveTracker::MakePath
- SineWaveTracker::MakePath

8.9.2. Exercise 2

Modify the WaveTool's SawWaveTracker implementation to create a rectangle oriented along the line on which the user is dragging the mouse.

Hint: there's code in **SawWaveTracker.cpp** to get you started.

8.9.3. Exercise 3

Modify the ShapeSelector sample's tracker to select shapes which do not match the shape chosen by the user.

8.9.4. Exercise 4

Modify the ShapeSelector's tracker to draw a marquee selection and select all shapes matching the shapes touched by the marquee.

Hint: the API provides a default tracker implementation that does this, kLayoutSelectionTrackerBoss.

8.10. References

- Abrash, Michael. *Graphics Programming Black Book Special*, The Coriolis Group.
- Foley, James D. *Introduction to Computer Graphics*, Addison-Wesley.
- Foley, James D. et al. *Computer Graphics : Principles and Practice*, Addison-Wesley.
- Adobe User Education. *Adobe InDesign User Guide*, 2001.
- Adobe InDesign SDK. *Technical Note #10070 Command reference*, 2002.
- Adobe InDesign SDK. *Technical Note #10050 User interface programming model*, 2002.
- Adobe InDesign SDK. *Technical Note #10056 User interface widgets*, 2002.

9.

Page Items

9.0. Overview

This chapter introduces page items, the building-block elements for an InDesign document. It covers the detailed information about page items, important interfaces for page item objects, creating and manipulating them in your plugins.

9.1. Goals

The questions this chapter addresses are

1. What is a page item?
2. What are the required interfaces for a page item?
3. What are the native page item bosses InDesign supports?
4. What are the commands to manipulate page items?
5. What are the content fitting settings and how can you use commands to control them?
6. What are page item standoffs?

9.2. Chapter-at-a-glance

"9.3.Class Diagram" on page 272 shows the native page item objects in InDesign.

"9.4.Example Of Page Items" on page 273 gives a couple examples of page items, spline item, image item and guide item along with their interface diagrams.

table 9.1.a. version history

Rev	Date	Author	Notes
1.0	8/28/2000	Jane Zhou	First Draft
1.1	10/10/2000	Jane Zhou	Second Draft
1.2	10/26/2000	Paul Norton	Add section for Specifier
1.3	10/29/2002	Jane Zhou	update to InDesign 2.0

“9.5.Page Items” on page 277 explains what a page item is.

“9.6.Interface Diagram” on page 283 illustrates the interface diagrams for InDesign supported native page items and provides a summary of each important interface.

“9.7.Working With Page Items” on page 288 provides some sample codes for working with page items.

“9.8.Specifiers” on page 297 explains the specifier and related interfaces and suite interfaces.

“9.9.Standoff Page Items” on page 300 explains what the standoff page item is.

“9.10.Commands For Page Items” on page 304 summarizes the set of commands to manipulate page items.

“9.11.Summary” on page 314 provides a summary of the content covered in this chapter.

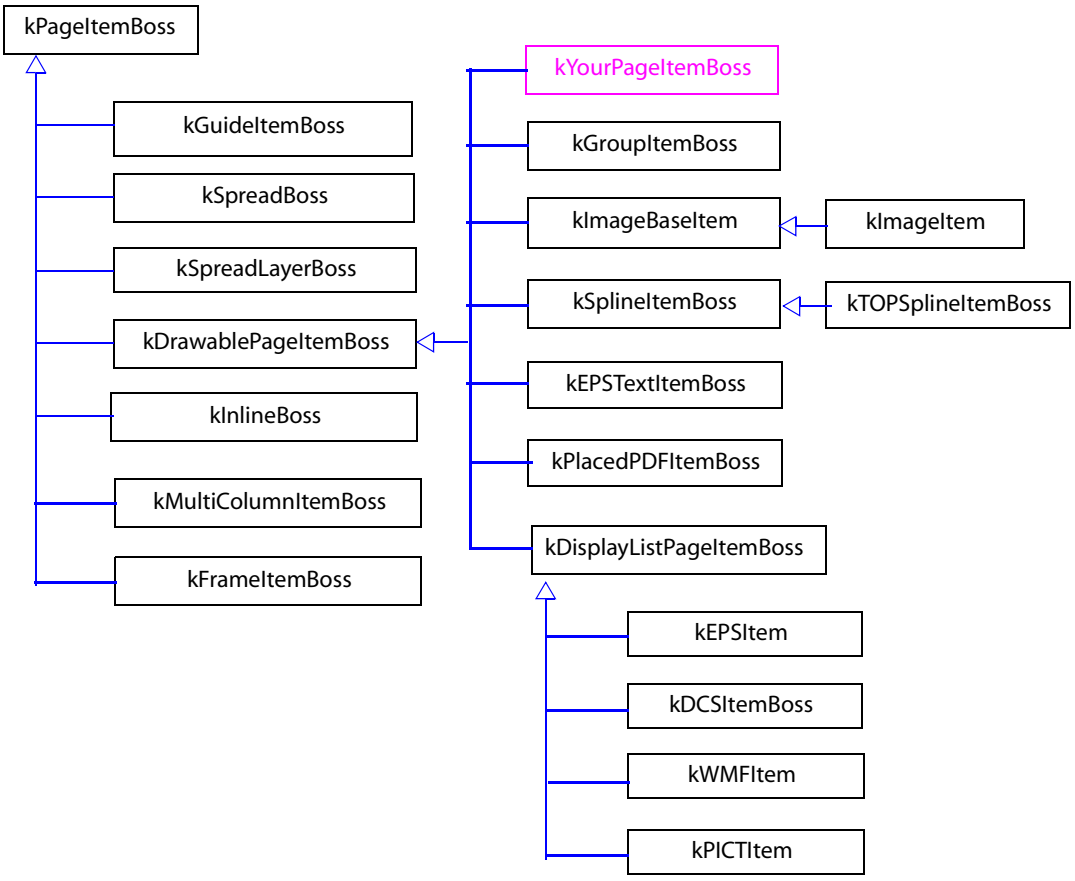
“9.12.Review” on page 314 provides some questions to test your basic understanding about page items.

“9.13.Exercises” on page 314 gives three exercises you might want to try after finish reading the chapter.

9.3. Class Diagram

In the "Document Structure" chapter we talked about page items as being part of the document content. They are the children of the spread layers. figure 9.3.a. shows the inheritance relationships between the page item objects in InDesign.

figure 9.3.a. Page Items Class Diagram



`kPageItemBoss` is the root of all InDesign page item boss classes. `kDrawablePageItemBoss` is the parent of all the drawable page items in a document. The InDesign object model is extensible so you can add your custom page item object to this diagram. For exampe, `kYourPageItemBoss` in figure 9.3.a.

9.4. Example Of Page Items

In the application, a page item could be a text frame, an image, a spline item, a guide, or a graphic frame with or without content. It is drawn in the document layout view window.

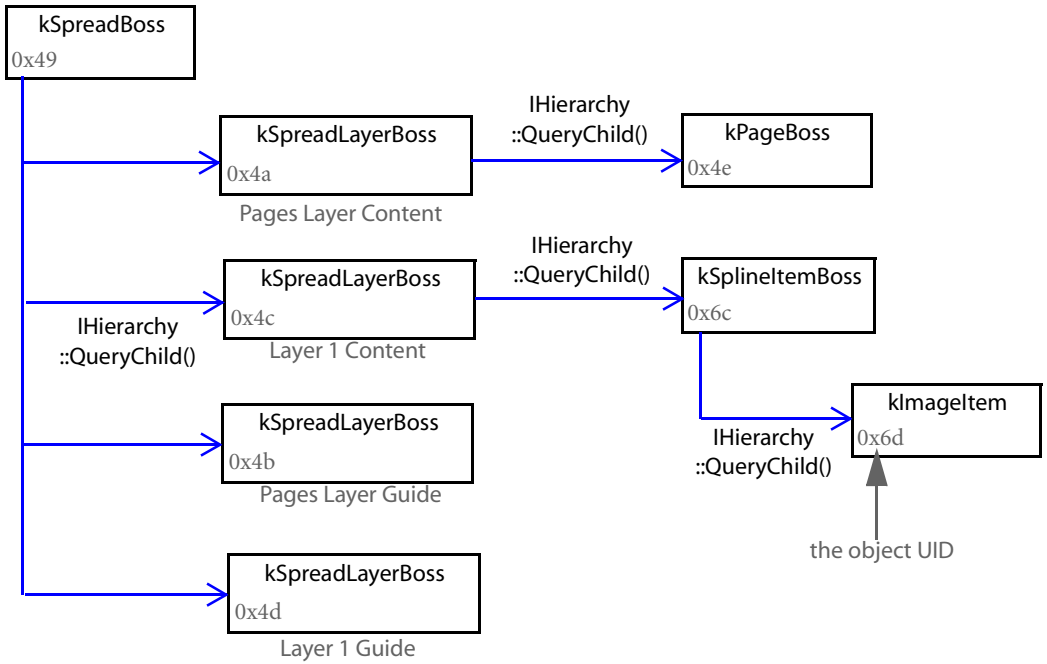
9.4.1. Spline And Image Item

The spline item and image item are two types of page items. figure 9.4.1.a. is a document that contains one spread and one page with an image. There is only one document layer in this sample document. To be more precise, there are two document layers (one page layer and the layer 1), but the page layer is not shown in the UI. The right hand view is the cropped frame so that you can see the image item is contained within a spline item. We set 10 points inset for the graphic frame just so you can see them.

figure 9.4.1.a. A Document Contains A Single Page With An Image

figure 9.4.1.b. shows the boss object tree. The layer one content is the layer on which the spline item (`kSplineItemBoss`) and image item (`kImageItem`) reside. The relationship between the spline item and the image item is maintained via the `IHierarchy` interface. You can navigate down from the spline to its associated image item using `QueryChild()` method in `IHierarchy` interface. On the other hand, you can navigate up from the image item to the spline item using `QueryParent()` method in `IHierarchy` interface. The hexadecimal number is the object UID for each boss in figure 9.4.1.b.

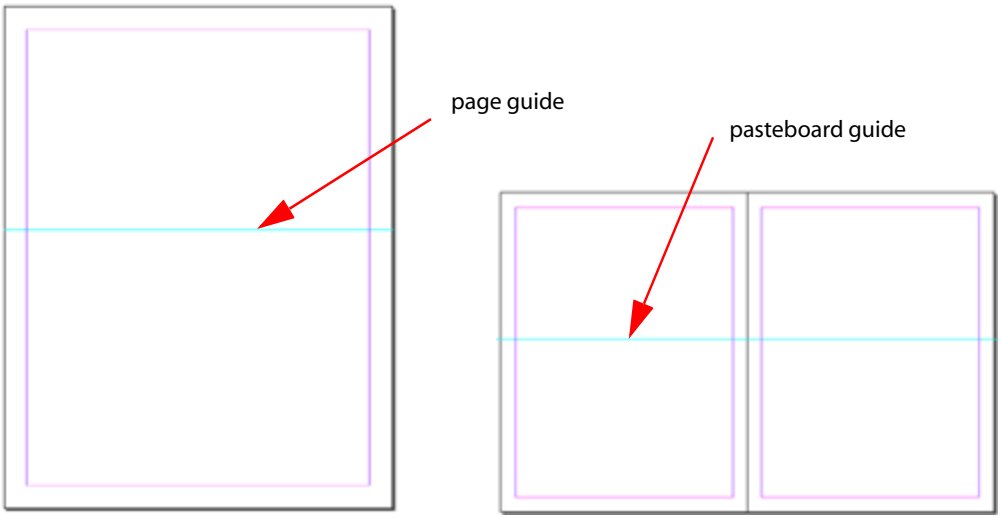
figure 9.4.1.b. Boss Object Tree For figure 9.4.1.a.



9.4.2. Guide Item

Guides can be positioned freely on a page or on a pasteboard. They are another type of page items. You can create two kinds of ruler guides: *page guides*, which appear only on the page on which you create them, or *pasteboard guides*, which span all pages and the pasteboard of a multiple-pages spread. When you add a ruler guide, it appears on the current target layer. The guide can be displayed or hidden with the layer on which it was created. figure 9.4.2.a. shows an example of both page guide and pasteboard guide.

figure 9.4.2.a. Guide Items Example

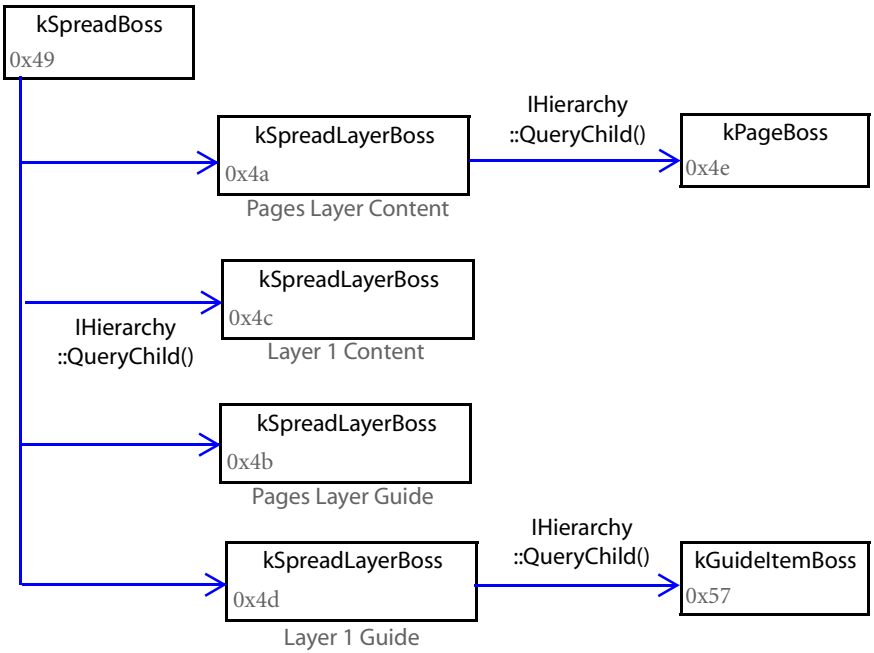


(a) One page per spread

(b) Two pages per spread

The left hand side screen shot is a page guide, while the right hand side is a pasteboard guide. There is only one layer in both examples. figure 9.4.2.b. shows the guide item is a child of the last spread layer, which is the guide layer for the spread's only content layer. For this specific example shown in figure 11.4.2.b, it's UID is 0x4d. Here interface `IHierarchy` maintains the relationship between the guide layer and the guide item.

figure 9.4.2.b. Boss Object Tree For figure 9.4.2.a. (a)



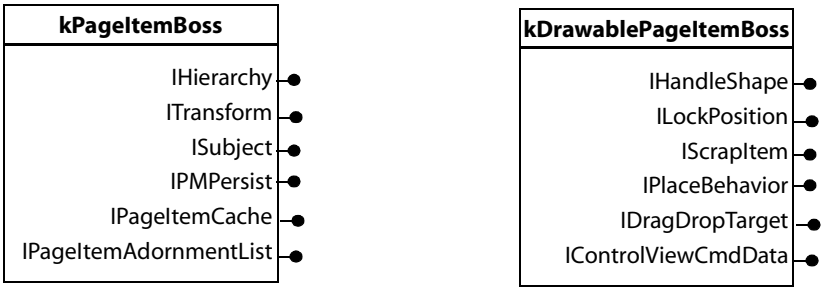
9.5. Page Items

9.5.1. What Is A Page Item?

Visually, a page item is a text frame, a spline item, an image, etc. Abstractly, in InDesign's object model a page item is a boss class, an object. Page items are the children of a spread within a document. Page items are defined in the resource definition just like you would define other objects in your plugin.

As figure 9.3.a shows, all page items inherit from `kPageItemBoss` which is the root of all page item objects. `kDrawablePageItemBoss` is a child of kPageItemBoss, which is the parent of all drawable page item objects, such as `kGroupItemBoss`, `kSplineItemBoss`, and `kPlacedPDFItemBoss`. In general, most page items are derived from either `kPageItemBoss` or `kDrawablePageItemBoss`. Through inheritance, there are a set of common interfaces that all the derived objects aggregate, as shown in figure 1.5.1.a.

figure 9.5.1.a. Common Interfaces



As you can see from the above interface diagram, the parent page item objects, such as `kPageItemBoss` and `kDrawablePageItemBoss`, do not aggregate interface `IShape` and `IGeometry`. This is because for those objects, there is no meaningful generic implementations for them. Interface `IGeometry` is used to specify the points that make up a page item, `IShape` is for drawing the page item. Those interfaces must be aggregated directly to the individual, meaningful page item objects, such as `kSplineItemBoss and kGuideItemBoss`. Hence, the set of interfaces required for a page item depends on the type of page item.

9.5.2. kPageItemBoss

A set of common interfaces aggregated by `kPageItemBoss` is illustrated in figure 9.5.1.a.

Page item objects form a part of the document **hierarchy** tree structure. Interface IHierarchy stores a persistent, UID-based structure that describes the page item's position in the document hierarchy. This interface provides methods to navigate between the parent and its children. The document hierarchy is used for storing page items in a tree structure. However, a page item, even one that aggregates the `IHierarchy`, need not be in the document hierarchy. This is not recommened if you are going to create your own custom page item. Otherwise, you would not be able to access all the page items on the spread while you are enumerating them. For example, in-line images are not on the page item hierarchy like the other page items. The root for the in-line images is not the spread layer, but rather itself, `kInlineBoss`. The object that owns the in-line image is part of the text model, `kOwnedItemStrandBoss`.

ITransform is a persistant interface containing transformation data for a page item. The transformation data is provided in the transform matrix and the type of the transformation, which could be the combination of moving, rotating, scaling and skewing. Each page item has it's own coordinate space, called inner coordinates. Points in that coordinate space can be translated to the containing parent coordinate space using the matrix obtained from ITransform. In other words, the transformation matrix is a conversion between the page item's inner coordinate space and its parent's coordinate space. If you take the information from a page item's IGeometry and apply the matrix from the page item's ITransform, you would have the page item's geometry data in its parent's coordinate space, either a group item, or a spline item or a spread layer, or even another page item.

There are couple of useful functions in TransformUtils.h that help to get the transform matrix. See the header file for more details. If you want to convert from one coordinate space to another, you need to combine the conversions step-by-step from the page item to the desired space.

When applying a transformation to a page item, you can choose to transform either the item only or the item and its children. All most all the transform methods provide this option. See ITransform.h for TransformAction enum definition.

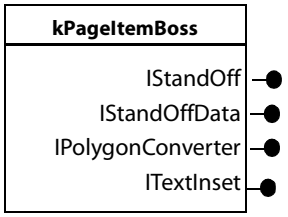
ISubject defines the "subject" of a change, part of the application's MVC notification mechanism. The inclusion of interface IPMPersist makes the page item object a persistent object. Any change to the object should be done through a command.

The purpose of IPageItemCache is to provide cache invalidation notifications for the page item. The default implementation for this interface forwards the changes to the appropriate interface, such as interface IGeometry, IPathGeometry, and IShape.

IPageItemAdornment maintains a list of adornments the page item object may have. Please refer to "Page Item Adornments" for more information.

For a page item that has standoff, the following interfaces were added to kPageItemBoss. See figure 9.5.2.a. We will cover those four interfaces in section "Standoff Page Items" on page 300.

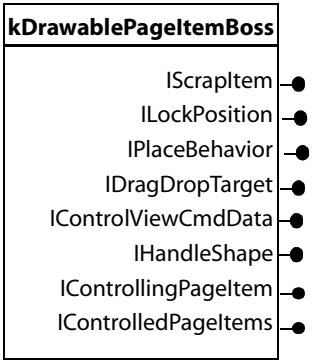
figure 9.5.2.a. Added Interfaces For kPageItemBoss



9.5.3. kDrawablePageItemBoss

Many InDesign page item objects share several additional interfaces that have useful generic implementations. `kDrawablePageItemBoss`, which is derived from `kPageItemBoss`, is the most frequently used object. In fact, except for text frames, guide items and inline images, all other InDesign page item objects are derived from `kDrawablePageItemBoss`.

figure 9.5.3.a. Interface Diagram For kDrawablePageItemBoss



The interface `IScrapItem` is the clipboard interface for all selectable objects. This interface is used to get a command that can delete, copy, or paste the item. It supports generic commands for page items, such as `DeleteCmd`, `PasteCmd`, `CopyCmd`.

There is also a utility class, IScrapUtils, which provides a set of copy page item objects functions. For example, if you want to copy a page item, including its children, into a different database, you could use IScrapUtils::CopyPageItemObject(), or IScrapUtils::CopyPageItemObjects().

All selectable page items should include interface `ILockPosition`. This will allow you to lock or unlock a page item position on the page. The interface

`IPlaceBehavior` specifies the placement behavior for a page item. It deals with placement of graphics, images, splines, and multiple frames. It includes the methods to support both the source of a placement operation and the target page item.

`IDragDropTarget` and `IControlViewCmdData` are for dragging and dropping to create new page items, such as from external applications.

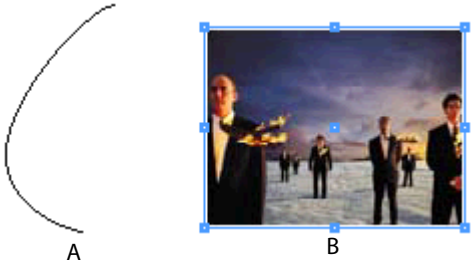
`IControllingPageItem` is used by master page overrides. It controls whether certain changes on a master page item are forwarded to overrides of that item. It is used in conjunction with `IControlledPageItems`, which is for keeping a list of dependent page items for a master page item.

9.5.4. Path

A path defines shapes and regions of all sorts. You can use paths to draw lines, specify boundaries of filled area, and define templates for clipping other graphics. A path is composed of straight and/or curved line segments. These segments may connect to one another by a control point or they may be disconnected. A path is either open or closed.

You can put text or graphics inside a path. When you put contents inside an open or closed path, we also call the path as a frame. Paths are spline items.

figure 9.5.4.a. Example Paths



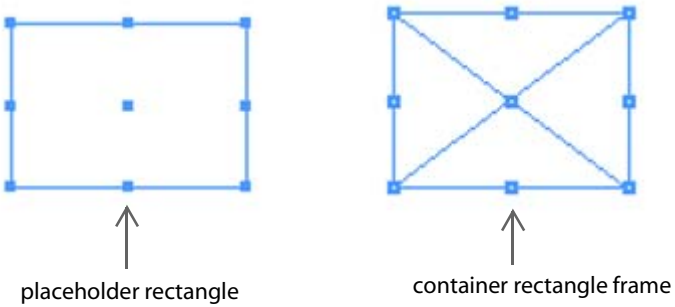
A. open path **B.** Imported image inside a frame (close path)

9.5.5. kSplineItemBoss

9.5.5.1. Introduction

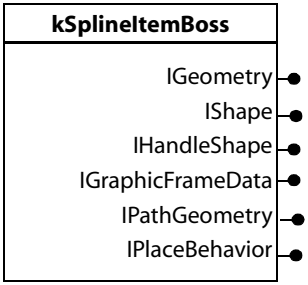
When using the tools in the tool palette to draw paths such as lines, rectangles, ellipses, and regular polygons on a page, the end user creates spline items, also called frames. Frames are identical to paths, with only one difference -- they can be containers for text or other objects. A frame can also be a placeholder when it is a container without content. See figure 9.5.5.1.a. Frames are the basic containers in a document's layout.

figure 9.5.5.1.a. Sample Spline Items



`kSplineItemBoss` is derived from `kDrawablePageItemBoss`, with a set of extra aggregated interfaces, such as IShape and IGraphicFrameData, as shown in figure 9.5.5.1.b.

figure 9.5.5.1.b. Interface Diagram For kSplineItemBoss



`IGeometry` is used for keeping track of the page item's dimensions. It calculates the bounding box of the page item. However, it makes no assumption about the shape of the item. It is designed to be a "geometry independent" way of defining an object. The data that `IGeometry` contains is all in inner coordinate space. The

origin for the page item inner coordinate space is coincident with the origin of its parent's coordinate space at the time the page item is created. Thereafter, `IGeometry` does not take into account the rotation, translation, shearing, or scaling of a page item.

Page items are defined by one or more points. It is up to the implementer of the page item to decide how to interpret these points in order to get its bounding box. Hence, there are two sets of methods, one for bounding box with stroke (also known as geometry bounding box) and one for bounding box without stroke (also known as path bounding box). For some page items, such as images, the path bounds and stroke bounds are the same.

When setting the page item's stroke or path bounding box, you could specify whether or not you want to resize its related children. This is defined in IGeometry.h `SetAction` enum type. Those values are hints to the implementation on how to set the bounds of the item and its children though.

`IPathGeometry` is a required interface for spline type page items. It is designed to support geometric data. It encapsulates the points and segments that make up a spline. Path geometry can contain multiple paths. Each path is either open (the default) or closed. The relationship between the paths is only that they exist as part of the same object.

When an image that has a clipping path defined is placed into a frame, the path of the frame (kSplineItemBoss) is set to be the clipping path from the image. However, the clipping path is not a separate entity associated with the image.

`IShape` is for drawing the spline item. It encapsulates the functions for drawing, hit testing, and iterating page items. See the "Page Item Drawing" chapter for more information.

`IGraphicFrameData` is also a required interface for spline items. It specifies the content in the graphic frame. A specific example of using this interface is presented in section "9.7.1.Detecting Frame Content" on page 288.

9.6. Interface Diagram

figure 11.6.a shows the interface diagrams for various application page item objects. Interfaces `IHierarchy`, `IShape`, `IGeometry` and `ITransform` are common

to all page items. They are shown in a light gray color. Interfaces that are specific to that page item object are shown in black.

figure 9.6.a. Interface Diagrams For Page Items

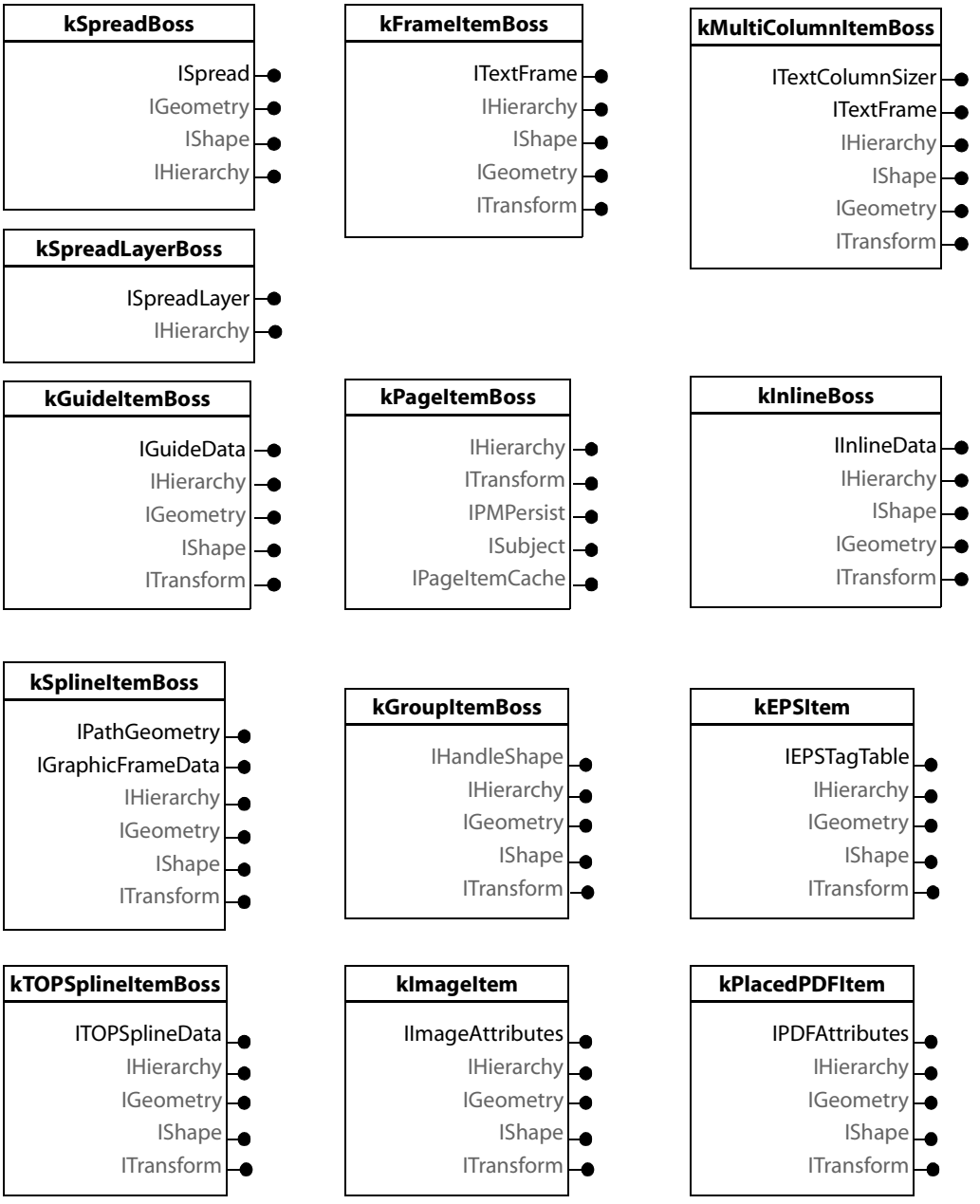
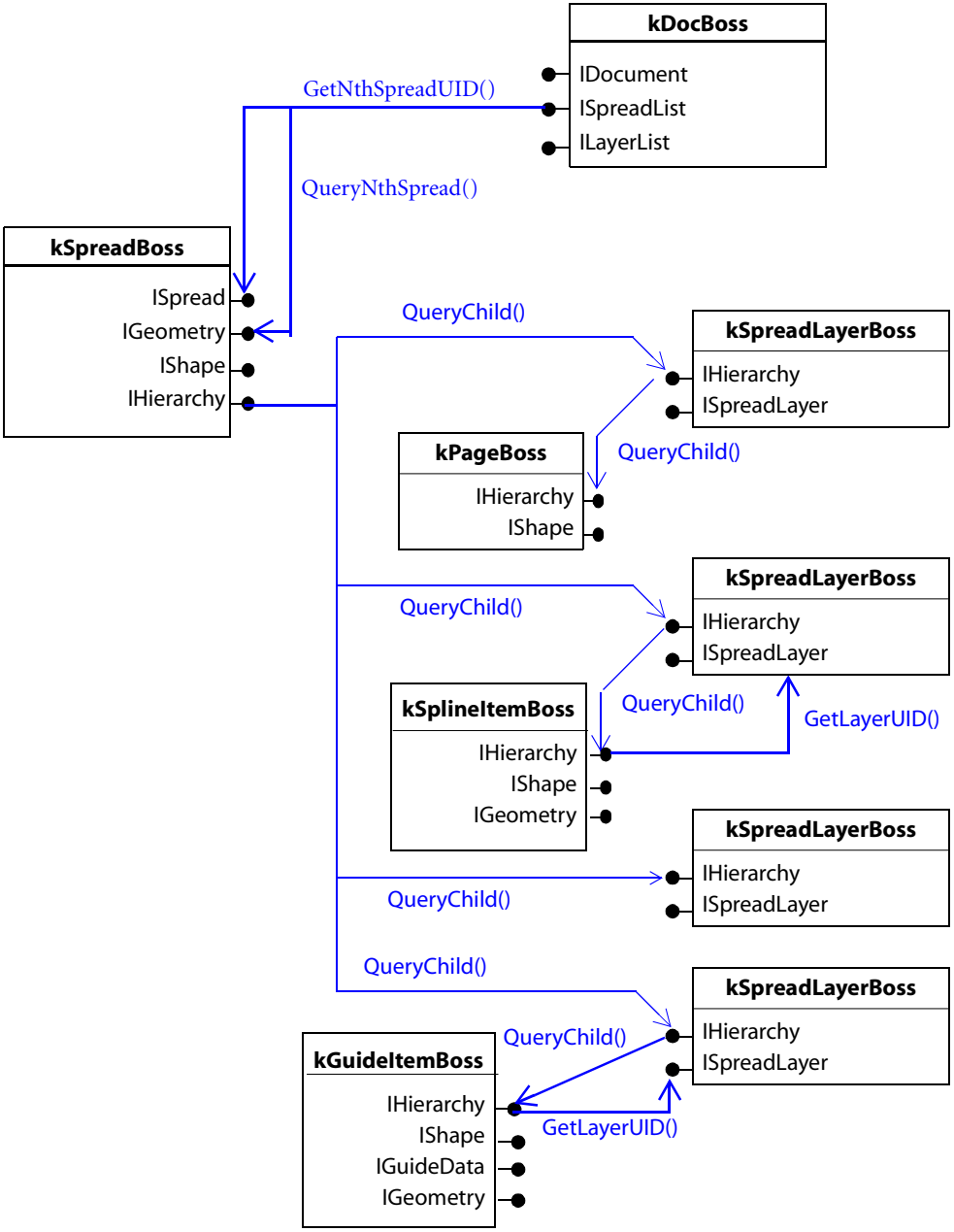
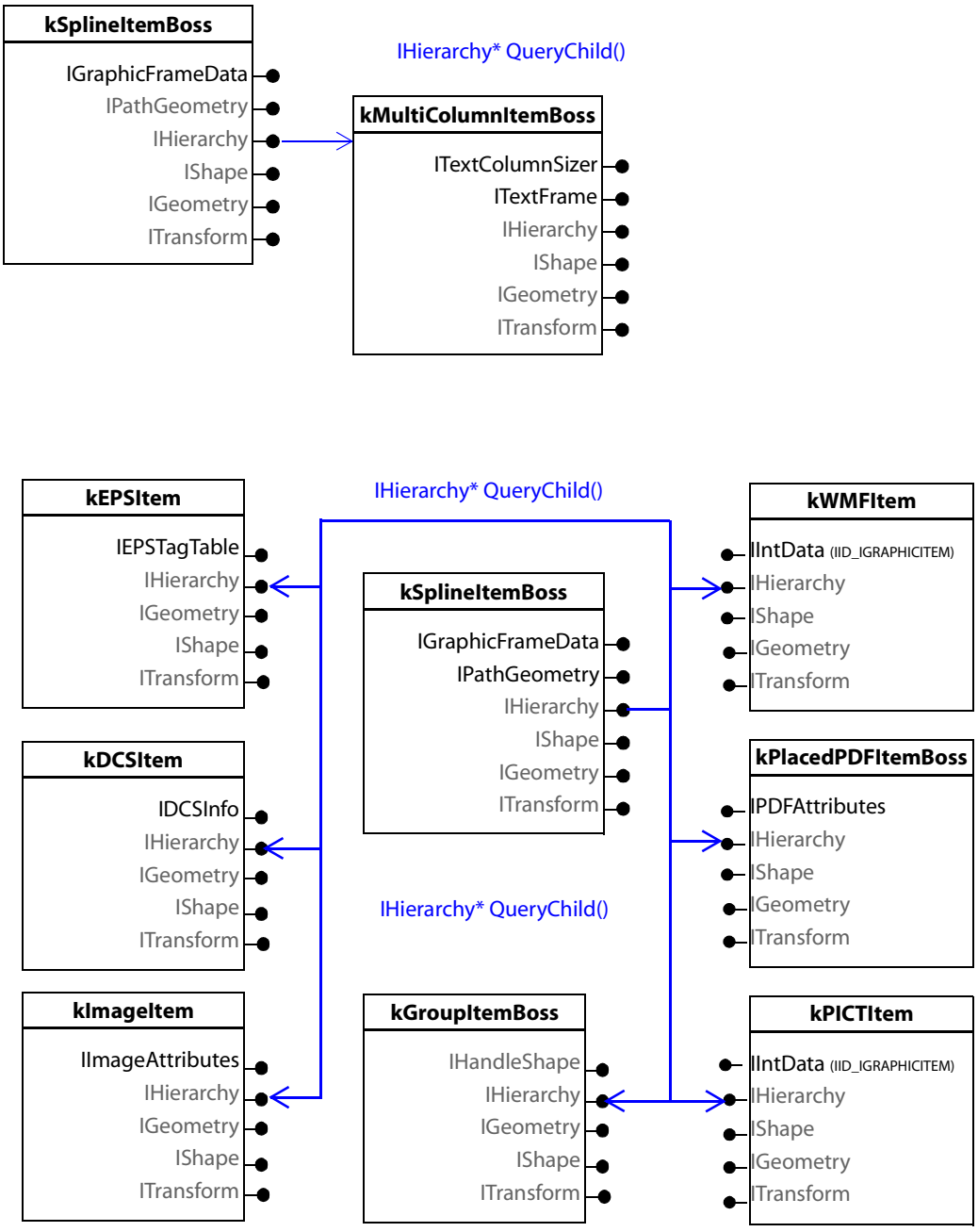


figure 11.6.b shows the navigation map between document, spreads, layers and spline items. The continuing figure shows how to navigate from spline item to the various content objects via the method `IHierarchy::QueryChild()`.

figure 9.6.b. Navigation Between Objects



(continued) figure 9.6.2.0. Navigation Between Page Item Objects



9.7. Working With Page Items

9.7.1. Detecting Frame Content

figure 9.7.1.a. shows a code snippet that detects the content of a frame. Suppose the UIDRef for the page item is `itemRef` in this example. `IGraphicFrameData` is an interface for spline page items. The code uses this interface to determine the content for the specified page item.

figure 9.7.1.a. Detect The Graphic Frame Content

```
// Get the UID for the page item
InterfacePtr<IPMUnknown> item(itemRef, IID_IUNKNOWN);
UID uid = ::GetUID(item);

InterfacePtr<IHierarchy> itemHier(itemRef, IID_IHIERARCHY);
InterfacePtr<IGraphicFrameData> frameData(itemRef,
IID_IGRAPHICFRAMEDATA);
if (frameData)
{
  if (!frameData->HasContent())
  {
    if (frameData->IsGraphicFrame())
    {
      // empty graphic frame created by frame tools
      TRACE("UID %u is an empty graphic frame.\n", uid);
    } else {
      InterfacePtr<IPathGeometry> pathGeo(itemRef, IID_IPATHGEOMETRY);
      if (!pathGeo)
        return;
      PMPageItemType itemType = Utils<IPathUtils>()-
      >WhichKindOfPageItem(pathGeo);
      if (itemType == kIsLine)
        TRACE("UID %u is a line.\n", uid);
      else if (itemType == kIsRectangle)
        TRACE("UID %u is a rectangle.\n", uid);
      else if (itemType == kIsCircle)
        TRACE("UID %u is a circle.\n", uid);
      // Other shapes
      ......
    }
  } else {
    // This frame contains an embeded or linked image, or a placed pdf
    // or eps, PICT, WMF etc.
    ReportGraphicType(itemHier->QueryChild(0));
  }
} else {
  if (itemHier->GetChildCount() > 1)
    TRACE("UID %u is a group item.\n", uid);
  else
```

```
    // the graphic item is selected via the Direct Selection tool
    ReportGraphicType(itemHier);
}

// implementation of ReportGraphicType
void ReportGraphicType(IHierarchy* graphicHier)
{
  if (graphicHier == nil)
    return;

  if (Utils<IImageUtils> -> IsRasterImage(graphicHier))
  {
    if (Utils<IImageUtils> -> IsEmbeddedImage(graphicHier))
      TRACE("an embedded ");
    else
      TRACE("a linked ");
    TRACE("raster image.\n");
  } else if (Utils<IImageUtils> -> IsVectorGraphic(graphicHier)) {
    if (Utils< IImageUtils> -> IsEmbeddedImage(graphicHier))
      TRACE("an embedded ");
    else
      TRACE("a linked ");

    ClassID id = ::GetClass(graphicHier);
    if (id == kWMFItem)
    {
      TRACE("WMF file.\n");
      return;
    } else if (id == kPICTItem)
    {
      TRACE("PICT file.\n");
      return;
    }

    // Does it contain a placed PDF??
    InterfacePtr<IPDFAttributes> pdfData(graphicHier,
    IID_IPDFATTRIBUTES);
    if (pdfData)
    {
      TRACE("PDF file.\n");
      return;
    }

    // Does it contain an EPS??
    K2::scoped_ptr<UIDList> descendents(new
    UIDList(::GetDataBase(graphicHier)));
    if (!descendents)
      return; //out of memory
```

```
    graphicHier->GetDescendents(descendents, IID_IEPSTAGTABLE2);
    // the length should be 1 if it contains eps
    if (descendents->Length() == 1)
    {
      TRACE("EPS file.\n");
      return;
    }

    // Does it contains DCS file??
    InterfacePtr<IDCSInfo> dcsInfo(graphicHier, IID_IDCSINFO);
    if (dcsInfo)
    {
      TRACE("DCS file.\n");
      return;
    }

    TRACE("unknow file type.\n");
  } else {
    // Recursive call
    ReportGraphicType(graphicHier->QueryChild(0));
  }
}
```

9.7.2. Create A Page Item At The Page's Origin

When creating a page item, its coordinates are specified in pasteboard space. The item itself stores its inner bounds in `IGeometry`. figure 9.7.2.a. shows a code snippet which uses the transformation to create a page item, 100 by 100 square, at the page's origin. First we create the square at the page's origin. Then we transform it to the pasteboard space, and use `CreateRectangleSpline` to create the page item.

figure 9.7.2.a. Create A Square At The Page's Origin

```
// Get the active layer and the database
InterfacePtr<ILayoutControlData>
layoutControlData(::QueryFrontLayoutData());
InterfacePtr<IHierarchy> layerHier(layoutControlData->
QueryActiveLayer());
UIDRef layerRef(::GetUIDRef(layerHier));
IDataBase* db = layerRef.GetDataBase();

// Get the current page and its geometry
UIDRef pageUIDRef = UIDRef(db, layoutControlData->GetPage());
InterfacePtr<IGeometry> pageGeom(pageUIDRef, IID_IGEOMETRY);

// a 100 point square at the page origin
PMRect squareBBox(0, 0, 100, 100);
```

```
// When creating a page item, we specify its coordinates in pasteboard
// space, so we need to do the transformation from page to pasteboard.
PBPMRect squareBBoxPasteboard(squareBBox);
InnerToPasteboard(pageGeom, &squareBBoxPasteboard);

// create the item
UIDRef itemUIDRef = Utils<IPathUtils> ->
CreateRectangleSpline(layerRef, squareBBoxPasteboard,
INewPageItemCmdData::kGraphicFrameAttributes);
```

9.7.3. Which Page Does The Page Item Lie On?

The page item's parent is not the page (kPageBoss) it lies on. It is the spread layer. Often times we would like to know which page the page item is on. Unfortunately, there is no utility function that would answer this question directly for a given page item.

There are couple ways to get the page number for a specified page item. Here is a recommended way to do this. Page items are the children of a spread layer. Use `ISpread::GetItemsOnPage()` to build a data structure that maps each page item UID to a page. When you iterate through the page items, you can look up each item you visit in your data structure and determine the page.

Another way to look at the problem is through the calculation of an item's geometry since InDesign looks at the geometry of an item in relation to the pages on a spread to determine its page. The rule is: if a page item whose bounding box most overlaps the page's bounding box, then that is the page the item lies on. Or if the item overlaps each page equally, then we consider the left page is the page the page item lies on. This applies when the binding is set to the left side of the publication, which is the default setting.

Figure 9.7.3.a. shows you the third way. Note the `itemRef` in the code is the UIDRef for the page item.

Figure 9.7.3.a. Get The Page Number For A Specified Page Item

```
IDocument* document = GetFrontDocument();
// Get the list of all pages in the document
InterfacePtr<IPageList> pageList(document, IID_IPAGELIST);

InterfacePtr<IHierarchy> itemHier(itemRef, IID_IHIERARCHY);
if (!itemHier)
  return;

//Get the pageIndex for this item
```

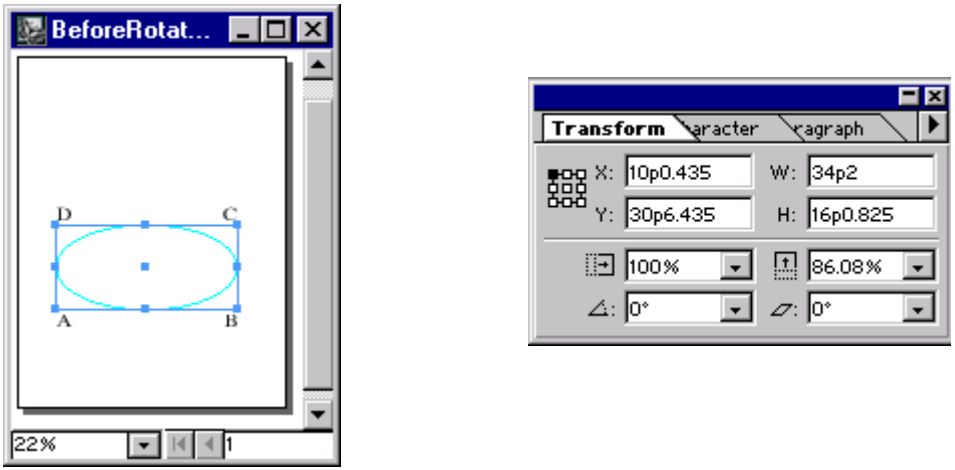
```
UID pageUID = ::GetOwnerPageUID(itemHier);

PMString pageString;
InterfacePtr<IPageNumberPrefs> iPageNumberPrefs((IPageNumberPrefs*)
  ::QueryPreferences(IID_IPAGENUMBERPREFS, kGetSessionPrefs));
bool16 bOrdinal = iPageNumberPrefs &&
  iPageNumberPrefs->GetOrdinalNumbering();
if (bOrdinal)
  pageList->GetPageString(pageUID, &pageString, kFalse, kTrue,
    kOrdinalType, kTrue);
else
  pageList->GetPageString(pageUID, &pageString, kTrue, kTrue,
    kActualType, kTrue);
// the pageString now has the page number for this item.
```

9.7.4. Get a rotated page item's bounding box

Each page item has three bounding boxes: path bounding box, geometry bounding box and painted bounding box. The path bounding box includes only the path and is only for path-based page items. Objects that don't have paths, such as images, won't have a path bounding box. The geometry bounding box, also known as the stroke bounding box, encompasses everything about the object, including corner styles, stroke weight, and line endings. For images, the geometry bounding box is the image's bounds. For group items, it will be the conglomeration of all its children. The painted bounding box is the bounds used for invalidation of page items.
Since interface `IGeometry` is a required interface for all page items, there are helper functions that help you to get the stroke bounds and path bounds of a specific page item, or even for a list of page items. See PageItemUtils.h for the various helper methods.

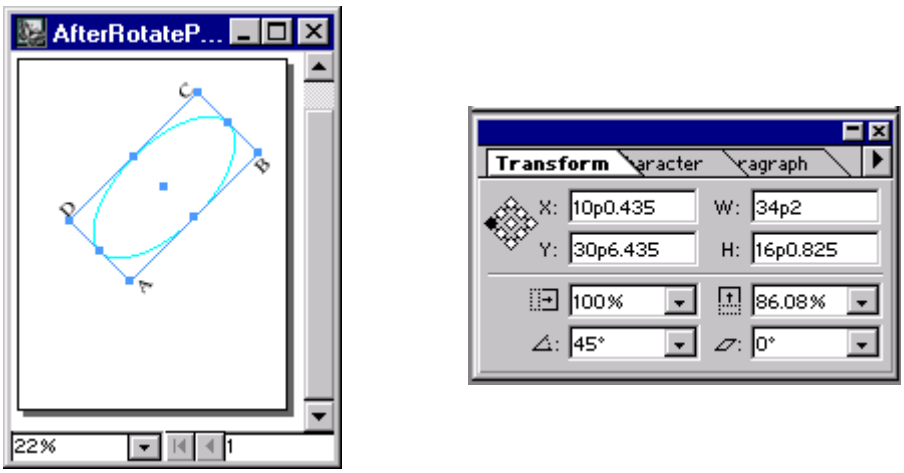
The following example shows how to get the bounding box for a rotated page item. In figure 9.7.4.a., an oval page item is selected and its bounding box is labeled as A, B, C, and D. On the right hand side is the snap shot of the Transform panel for the oval item.

figure 9.7.4.a. Page Item And Its Transform Panel Before The Rotation



Now suppose we rotate the oval item 45 degrees anti-clockwise, the page item and its bounding box would look like this:

figure 9.7.4.1.a. Page Item And Its Transform Panel After Rotating 45 Degree



Suppose we want to get the coordinates of the bounding box, specifically the coordinates for points A, B, C and D after the rotation. Note, the reference point in this example is at the top left corner, which is the default for the application. Since the bounds we get from `GetStrokeBoundingBox()` is in page item's inner coordinate space, we need a transform matrix to translate those bounds into the proper coordinate space. The `ITransform` interface would give

us the appropriate matrix if we need to get the page item's parent. However, there are cases where the parent's coordinate space isn't helpful by itself, for example group page items. In those cases, we need the transformation that would translate the points to the spread coordinate space, and `InnerToArbitraryParentMatrix` from TransformUtils.h can do that.

The following code snippet will show you how to get the coordinates for points A, B, C, and D after the rotation.

figure 9.7.4.1.a. Get The Coordinates For A. B. C. and D

```
InterfacePtr<ISelection> selection (::QuerySelection());
if (!selection)
  return; // Handle error

UIDList uidList = selection->GetUIDList();

// For simplicity, we only consider one item selected in this example
if (uidList.Length() == 1)
{
  InterfacePtr<IGeometry> itemGeom(uidList.GetRef(0), IID_IGEOMETRY);
  if (!itemGeom)
    return;

  // Get the inner bounding box for the selected item
  PMRect innerBBox = itemGeom->GetStrokeBoundingBox();
  PMPoint A(innerBBox.LeftBottom());
  PMPoint B(innerBBox.Right(), innerBBox.Bottom());
  PMPoint C(innerBBox.RightTop());
  PMPoint D(innerBBox.Left(), innerBBox.Top());

  InterfacePtr<IHierarchy> itemHier(uidList.GetRef(0),
  IID_IHIERARCHY);
  if (!itemHier)
    return;

  InterfacePtr<ILayoutControlData>
  layoutData(::QueryFrontLayoutData());
  if (!layoutData) // This should not happen.
    return;

  IDocument* document = layoutData->GetDocument();
  IDataBase* database = ::GetDataBase(document);

  UID pageUID = GetOwnerPageUID(itemHier);
  InterfacePtr<IGeometry> pageGeom(database, pageUID, IID_IGEOMETRY);
  if (!pageGeom)
```

```
    return;

  // Get the spread hierarchy
  InterfacePtr<IHierarchy> spreadHier(itemHier->QueryRoot());
  if (!spreadHier)
    return;

  PMMatrix page2Spread;
  ::InnerToArbitraryParentMatrix(&page2Spread, pageGeom, spreadHier);

  PMMatrix item2Spread;
  ::InnerToArbitraryParentMatrix(&item2Spread, itemGeom, spreadHier);

  PMMatrix item2Page = item2Spread;
  PMMatrix spread2Page = page2Spread;
  spread2Page.Invert();
  item2Page.PostConcat(spread2Page); // item2Spread * spread2Page

  // Get the coordinates for A, B, C, and D relative to the pageÕs
  // origin.
  item2Page.Transform(A);
  item2Page.Transform(B);
  item2Page.Transform(C);
  item2Page.Transform(D);

  // Get the width and height for the bounding box
  PMRect strokeDim = PageItemUtils::GetStrokeDimensions(uidList);
  PMReal width = strokeDim.Width();
  PMReal height = strokeDim.Height();

  // Get the rotation, skew, and scale
  PMReal rotation = item2Spread.GetRotationAngle();
  PMReal xSkew = item2Spread.GetXSkewAngle();
  PMReal xScale = item2Spread.GetXScale();
  PMReal yScale = item2Spread.GetYScale();

  // If you are using debugger version of InDesign, you could dump
  // those information into the trace window.
}
```

9.7.5. Place PDF Into A Page Item

There are two ways to place a PDF file or a file of any other format into a page item. You can use either the `ImportFileCmd or the PDFPlaceCmd`.

If you choose to use `ImportFileCmd`, you will need to manipulate the PDF place preferences for the session. Temporarily store the old value of the session preferences, then set your new preferences using the `kSetPDFPlacePrefsCmd`.

This command has a data interface IPDFPlacePrefs with methods to set each preference value. After the execution of the kSetPDFPlacePrefsCmd, you could call ImportFileCmd. Then you can restore the preferences you saved before using the kSetPDFPlacePrefsCmd. It would be a good idea to wrap the three commands' in a command sequence. If any one fails, the code could abort gracefully.

Using PDFPlaceCmd has more flexibility, but you need to do more work. In order to create a link between the page item and the original PDF file, you need to attach a data link after the file is imported into the page item. This is because the application puts a rasterized image of the file into the page item. When the high resolution file is needed, such as at the printing time, it will locate the original high resolution file via the data link to replace the low resolution one. If you use ImportFileCmd or other import service providers, the appropriate data link will be created for you.

The information about a data link for a page item is not stored in the page item itself. Instead, it is stored in a separate boss object. For file links, the boss is a kDataLinkBoss. Page items store the UID of their associated kDataLinkBoss in their IDataLinkReference interface.

The GetUID() method returns the UID of the data link boss associated with this page item. For example, suppose you have a pointer to an object kPlacedPDFItemBoss, you would do this:

figure 9.7.5.a. Get The Data Link From The Associated Page Item

```
InterfacePtr<IDataLinkReference> itemDataLinkRef(placedPDFItem,
IID_IDATALINKREFERENCE);
UID dataLinkUID = itemDataLinkRef->GetUID();
if (dataLinkUID != kInvalidUID)
{
  InterfacePtr<IDataLink>
  dataLink(UIDrRef(::(GetDataBase(placedPDFItem), dataLinkUID),
  IID_IDATALINK);
  PMString* fileName = dataLink->GetFullName();
}
```

The data link boss also stores the UID of the page item it references:

figure 9.7.5.b. Get The Page Item From The Attached Data Link

```
// suppose the dataLink is a boss of type kDataLinkBoss.
InterfacePtr<IDataLinkReference> dataLinkRef(dataLink,
IID_IDATALINKREFERENCE);
```

```
UID pageItemUID = dataLinkRef->GetUID();
```

There is a utility class `IDataLinkHelper` which provides methods to create, add and remove data link.

Figure 9.7.5.c. How to Use IDataLinkHelper

```
InterfacePtr<IDataLinkHelper> linkHelper((IDataLinkHelper*)::CreateObject(kDataLinkHelperBoss,
IID_IDATALINKHELPER));
InterfacePtr<IDataLink> iDL(linkHelper->CreateDataLink(sysFile));
```

There is a reason that you would want to use the `IDataLinkHelper`. Page items store the UID of their data link bosses, but not ref-counted pointers. Therefore, just storing the UID of a data link boss in the page item boss does not preserve the data link boss. For this reason, `DataLinkHelper::CreateDataLink()` purposely calls `AddRef()` on the data link boss. The `DataLinkHelper::RemoveDataLink()` does the equivalent of calling `Release()`. If you choose not to use the helper utility, you will be responsible for maintaining the ref-count of the data link boss.

9.8. Specifiers

We used specifiers in our old selection architecture. In the new selection architecture, this is no longer needed. So this section information is for supporting the old 1.x architecture and it will not be valid once the new selection architecture is completed in our code during InDesign 3.x time.

9.8.1. Definition

A specifier is a boss that aggregates an `ISpecifier`, and a set of suite interfaces. Both `ISpecifier` and the suite interfaces are data independent. A suite interface is a set of methods that perform operations on the specified data. A specifier boss also has a data dependent interface, such as `IPageItemSelector`, for setting the range of data specified by the boss.

9.8.2. Specifier Bosses

There are six specifier bosses defined in the application. They are:

- kPageItemSpecifierBoss
- kTextFocusBoss
- kNoPageItemSpecifierBoss
- kPathPointSpecifierBoss
- kGuideSpecifierBoss
- kInlineSpecifierBoss

kPageItemSpecifierBoss, as its name implies, this specifier has a list of page items. `IPageItemSelector` has the methods for creating and returning the list of page items. `IPageItemSelector` does not do a UI selection of the page items, it is really just a data interface.

kTextFocusBoss is a specifier aggregates the `ITextFocus`, which identifies a text location and range. Text focus is unique, in that the boss objects should not be created using `CreateObject`, but by using the `ITextFocusManager`, which is aggregated by `kTextStoryBoss`. See figure 9.8.2.a for an example. And "The Text Model" chapter for more information.

figure 9.8.2.a. Create A Text Focus Object

```
// Here model is a pointer to ITextModel
InterfacePtr<ITextFocusManager> focusMgr(model,
IID_ITEXTFOCUSMANAGER);
//a focus that identifies the first 'len' characters in a story.
InterfacePtr<ITextFocus> newFocus(focusMgr->NewFocus(0, len));
```

kNoPageItemSpecifierBoss is for the "empty specifier" case. Its most common use is in paste operations. The contents of the scrap are to be pasted, but you still need a specifier in the document that will receive the page items, that is what the `kNoPageItemSpecifierBoss` is for. This boss has an `IPageItemSelector`. In addition to calling `ISpecifier::Initialize`, client code must also supply `IPageItemSelector::Select(UIDList)` with an empty UIDList.

kPathPointSpecifierBoss is for identifying one or more path points. `IPageItemSelector` identifies the page item(s) whose points are specified. `IPathSelectionList` identifies the page items and the path points on those page items which are indicated. The client code is required to keep the two lists in sync. `kPathPointSpecifierBoss` is a subclass of `kPageItemSpecifierBoss`.

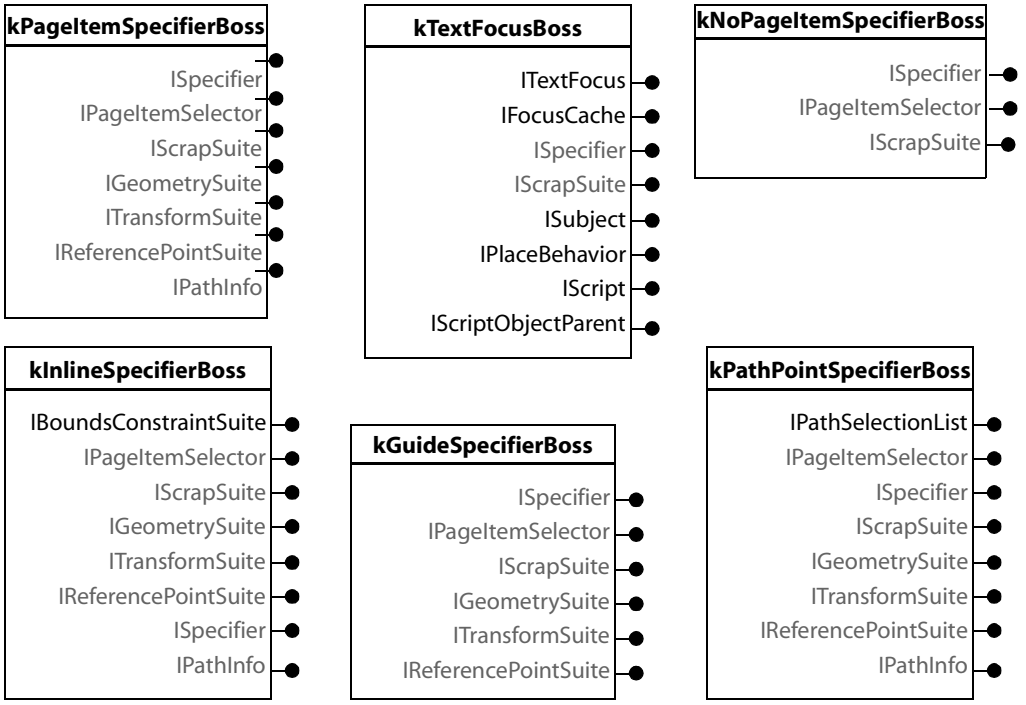
kGuideSpecifierBoss is the specifier for guides. You can copy, paste, transform, and manipulate guides, you can specify them for these operations too.

kInlineSpecifierBoss is actually much like the specifier for page items, but it also provides `IBoundsConstraintSuite`, since the range of movement is limited for an inline graphic.

9.8.3. Interface Diagram

The interface diagrams for the six specifiers are shown in figure 9.8.3.a. Interfaces that are common for all bosses are shown in a gray color.

figure 9.8.3.a. Interface Diagrams For Specifier Bosses



9.8.3.1. ISpecifier And IPageItemSelector

`ISpecifier` isn't completely data independent. It does hold a UIDRef for the document that contains the data that is specified. In fact, client code that creates a specifier boss (of any type) is required to call `ISpecifier::Initialize(IDocument*)` before it can use any of the suite interfaces on the specifier.

`IPageItemSelector` is an interface for specifying a set of page items. It is used in conjuntion with the specifier metaphore.

9.8.3.2. Common Suite Interfaces

There are some suite interfaces that are common to most or all of the specifiers. When you have a specifier, you can use those interfaces to manipulate the range of data.

IScrapSuite provides the funtionality for copying the contents of the specifier to the scrap document, or pasting the contents of the scrap document to the user document identified by the specifier. Note: All InDesign Implementations of `IScrapSuite` require a front document and a front view. `IScrapSuite` doesn't work if you open a document without a window.

ITransformSuite provides methods for skewing , scaling, and rotating page items. This suite needs a reference point for those operations. The default reference point can be retrieved from `IReferencePointSuite`.

IGeometrySuite manipulates the X, Y location and width and height of the specified data. It also provides the commands to resize and move page items.

IReferencePointSuite has the reference point related information. For page items, changing the reference point can only be done if the specifier is associated with a selection. For an in-line graphic, the reference point can not be changed, It is always the center point.

9.9. Standoff Page Items

9.9.1. Introduction

The standoff page item is similar in nature to a page item, it has a path geometry that represents the standoff path. Both frames and its content can have separate standoffs. For example, group items. But they are not hooked into the document hierarchy, even though they support the `IHierarchy`. They are connected to the text model by the page item which has the standoff.

When a stand off is created for a page item using the command `StandOffModeCmd` or the Text Wrap panel, a `kStandOffPageItemBoss` object is created and connected to the main page item in two ways. First, it is set as the standoff page item through `IStandOffData::SetStandOffUID()`. Second, it is registered as the main item's secondary scrap item through `IScrapItem::RegisterScrapItem()`. This is necessary to support cut, copy and paste the main page item along with their standoffs.

InDesign describes "text wrap type" as a mode, and "offset" as a margin. The various modes the application supports are defined in IStandOff.h. Methods to get and set the mode and margin are defined in interface IStandOffData.

How does the text composition engine know about the text wrap? The text composer asks the `SpreadOverlapManager` for the closest rectangle that is available for the next line of text. The `SpreadOverlapManager` tracks every page item that has a standoff and calls its `IStandOff::GetTilesByHeight()`. Then the text is flowed into those tiles.

The page item interfaces `IStandOff`, `IStandOffData` and `ITextInset` are used to manage standoffs. The `StandOffPageItem` object aggregates `IStandOffItemData` that is used to get the information about its main page item.

9.9.2. IStandOff

This interface does two things. It calculates the rectangles that will hold the text, called text tiles, and it also calculates the shape of the standoff. The standoff geometry is different from the page item's geometry.

9.9.3. IStandOffData

This data interface manipulates only the data for the standoff, such as mode, form, and margin. You can also get the UID for the standoff via this interface.

9.9.4. ITextInset

`ITextInset` sets and gets the inset for the drawable page items. You can also get the geometry of the inset and its UID. Basically, you can consider the text inset as an internal "standoff" for a page item. But you cannot select the text inset, nor can you modify the inset polygon anchor points like you could for a normal standoff. You can, however, use `SetTextInsetCmd` to set the insets of a drawable page item.

Notice that `QueryInsetGeometry()` and `GetInset()` are independent. You could get an inset geometry even if the inset value was 0.0.

9.9.5. IStandOffItemData

`IStandOffItemData` is aggregated by boss class named `kStandOffPageItemBoss`. This is the interface that you can use to get the information about the main page item for this standoff item.

9.9.6. Working With StandOffs

When you resize a page item, what would happen to its standoff? It would resize as its main page item does, providing the standoff polygon has not been changed by you. If you modify the standoff polygon, resizing the main page item will have no impact on the modified standoff.

Transformations applied to the main item, such as moving, scaling, skewing and rotation, is immediately applied to the standoffs. This is done in the implementation for `ITransform` interface (`kStandOffTransformImpl`). It redirects all the transformations to the main item's transformations. The `SpreadOverlapManager` gets notification and calculates the areas of the text frames that need to be recomposed.

Deletion, cut, copy and paste of main page items will cause their standoffs to follow wherever the main page items go. These operations are observed by the `SpreadOverlapManager`. It also invalidates those text frames that intersect with the standoffs for recomposition. When you resize and transform the main page items, the standoffs usually "follow" their main items in a user expected way. The majority of the synchronization is accomplished by the `kMainItemObserver` that observes the main item's geometry changes.

As an end user, you can also delete the anchor points of a standoff polygon just like you do for the frame paths using the pen tool.

There are three public commands that allow you to create a standoff, change its form and margin. They are used by Text Wrap panel. They are: `kStandOffModeCmdBoss`, `kStandOffFormCmdBoss`, and `kStandOffMarginCmdBoss`. See figure 9.9.6.a and figure 9.9.6.b for code examples.

figure 9.9.6.a. Use StandOffModeCmd To Set The Mode

```
// Create a StandOffModeCmd
InterfacePtr<ICommand>
standOffModeCmd(CmdUtils::CreateCommand(kStandOffModeCmdBoss));
if (!standOffModeCmd)
  return;

// Set the StandOffModeCmd ItemList
InterfacePtr<ISelection> selection(QuerySelection());
if (!selection)
  return;
const UIDList& selectionList = selection->GetUIDList();
standOffModeCmd->SetItemList(selectionList);
```

```
// Get IStandOffModeCmdData Interface for the StandOffModeCmd
InterfacePtr<IStandOffModeCmdData> standOffModeData(standOffModeCmd,
IID_ISTANDOFFMODECMDDATA);

// Set mode: kAutoContour, text follows the shape
standOffModeData->SetMode(IStandOff::kAutoContour);

// Process the StandOffModeCmd
error = CmdUtils::ProcessCommand(standOffModeCmd);
// Report any error, if error != kSuccess
```

figure 9.9.6.b. Use StandOffMarginCmd To Set The Margin

```
ErrorCode CreateAndProcessStandOffMarginCmd(const UIDRef& itemList,
  PMRect::PointIndex nWhichPoint, PMReal nMargin)
{
  // Create a StandOffMarginCmd
  InterfacePtr<ICommand>
  standOffMarginCmd(CmdUtils::CreateCommand(kStandOffMarginCmdBoss));
  if (!standOffMarginCmd)
    return;

  // Set the StandOffMarginCmd ItemList
  standOffMarginCmd->SetItemList(itemList);

  // Get IStandOffMarginCmdData interface fro the StandOffMarginCmd
  InterfacePtr<IStandOffMarginCmdData>
  standoffMarginData(standOffMarginCmd, IID_ISTANDOFFMARGINCMDDATA);

  standoffMarginData->SetMargin(nWhichPoint, nMargin);

  // Process the StandOffMarginCmd
  return CmdUtils::ProcessCommand(standOffMarginCmd);
  }
```

Note that you need to call `StandOffMarginCmd` once for each margin, `kMiddleTop`, `kMiddleBottom`, `kLeftMiddle` and `kRightMiddle`.

9.9.7. Local StandOffs

Local standoffs are used for drop caps, baseline grid and inline graphics. Text composition relies on the `SpreadOverlapManager` for space to reflow the text. In the case of drop caps and inline graphics, the `SpreadOverlapManager` requests the "local standoffs" of the text frame to modify the list of text tiles. The main idea for the `ILocalStandOffs` interface is that you can register standoffs that are "local" and only in effect for a particular text frame.

9.10. Commands For Page Items

There are a set of commands for manupilating page items.

9.10.1. Create Page Item

kNewPageItemCmdBoss is used to create a new page item. The newly created page item can be any simple rectangular page item that supports the `IGeometry` interface. All the attributes for the new page item are stored in `INewPageItemCmdData` interface. The UID of the new page item is returned in the command's item list. If the parent is supplied, the new page item will be added to the hierarchy. The following code shows how to create a new page item using this command.

figure 9.10.1.a. Create a new kYourPageItemBoss object

```
PMPoint firstPt(0,0);
PMPoint lastPt(100,100);

PMPointList points(2);
points.Append(firstPt);
points.Append(lastPt);

InterfacePtr<IControlView> theView(::QueryFrontView());
if (theView == nil)
  return;

InterfacePtr<ILayoutControlData> viewLayerMgr(theView,
IID_ILAYOUTCONTROLDATA);
UID parent = viewLayerMgr->GetActiveLayerUID();
IDataBase *db = ::GetDataBase(::GetFrontDocument());

InterfacePtr<ICommand>
  cmd(CmdUtils::CreateCommand(kNewPageItemCmdBoss));
InterfacePtr<INewPageItemCmdData> data(cmd, IID_INEWPAGEITEMCMDDATA);
data->Set(db, kYourPageItemBoss,
  INewPageItemCmdData::kDefaultGraphicAttributes, parent, points);
ErrorCode status = CmdUtils::ProcessCommand(cmd);
```

The data associated with this command is defined in the `INewPageItemCmdData` interface.

The `parent` is set to the current spread layer in this case. The `ClassID` is the boss ID of the page item you want to create. The `initialPoints` are the points that define the position and size - and possibly the shape - of a particular instance of the page item. The `GraphicAttrType` refers to the set of graphical attributes that

would be applied to the page item when it is created. The default value is often enough, but the full set of values is listed in INewPageItemCmdData.h:

figure 9.10.1.b. GraphicAttrType defined in INewPageItemCmdData

```
enum GraphicAttrType
{
  kNoGraphicAttributes= 0,
  kDefaultGraphicAttributes,
  kGraphicFrameAttributes,
  kTextFrameAttributes
};
```

kCreateMultiColumnItemCmdBoss creates a new text frame.

kPlacePICmdBoss places a page item. This command does not create a new page item. Instead, it takes an already created page item either from the command's item list, or from the place gun, and places it into the page item hierarchy.

kPlaceGraphicFrameCmdBoss creates a graphic frame and then places an image item into it. The item to be placed can be passed through the command's item list, or it can be placed from the place gun. To use the place gun, set the `usePlaceGunContents` parameter on the `IPlacePIData` interface to `kTrue`, and don't set the command's item list. When passing the UID of the placed item via the command's item list, set the `usePlaceGunContents` parameter `kFalse`.

kPlaceItemInGraphicFrameCmdBoss places a page item into an existing graphic frame. The page item can be passed into the command's item list, or it can be placed from the place gun. The UID of the graphic frame is returned on the command's item list.

kReplaceCmdBoss replaces one page item with another. Both the old page item and the new page item are specified in the `IReplaceCmdData` interface.

kLoadPlaceGunCmdBoss loads the item specified on the command's item list into the place gun. Only one item can be loaded by this command.

kImportPIFromFileCmdBoss imports the file first. If what was imported is a story, a multicolumn item is created; if what was imported is not in a graphic frame, a new graphic frame is created and the imported file is put into the frame. The UID of the new item is returned on the command's item list.

kImportAndLoadPlaceGunCmdBoss is the combination of `kImportPIFromFileCmdBoss` and `kLoadPlaceGunCmdBoss`.

kImportAndPlaceCmdBoss is the combination of `kImportPIFromFileCmdBoss` and `kPlacePICmdBoss`.

9.10.2. Modify Page Item

9.10.2.1. Add/Remove Page Item To/From The Hierarchy

kAddToHierarchyCmdBoss adds the page item in the command's item list to the parent specified in the `IHierarchyCmdData` interface. The index position for the page item is also specified on the `IHierarchyCmdData` interface.

For example, when a new page item is created, it will call this command if the new item's parent was supplied.

figure 9.10.2.1.a. AddToHierarchyCmd

```
// newItem is the UIDRef of the newly created page item, parent is the
// UIDRef of its parent, it could be the layer or another page item.
InterfacePtr<ICommand> addToCmd(CmdUtils::CreateCommand(
  kAddToHierarchyCmdBoss));
if(addToCmd)
{
  InterfacePtr<IHierarchyCmdData> cmdData(addToCmd,
  IID_IHIERARCHYCMDDATA );
  cmdData->SetParent(parent);
  cmdData->SetIndexInParent(IHierarchy::kAtTheEnd);
  addToCmd->SetItemList(UIDList(newItem));

  ErrorCode status = CmdUtils::ProcessCommand (addToCmd);
}
```

kRemoveFromHierarchyCmdBoss removes a page item from its parent when a page item is deleted or when detaching the imported content from the imported frame.

9.10.2.2. Position Page Items

kCenterItemsInViewCmdBoss moves a set of page items so that they appear centered in the current view. This command is not undoable.

kFitPageItemInWindowCmdBoss is used to make the current selected page items fit in a window. This command is not undoable.

kAlignCmdBoss aligns the page items in the command's item list to the alignment type specified in the `IIntData` interface. The command itself is a compound command made up of a set of move relative commands. It is not undoable. However, since the move commands are undoable, the align command is undoable too.

kMoveToLayerCmdBoss moves the page items specified on the command's item list to the document layer specified on the `IUIDData` interface. The page items will appear in the same z-order as before, vis-a-vis each others in the front of the new layer. This command does not move the items that are children of a group or a graphic frame. Nor does it move standoffs.

kMoveToSpreadCmdBoss is similar to `kMoveToLayerCmdBoss`, except it moves the page items from one spread to another.

9.10.2.3. Content Fitting

Sometimes, after the replace command or paste into operation, the graphic frame content, such as the placed image, PDF or EPS does not fit into the frame or certain position you want inside the frame. Unfortunately, there is no graphic attribute nor helper function that can determine the fitting mode for a page item. One way to determine this is to compare the bounding boxes for the content (for example the image item) and the parent (the frame) to decide whether the content should position in the center or fit into the frame, or the corner of the frame. Based on that, you can use one of the fitting commands to set the desired fitting mode for the page item. However, these commands have to be executed again if you resize the page items. i.e. they aren't attributes, rather they are one-time actions.

kAlignContentInFrameCmdBoss aligns the contents in the command's item list to one of the corners of their respective frames. The corner, which is the same for all items, is specified on the `IAlignContentInFrameCmdData` interface. This command will ignore frames that do not have content. The command's item list holds the UIDs of the contents, not the UIDs of the frames that contain the contents. This command will send out a notification to the content's subject that it has changed.

kCenterContentInFrameCmdBoss positions the contents to the center of their respective frames. The content UIDs are stored in the command's item list.

The following code snippet compares the bounding boxes for the content and its parent and calls the kCenterContentInFrameCmdBoss if their center is not aligned. Assuming that you have the UIDRef for the frame, called frameRef.

figure 9.10.2.3.a. kCenterContentInFrameCmdBoss

```
//Get the geometry for the frame
InterfacePtr<IGeometry> frameGeo(frameRef, IID_IGEOMETRY);
//Get the bounding box for the frame in inner space
PMRect frameBounds = frameGeo->GetStrokeBoundingBox();

InterfacePtr<IHierarchy> frameHier(frameGeo, IID_IHIERARCHY);
// Get the frame's child geometry
InterfacePtr<IHierarchy> childHier(frameHier->QueryChild(0));
InterfacePtr<IGeometry> childGeo(childHier, IID_IGEOMETRY);

// Get the transform matrix from the child's inner space to the
// parent space
PMMatrix inner2Parent = ::InnerToParentMatrix(childGeo);

// Get the bounding box for the child in the frame's space
PMRect childBoundsInParent =
  childGeo-> GetPathBoundingBox(inner2Parent);

// Compare the frameBounds and childBoundsInParent to determine which
// command to call, FitFrameToContent, FitContentToFrame,
// CenterContentInFrame or AlignContentInFrame, etc.
PMPoint frameCenter = frameBounds.GetCenter();
PMPoint imageCenter = imageBoundsInParent.GetCenter();
if (frameBounds.GetCenter() != imageBoundsInParent.GetCenter())
{
  InterfacePtr<ICommand> centerCmd = CmdUtils::CreateCommand(
  kCenterContentInFrameCmdBoss ) ;
  if (!centerCmd)
    return;

  // Set the command item list to the UIDList of the content
  centerCmd->SetItemList(UIDList(childHier));
  ErrorCode error = CmdUtils::ProcessCommand(centerCmd);
  // check the return error here
} else {
  // try other commands here!
}
```

kFitContentPropCmdBoss takes a list of frame content and modifies the content size and tansformation to fit the frames and maintain the content's proportions.

kFitContentToFrameCmdBoss modifies the content bounding boxes to fit into their parent frames. The command's item list holds the UIDs of the contents.

kFitFrameToContentCmdBoss resizes each frame in the command's item list to fit its content's path bounding box. This command takes a list of selected items and filters out the empty frame and non-graphical frame, then transforms the frame's path geometry. Note, the text frames are still in the command's item list, even though they are not affected by this and other commands.

Now, suppose that you have a selection of page items and you want to call `kFitFrameToContentCmdBoss` to modify the sizes for the frames to fit their content. figure 9.10.2.d. illustrates how to use `kFitFrameToContentCmdBoss`.

figure 9.10.2.d. kFitFrameToContentCmdBoss

```
ErrorCode error = kSuccess;
InterfacePtr<ISelection> selection (::QuerySelection());
if (!selection)
  break;

UIDList pageItemList = selection->GetUIDList();

InterfacePtr<ICommand> fitFrameCmd = CmdUtils::CreateCommand(
kFitFrameToContentCmdBoss ) ;
if (!fitFrameCmd)
{
  fitFrameCmd->SetItemList(pageItemList);
  error = CmdUtils::ProcessCommand(fitFrameCmd);
  // handle error here
}
```

9.10.2.5. Conversions Between Frames And Items

kConvertFrameToItemCmdBoss takes a list of graphic frames and text frames with no content and converts them to graphic items (unassigned), which is neither a text frame nor graphic frame. This command sets the graphic frame attribute of the specified page items to `kFalse`.

kConvertItemToFrameCmdBoss is the opposite of `kConvertFrameToItemCmdBoss`. It sets the graphic frame attribute of the specified page items to `kTrue`, and converts unassigned graphic items to empty text frames or graphic frames. This command will also convert empty text frames to empty graphic frames.

kConvertItemToTextCmdBoss converts unassigned page items and empty graphic frames to empty text frames.

9.10.2.6. Copy And Paste Commands

kCopyCmdBoss is a generic command for copying page items from one document to another. This command applies for any page item that supports the IScrapItem interface.

kCopyPageItemCmdBoss copies one or more page items to the specified parent object, if any. A UIDList of the page items created is returned in the command's item list.

kCopyImageItemCmdBoss copies the specified image item to the specified target. Both the image item and the target are specified in the `ICopyCmdData` interface.

kDuplicateCmdBoss duplicates the items specified in the command's item list. The page items in the command's item list are duplicated if the command is successfully processed.

kPasteCmdBoss pastes one or more page items to the specified database in the command's `ICopyCmdData`. The UIDList of the items to paste are passed to the command in the `ICopyCmdData` interface.

kPasteGraphicItemCmdBoss is used for pasting EPS, image, and PDF into the destination database. The difference between k`PasteGraphicItemCmdBoss` and k`CopyPageItemCmdBoss` is that if the specified parent is a graphic frame, the graphic item (EPS, image, PDF) is created as a child of the frame. If no frame was specified as the parent, then k`PasteGraphicItemCmdBoss` creates a new rectangular frame as its parent and applies all its transformation values to the frame so that it appears in the correct location.

kPasteInsideCmdBoss pastes the specified content into a frame, deleting previous content if needed. The content is aligned to the top left.

9.10.2.7. Select And Deselect Commands

The following set of commands are not undoable.

kSelectPageItemCmdBoss selects one or more page items. The new selection will either replace the current selection or be added to the current selection depending on the defined selection type.

kDeselectPageItemCmdBoss deselects the items specified on the command's item list.

kDeselectAllCmdBoss deselects the selection passed on the `ISelectCmdData` interface.

kSelectStandOffCmdBoss selects the standoff pageitem.

kDeselectStandOffCmdBoss deselects the standoff pageitem.

There are also a set of helper functions to create these commands for you. They are defined in ISelectUtils.h.

9.10.2.8. Transform Commands

kMoveAbsoluteCmdBoss moves the page items specified on the command's item list to the coordinate location specified on the `IPointListData` interface. All locations are in pasteboard space.

kMoveRelativeCmdBoss moves the page items specified in the command's item list to the position specified in the command's `IMoveRelativeCmdData` interface. The `IMoveRelativeCmdData` interface also specifies the transform action as whether the children of the item should share any transformation of their parent.

kResizeItemsCmdBoss resizes a set of items by a given factor in x and y direction. This command is used when changing width or height in the Transform panel. The `IResizeItemsCmdData` interface provides the horizontal and vertical resize factor, the reference point and the enum value for `SetAction` that is defined in `IGeometry`.

There are another set of commands that allow you to set the width and height of a page item individually. The commands are `CreateDefaultSetWidthCommand` and `CreateDefaultSetHeightCommand` in IPageItemUtils.h, `CreateSetWidthCommand` and `CreateSetHeightCommand` in IGeometrySuite.h.

kSetDimensionsCmdBoss sets a set of items to a given width or height (or both). This command is useful when changing a width or height of 0, which `kResizeItemsCmdBoss` fails to do.

kSetBoundingBoxCmdBoss changes the bounding boxes for a set of page items specifed in the command's item list. The `ISetBoundingBoxCmdData` interface holds the new bounding boxes, indicates whether bounds are in pasteboard or inner coordinates, and sets the action that the page item should take for this command. It is used by the resize tracker. Since it requires a bounding box for each item to be resized, it is less convenient for multiple selections.

kRotateItemCmdBoss rotates a set of items by a specified angle around a given reference point. The `IRotateCmdData` interface specifies the transform context (relative to pasteboard or to parent) , the rotation reference point and the transform action.

kScaleItemCmdBoss scales a set of items by a specified percentage with respect to a given reference point. The `IScaleItemCmdData` interface specifies the horizontal and vertical scale value, the reference point, scale context (relative to inner, parent or pasteboard), and the transform action.

kSkewItemCmdBoss performs a horizontal shear transformation on a set of items with respect to a given reference point. The `ISkewItemCmdData` interface provides skew angle, rotation angle, reference point, transform context and transform action.

9.10.2.9. Group Page Items

kGroupCmdBoss groups the selected items in the list, and creates a new page item consisting of the group. The parent for the group is the same as the parent of the last item in the sorted selected item list. The UID of the new page item, the group, is returned in the command's item list. This command requires that the items to be grouped have valid parents because only the items at the same level in the hierarchy can form a group. For instance, it is invalid to attempt to group an image with the spline item that contains it, or any other splines not at the same level of the document hierarchy.

kUngroupCmdBoss ungroups the items specified in the command's item list. The parent of the group becomes the parent of all the ungrouped items.

9.10.2.10. Lock Page Item

kSetLockPositionCmdBoss is used to lock the current selected page items.

kUnLockCmdBoss is used to unlock the current selected page items.

These two commands both modify the `IID_ILOCKPOSITION` interface.

9.10.3. Delete Page Item

kDeleteCmdBoss deletes the page items specified in the command's item list. Any groups left empty by the deletions are deleted too.

kDeleteFrameCmdBoss deletes both the frame and its contents. In general, you should avoid directly calling this command. Instead use the `GetDeleteCmd()` method of the `IScrapItem` interface to delete the frame.

kDeletePageItemCmdBoss deletes the page items specified in the command's item list, and removes the items from the hierarchy. In general, don't create this command directly, instead use the `GetDeleteCmd()` method of the `IScrapItem` interface to delete the page item.

kDeleteImageItemCmdBoss is a sub-class of `kDeletePageItemCmdBoss`. The purpose of this command is to release an image object when the page item is deleted. This command deletes the image items on the command's item list. If the ClassID of any item is not `kImageItem`, it is not deleted.

kDeleteLayerCmdBoss deletes the layer specified on the command's item list. The layers in the item list must be in the same document. After this operation, all page items on the layer list are deleted too.

kDeletePageCmdBoss deletes the pages specified on the command's item list. Page items on the pages are also deleted. If the spread is left without pages by this command, it is also deleted. If page reshuffling is specified on the `IBoolData` interface, the remaining pages in the affected spread and pages in the spreads
that follow are reallocated so that each spread has the number of pages specified in the page setup preferences for the document.

kDeleteSpreadCmdBoss deletes one or more spreads and all their pages and page items. If the deletion would leave the document without spreads, the

command is aborted and nothing is deleted. The list of spreads to delete is specified in the command's item list.

kDeleteUIDsCmdBoss deletes the UIDs specified on the command's item list.

kRemoveInternalCmdBoss is used when you delete a page item with embedded data. It removes the embedded data from the publication.

9.11. Summary

This chapter outlined page items and the overall object inheritance related to the page item objects. The bosses and interfaces involved were described. We also showed some practical examples related to page items, such as rotation, transformation and creation. In this chapter we also discussed the commands to manipulate the page items and standoff page items.

9.12. Review

You should be able to answer the following questions:

1. What is a page item?
2. What is a standoff page item?
3. What are the important interfaces that a spline item must aggregate?
4. Which interface stores the UID-based tree structure for page items within a document?
5. What are the three bounding boxes for each page item? How to get them?
6. How do you detect which page a page item lies on?
7. What are the commands that delete page items?

9.13. Exercises

9.13.1. Create Custom Page Item

InDesign object model is extensible. In figure 9.3.a, we added `kYourPageItemBoss` to the inheritance diagram. How would you create your own custom page item?

9.13.2. Find The Selected Page Item's Children And Parents

In order to understand the interface `IHierarchy` and various page item objects, try writing some sample code to explore the methods it supports to find out the selected page item's children and parents, if any. What are their ClassIDs and UIDs?

9.13.3. Place An EPS Into A Page Item

Implement this as an exercise after reading “Place PDF Into A Page Item” on page 295.

10.

Page Item Drawing

10.0. Overview

A layout is a view of a document. It is displayed in an InDesign window, and provides the infrastructure for drawing the document. In the context of InDesign, the term "drawing" can mean rendering objects to the screen, to print, or to other devices.

Drawing to the screen really means drawing to an InDesign window, which is a platform-independent construct containing layout widgets that display the contents of the document. Each item in the document is responsible for drawing itself and requesting each of it's children to draw themselves. Document items such as spreads, layers, and page items draw themselves by receiving messages (calls) on one or more of their interfaces. See the Page Items and Document Structure chapters for more information about page item interfaces and the document hierarchy.

10.1. Goals

The questions this guide answers are:

1. How are documents displayed?
2. What objects in InDesign are responsible for drawing?
3. How is drawing managed within InDesign?
4. What drawing primitives are supported?
5. What causes my page item to draw?

10.2. Chapter-at-a-glance

This chapter explains how page items draw and the context in which they draw. Several foundation concepts are first presented to define the elements involved in displaying a view of a document. These concepts include:

- A description of InDesign windows in "10.3.1.InDesign Windows" on page 319.
- How a document is represented as the layout in "10.3.2.The Layout Hierarchy" on page 322.

- InDesign's drawing context in "10.3.3.The InDesign Graphics Context" on page 326.

Building on the foundation concepts, the sequence of drawing the layout is presented. This sequence description includes:

- Invalidating a view, and the role of the underlying platform in "10.4.1.Invalidating a View" on page 331.
- The high-level steps of updating a window are presented in "10.4.2.Window Updates" on page 332,
- The detailed steps of the layout draw order are then presented in "10.4.3.Layout Draw Order" on page 334.

When page items are called to draw, they receive information about how they should draw, and the specific context for their draw. This includes:

- The drawing control flags in "10.5.1.IShape Flags" on page 339
- The collection of information about the context in "10.5.2.GraphicsData Class" on page 339
- The InDesign drawing interface in "10.5.3.IGraphicsPort" on page 340
- Determining the destination of the draw in "10.5.4.Detecting the Device Context for Drawing" on page 342

Given the draw order and the context, the details of how a page item draws is presented. This includes:

- The relevant interfaces in "10.6.1.Overview of Page Item Interfaces for Drawing" on page 344
- The main drawing interface in "10.6.2.IShape Interface" on page 344
- A specialized interface for path drawing in "10.6.3.The IPathPageItem Interface" on page 352
- The selection drawing interface in "10.6.4.The IHandleShape Interface" on page 352

10.3. Foundation

Documents can contain a variety of objects: text, graphics, and images. While the document hierarchy provides a framework for storing these objects, displaying these objects is the responsibility of the layout hierarchy. It is the layout's job to draw the document to the screen, printer, or to other devices.

This section describes the objects that comprise the layout hierarchy: a window boss, layout widgets, and the document hierarchy. Drawing the layout requires a graphics context, and this section also describes the graphics context associated with the layout window.

10.3.1. InDesign Windows

The layout hierarchy has an InDesign window object at it's root. InDesign represents a window as a platform-independent object called a `kWindowBoss`.

10.3.1.1. Window Bosses

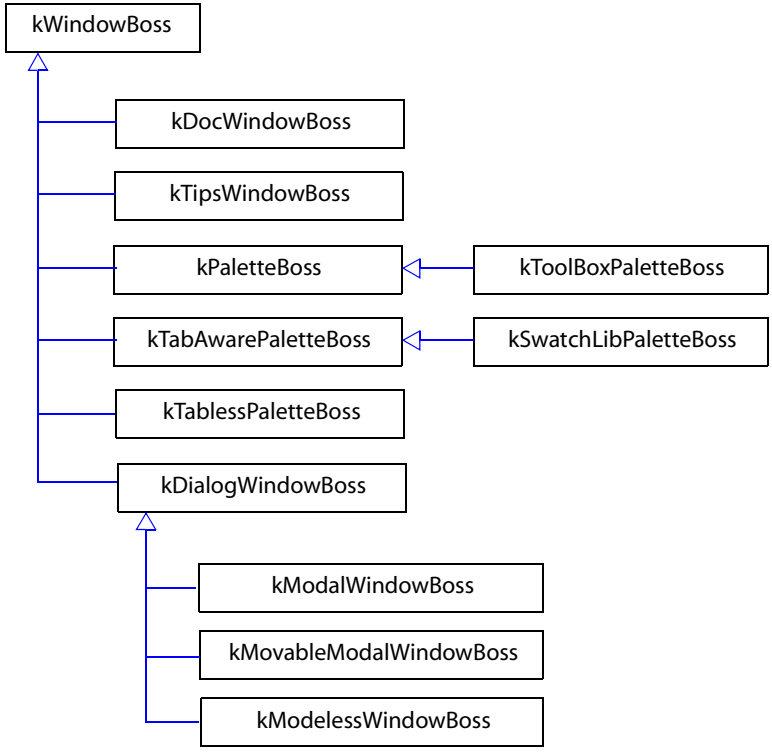
Window bosses provide core interfaces for performing common operations such as creating, resizing, and drawing windows, as well as handling events and describing cursor regions. As shown in figure 10.3.1.a., the InDesign API generalizes window bosses for a variety of uses: palettes, the document, tips, and dialogs.

Typically, InDesign windows for palettes and dialogs are not created and managed directly by a plug-in, but instead are specified and instantiated as a part of widgets. For example, a plug-in might define a palette as a localized widget resource, then open it at run-time. Behind the scenes, InDesign creates and manages the associated window for the palette. Similarly, windows for displaying the document are created and managed by InDesign as part of creating a new view on the document.

table 10.3.a. version history

Rev	Date	Author	Notes
1.0	10/27/00	John Hake	First Release
0.1	8/1/2000	John Hake	First Draft
0.0	6/29/2000	John Hake	Initial Outline.

figure 10.3.1.a. InDesign Window Boss Hierarchy



Under the hood, InDesign windows have a corresponding platform window. The InDesign window is responsible for creating, managing, and destroying the associated platform window. The platform window is the basis for the graphics context used for drawing to the InDesign window.

10.3.1.2. The Document Window Boss

The layout view of a document appears in a window defined by a `kDocWindowBoss`. A layout window is owned and managed by the InDesign application. InDesign may have several layout windows open at once, each containing a different view of the same document.

As with all window bosses, kDocWindowBoss has several interfaces of particular interest for drawing, as shown in figure 10.3.1.a.. The IWindow interface

figure 10.3.1.a. Window Boss Interfaces

Interface	Function
IWindow	Used for manipulating the window.
IEventHandler	Used for handling events directed at the window: mouse clicks, update events, etc.
IControlView	Used for drawing the Window, Content to Local transformations
IPanelControlData	Used for managing child widgets in hierarchy

provides methods for common window operations such as creating, opening, resizing, and closing them. The implementation behind the interface is designed to be a thin layer of core APIs that sit over the platform-provided window functions.

Drawing support in the IWindow interface is considerably less direct than calls to the platform. The IWindow interface is responsible for creating and maintaining the structures used for drawing by IControlView and other interfaces. These structures include the underlying platform-dependent window and the view port boss. The view port boss provides a platform-independent, high performance interface for drawing to the platform window. View port bosses are discussed in greater depth in “10.3.3.1. View Port Bosses” .

The remaining interfaces are familiar from widget bosses. The IEventHandler interface receives events directed at the window, and provides a platform-independent API for fielding the events. Methods on this interface are called to handle events such as mouse clicks, activation events, and key events. Methods on a window’s event handler interface are called automatically by InDesign’s event dispatcher to handle events targeted at that window. The role of a window’s event handler in drawing a view is discussed further in “10.4.2. Window Updates” .

The IControlView interface on the window boss has two important roles with respect to drawing: it is the starting point for the window drawing sequence and it maintains the geometric relationship of the window to it’s contents. The

sequence of drawing window contents is described in "10.4.3. Layout Draw Order" .

The IPanelControlData interface is responsible for maintaining a list of kDocWindowBoss' child widgets. It's role is analogous to the role of the IHierarchy interface for page items. The kDocWindowBoss and it's child widgets constitute the layout hierarchy.

10.3.2. The Layout Hierarchy

Drawing a document in a window is the responsibility of the layout hierarchy. The layout is comprised of kDocWindowBoss and it's child widgets. A document has one kDocWindowBoss (InDesign window) for each view of the document. As shown in figure 10.3.2.a., the views are accessed by using methods on the IWindowList interface of the kDocBoss.

Arranged under kDocWindowBoss is a hierarchy of widgets that represent the view of the document. Typically, the widgets use an IPanelControlData interface to list their children, and an IWidgetParent interface to point at their immediate parent.

The kDocWindowBoss has an IPanelControlData interface that stores a reference to it's only child: a kLayoutPanelBoss. The kLayoutPanelBoss defines the top-level widget used for representing a view of a document. The children of the kLayoutPanelBoss comprise the visible elements of the view: the document layout, scroll bars, rulers, and navigation buttons. When a window draws, the children of the kLayoutPanelBoss draw in the top-to-bottom order shown in figure 10.3.2.a.. Among those child widgets is the kLayoutWidgetBoss.

The visible portion of the document is represented by the LayoutWidget, defined by the kLayoutWidgetBoss. The LayoutWidget has the responsibility for causing all the visible document elements to draw. It does this by iterating the document hierarchy to get the visible spreads and calling each spread to draw.

The LayoutWidget navigates the document hierarchy through kDocBoss, as shown in figure 10.3.2.b.. In this example the document has "n" spreads of "m" content layers. The layout widget uses its ILayoutControlData interface to get to its associated document boss. The ISpreadList interface on the document boss provides access to any particular spread. As discussed in the previous chapter, the IHierarchy interface can be used to access children of the spread.

For reasons of efficiency, navigation of the layout hierarchy during a window draw is somewhat more selective than shown in figure 10.3.2.b.. Spreads or elements of spreads that aren't visible in a window are not called to draw. InDesign also discriminates between redrawing an entire window and only drawing the region that changed. These two strategies mean that page items are not guaranteed to be called to draw during every window draw.

figure 10.3.2.a. The Layout Hierarchy

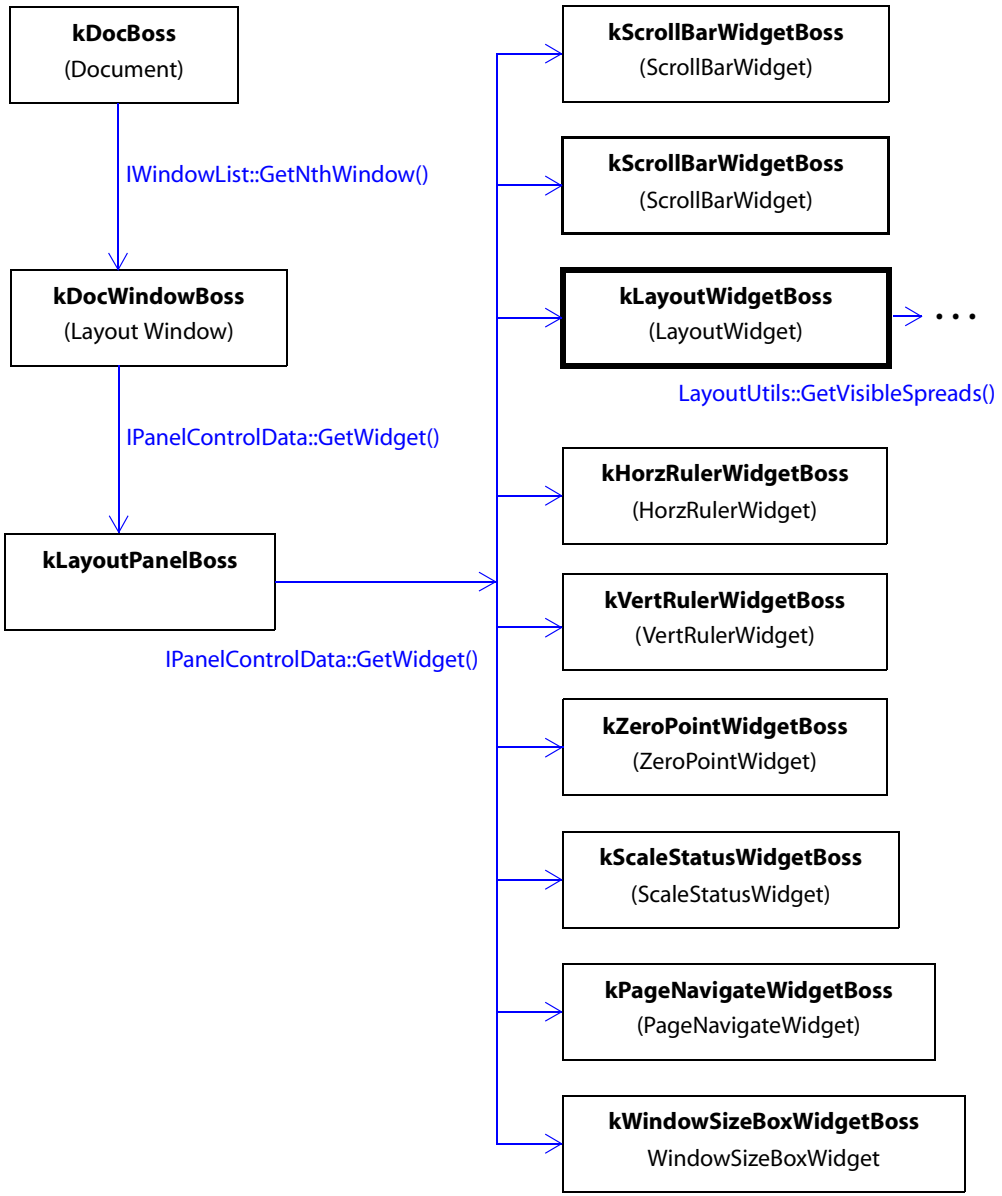
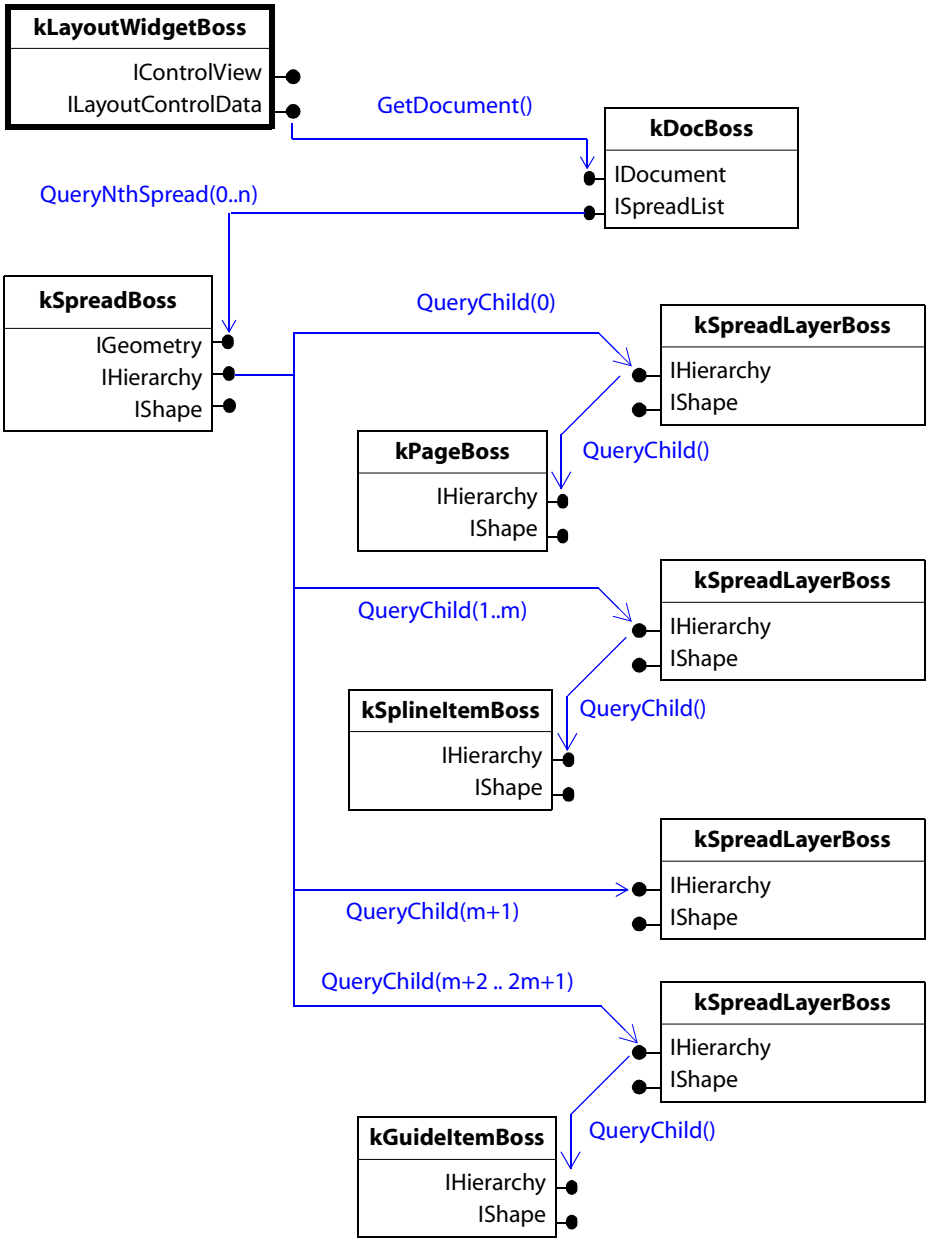


figure 10.3.2.b. Navigating the Layout Hierarchy for a Document

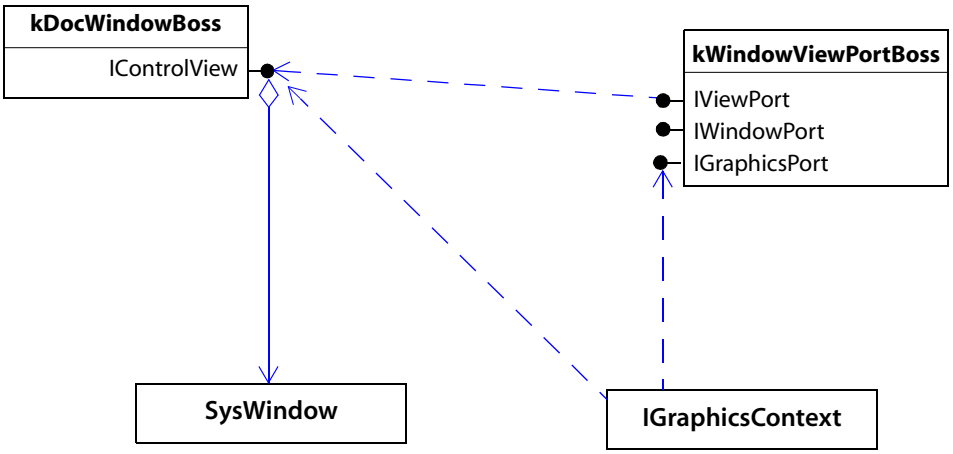


10.3.3. The InDesign Graphics Context

Drawing requires a graphics context. When page items are called to draw they are provided a `GraphicsData` object, which contains pointers to the objects that comprise an InDesign graphics context. Using InDesign's graphics context, page items can perform platform-independent drawing to a variety of device contexts: the screen, print, or PDF. This section will illustrate drawing to the screen.

figure 10.3.3.a. shows the relationships between the bosses and classes that provide the InDesign graphics context for a window. The window boss is responsible for creating, maintaining, and destroying it's associated (platform) `SysWindow`. A `SysWindow` is a wrapper class for a platform window object.

figure 10.3.3.a. Graphics Context for InDesign Windows



InDesign's platform-independent API for drawing is provided by the view port boss. Page items use the `IGraphicsPort` interface on the view port boss for drawing. Behind the scenes, the view port boss doesn't actually draw directly to the platform window. Instead, it draws through the Adobe Graphics Manager (AGM), which has been specialized for the type of drawing device. (The device type describes PostScript printing, the Screen, etc.) The specialization is transparent to clients of the graphics context and the view port boss.

10.3.3.1. View Port Bosses

View port bosses provide a platform independent interface for drawing. A view port boss operates as a wrapper between the drawing client (often a page item) and the underlying AGM code that defines the graphics context for the output device. There are eight different types of view port bosses, each tailored to a particular type of drawing output:

- `kWindowViewPortBoss` - for InDesign window bosses
- `kAGMImageViewPortBoss` - general image port
- `kOffscreenViewPortBoss` - offscreen port for screen draws
- `kHTMLViewPortBoss` - for drawing HTML output
- `kPDFViewPortBoss` - for drawing PDF output
- `kPrintPSViewPortBoss` - for drawing to a PostScript port.
- `kPrintNonPSViewPortBoss` - for drawing to a non-PostScript port.
- `kSVGViewPortBoss` - for drawing SVG outpout.

For example, the `kWindowViewPortBoss` is used for drawing to InDesign windows. The interfaces on `kWindowViewPortBoss` are shown in figure 10.3.3.1.a..

figure 10.3.3.1.a. kWindowViewPortBoss Interfaces

Interface	Function
IViewPort	A generic "handle" to a viewport boss, stores focus state
IViewPortAttributes	Settings for the view port
IWindowPort	Invalidation, screen to window coordinate transforms
IWindowPortData	Stores SysWindow and Port data
IGraphicsPort	Provides shell over AGM's drawing API
IRasterPort	Provides shell over AGM's rasterport specific API
IAGMPortData	Stores AGM port

The `IGraphicsPort` interface is used extensively for drawing. This interface provides methods that draw to the associated graphics port. The methods are similar to PostScript graphics operators. More information about using the IGraphicsPort interface for drawing is presented in "10.5.3. IGraphicsPort" .

On the Macintosh platform a single view port boss is created for the lifetime of the (platform) `SysWindow`. On the PC the view port boss only exists during drawing. Page items are supplied a reference to the view port boss as part of the `GraphicsData` object when they are asked to draw.

10.3.3.2. IGraphicsContext

The graphics context for InDesign drawing is described by an object derived from `IGraphicsContext`, an abstract data container interface. This interface does not reside on a boss, nor is it derived from `IPMUnknown`. Instead, implementations of `IGraphicsContext` are specialized for different drawing devices.

A graphics context is instantiated based on a view port boss, an `IControlView` interface pointer, and an update region. Several important pieces of information are stored in the graphics context object:

- the current rectangular clip region for the drawing port,
- the transform for mapping content to drawing device coordinates.

Screen draws do not paint the entire document and then copy only a portion of it to the window. Instead, only the invalid region of the window is redrawn. The clip region stored in the graphics context is applied like a mask, discarding any drawing outside the clip bounds. During a draw sequence the clip represents the update region in the window, and is stored in window coordinates. The window coordinate system is described in the next section.

The transform describes the relationship of the content coordinates to the drawing device coordinates. For screen drawing, the drawing device is a window. The transform is based on the `IControlView` implementation supplied at the time of the graphics context instantiation. During a normal screen draw sequence, it is the `IControlView` implementation on the `kLayoutWidgetBoss` that instantiates the graphics context, so the transform is initialized to be pasteboard to InDesign window coordinates. During the draw sequence this transform is modified to represent parent to window coordinates.

For drawing to the screen, AGM is used to provide the graphics context. Under the hood an offscreen context is used for drawing to facilitate a smooth, flicker free screen update. The drawing code renders offscreen and the completed draw is subsequently copied to the screen. The use of offscreen contexts is transparent to page items when they draw. The graphics context provided to the page item hides these implementation details.

10.3.3.3. The Window Coordinate System

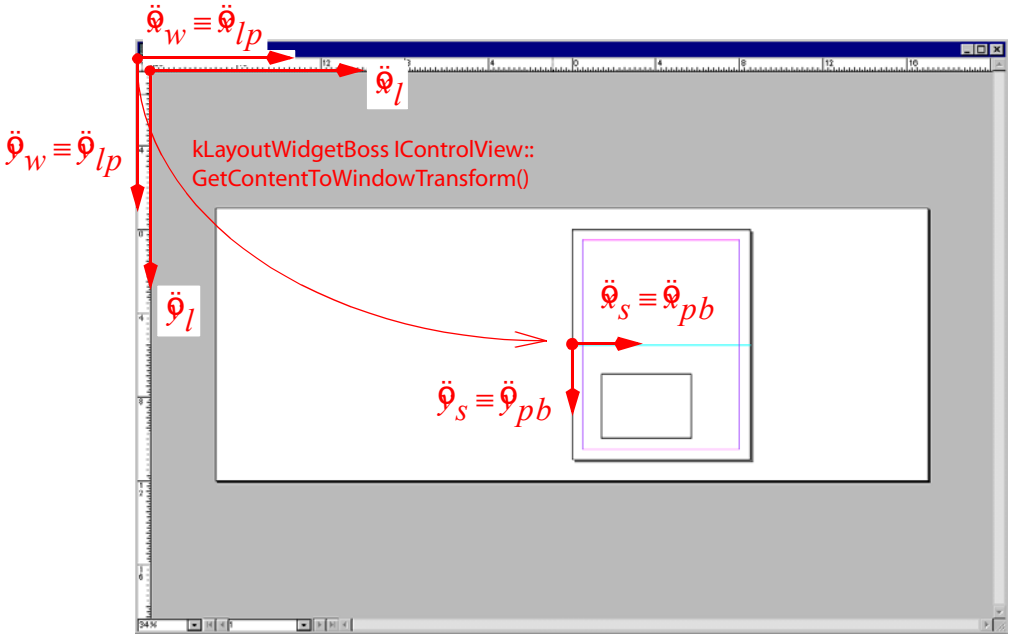
The relationships between coordinate systems for the pasteboard, document spreads, layers, and page items are described in detail by the Document Structure chapter. In summary, for any document:

- the pasteboard coordinate system is the parent for all spread coordinate systems,
- the origin of the pasteboard coordinate system is coincident with the origin of the coordinates for the first spread in the document.

Those relationships still hold in the context of drawing into an InDesign window.

The introduction of InDesign windows raises a new question: what is the relationship between an InDesign window and the pasteboard coordinate system? This question is illustrated in figure 10.3.3.3.a., which shows a single page, two pages per spread document. The relationship between the window, `LayoutPanelWidget`, and `LayoutWidget` coordinates systems are relatively static and described by their `IControlView` implementations. The term "relatively static" refers to the change that occurs when the user hides the rulers and the layout widget coordinate system becomes coincident with the `LayoutPanelWidget` and window coordinate systems.

figure 10.3.3.3.a. Window, Layout, and Document Coordinates



As the user zooms and scrolls the view, the relationship between the `LayoutWidget` coordinates and the pasteboard coordinates changes. The `LayoutWidget`'s boss has an `IPanorama` interface to track the scroll and zoom changes. The relationship between the pasteboard and `LayoutWidget` coordinate system is stored in the `LayoutWidget`'s `IControlView` implementation. The `LayoutWidget`'s `IControlView::GetContentToWindowTransform()` method returns the transform to map a region in pasteboard coordinates to window coordinates. This relationship is also stored in the `GraphicsContext` object. By using the known coordinate relationships in the document hierarchy, a region described in any page item's coordinates can be mapped to the window coordinate system.

The window coordinate system can be mapped to the screen coordinate system by using methods of the `IWindowPort` interface on the view port boss. For example, event handlers often return mouse hit locations in screen coordinates. The code shown in figure 10.3.3.3.b. shows how to perform this conversion. The code is the functional equivalent of `ILayoutUtils::ComputePasteboardPoint()`. (See **ILayoutUtils.h**.)

figure 10.3.3.3.b. Screen to Window Coordinate Conversion

```
// Get the interface that stores the content to window xform
InterfacePtr<IControlView> myView(this, IID_ICONTROLVIEW);

// Get the interface that provides screen to local coord conversion
ViewPortAccess<IWindowPort> myCanvas (myView, IID_IWINDOWPORT);
AcquireViewPort aqViewPort(myCanvas)

// Convert the screen (global) coordinates to window (local)
PMPoint winLoc = myCanvas->GlobalToLocal(screenLoc);

// Convert window to 'this' IControlView's (widget) coordinate system.
myView->GetContentToWindowTransform()->InverseTransform(&winLoc);
```

The example code assumes that it resides on a boss that aggregates the `IControlView` interface, such as the `kLayoutWidgetBoss`. Assuming that we start with a screen location called `screenLoc`, we need to covert it to window coordinates. The implementation of the `IWindowPort` interface on the view port boss will do this conversion. (See figure 10.3.3.a..) Access to the view port boss is through the `ViewPortAccess` template and `AcquireViewPort` class. However, access to the view port boss is also possible by:

- Given a graphics context, use `IGraphicsContext:::GetViewPort()`
- Given a `GraphicsData*`, use `GraphicsData::GetGraphicsPort()`

Once the `IViewPort` interface is acquired on the view port boss, the `IWindowPort` interface can be queried. The `IWindowPort` method `GlobalToLocal()` will convert the location to window coordinates. If the example code resides on a boss that aggregates an `IControlView` interface, then the location can be converted to the widget coordinates stored in the `IControlView` implementation.

10.4. Drawing the Layout

InDesign drawing occurs in response to invalidation of a view, window, or region. Although InDesign provides the platform-independent APIs for invalidating a view, the APIs simply forward the invalidation to the platform. The invalidation state is maintained by the platform, which generates update events to InDesign.

10.4.1. Invalidating a View

Invalidation can be caused by changes to the model (persistent data in a document) or by direct invalidation. Both use the same mechanism for invalidating a view.

Changes to the model are broadcast through the change manager to observers of interest. For example, InDesign uses an observer on the `LayoutWidget` to monitor changes to page items in the layout. When the observer receives notification of a change, it asks the subject of the change to invalidate a region based on its stroke bounding box.

Views can be directly invalidated by using the `LayoutUtils` method `InvalidateViews()`. figure 10.4.1.a.. shows the SDK `HelloWorld` plug-in source file `HelloWorld.cpp` modified to invalidate all views of the front document.

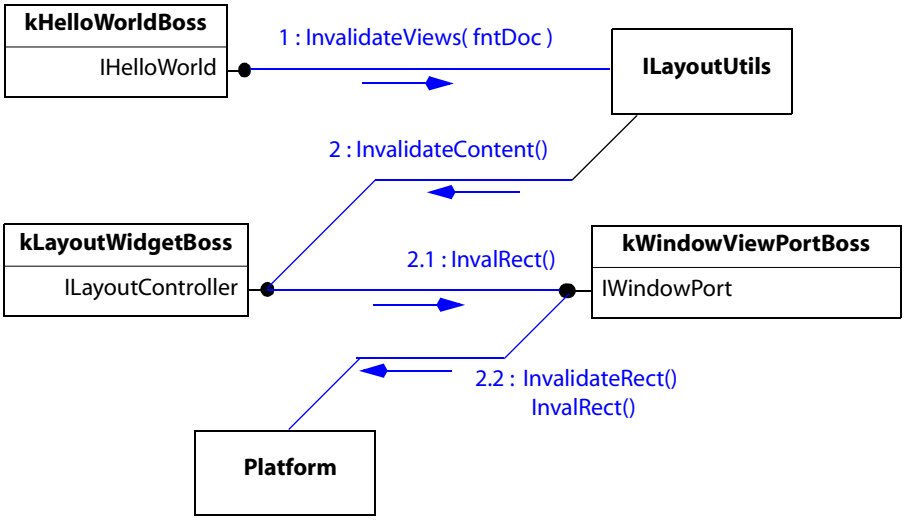
figure 10.4.1.a. Client Code to invalidate the document

```
#include "LayoutUtils.h"
int32 HelloWorld::ShowMsg()
{
  IDocument* fntDoc = ::GetFrontDocument();
  if (fntDoc != nil)
```

```
    Utils<ILayoutUtils>()->InvalidateViews( fntDoc );
  return 0;
}
```

When compiled and run, the code causes the collaboration shown in figure 10.4.1.b.. The `ILayoutUtils` function `InvalidateViews()` uses the document pointer to locate the views for a document. For each view it gets the `ILayoutController` interface on the `kLayoutWidgetBoss` and calls `InvalidateContent()`, which creates an invalidation region equal to the view's window. The invalidation region is passed to the `InvalRect()` method on the `IWindowPort` interface of the `kWindowViewPortBoss` corresponding to the window. The `InvalRect()` method then passes the invalidation region to the platform.

figure 10.4.1.b. Boss Collaboration for Invalidation



The invalidation region is then accumulated by the platform and generates a paint message directed at that window. The next section describes how InDesign receives and processes the update message.

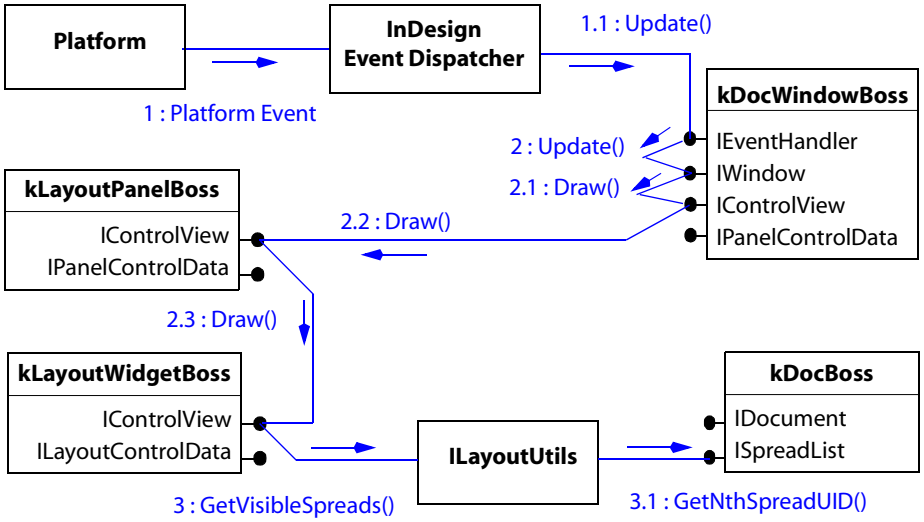
10.4.2. Window Updates

Drawing in InDesign is a response to an update event aimed at a specific window. In response to such an event, the window draws (or causes to draw) all

it's visible content. figure 10.4.2.a. shows the collaboration involved in initiating a window draw. The platform is responsible for accumulating the window regions that have previously been marked as invalid. The platform sends an update message (event) to InDesign's event dispatcher, where it is wrapped in a platform-independent class and routed to the event handler on the `kDocWindowBoss` for the appropriate window.

The window's event handler calls the `Update()` method on its `IWindow` interface, which in turn calls the `Draw()` method on its `IControlView` interface. At that point the drawing sequence begins following the pattern for drawing a widget hierarchy: `Draw()` uses the `IPanelControlData` interface to locate each of its children and call `Draw()` on the child's `IControlView` interface. This means the `kLayoutPanelBoss` is called to draw, and it iterates each of it's child widgets: scroll bars, the `LayoutWidget`, rulers, etc.

figure 10.4.2.a. Boss Collaboration for Redrawing the Layout



The `kLayoutWidgetBoss`' `IControlView` uses `ILayoutUtils` to determine which of the document's spreads are visible in the window's invalid region. Each visible spread is then called to draw it's contents and any decoration features for selected items. The details of the actual draw sequence are more involved, and are described in the next section.

The drawing sequence concludes with validating the contents of the window. This completes the update cycle, from invalidation to redraw.

10.4.3. Layout Draw Order

Layout windows are updated in several steps that allow better performance and the opportunity to interrupt the draw. Good performance is achieved by specializing the drawing operations according to: the view's z-order, whether the invalidation is due to a selection change, or whether all objects have changed.

10.4.3.1. Foreground and Background Draws

At the level of the `kLayoutWidgetBoss`, several decisions are made behind the scenes for the sake of drawing performance. The `IControlView` implementation on the `kLayoutWidgetBoss` chooses what to draw based on the window's z-order, the selection, and the update region.

If the window is the front view, then two views may be drawn behind the scenes: a background view containing all the objects and a foreground view that contains only the decorations for the selection. Offscreen graphics contexts are created and cached for both views. If the update region overlaps the window, or if the current front view was not the last view to have drawn, the background view is redrawn. If the selection is not empty, then the foreground view is redrawn as well.

Based on the above rules, `kLayoutWidgetBoss`' `IControlView` filters the visible spreads and calls their `IShape::Draw()` methods through InDesign's Draw Manager. This filtering means that page items aren't guaranteed to be called for a screen draw. The background draw then propagates through the document hierarchy as described in section "10.4.3.3. Drawing the Background" .

When the background draw is complete, the `IID_IBACKGROUNDOFFSCREENCHANGED` notification is sent to InDesign's change manager. If the selection is empty the background image is copied to the window and the draw is complete. If the selection is not empty then the foreground draw starts by copying the background image to the foreground offscreen context. The selection is drawn by iterating the selection list calling the `IHandleShape::Draw()` method for each item. The foreground image is then copied to the screen.

The use of foreground and background draws means that a page item could be called twice during a redraw. The first call to `IShape::Draw()` in the order of the document hierarchy for the background draw, and the second call to `IHandleShape::Draw()` in the order of the selection list for the foreground draw.

If the window is not the front view, then a more abbreviated draw takes place. Both the document items and the selection are drawn to a foreground offscreen context, and it is copied to the screen.

10.4.3.2. Introduction to the Draw Manager

Until now, document drawing has implied the `kLayoutWidgetBoss` is directly calling each spread to draw. In fact, `kLayoutWidgetBoss` calls through InDesign's Draw Manager facility. The Draw Manager is a session level interface through which all drawing for the screen, PDF, and print passes. As described above, drawing in InDesign occurs on a spread-by-spread basis, and is hierarchical. Without a service like the draw manager, it would be difficult to change the behavior of drawing a sub hierarchy.

Funneling all drawing activity through the Draw Manager provides three important features for changing the behavior of draws:

- Clipping of areas to be drawn
- Filtering of items to be drawn
- Interrupting a draw sequence

Clipping and filtering provide a means to select items for the draw based on regions. The draw manager maintains the current values for the clip and filter regions. Interruption of the drawing sequence relies on a broader mechanism called draw events. As items draw they broadcast standard messages that announce the beginning and end of discrete drawing operations. Draw events are received by special handlers that register interest in particular types of messages, and each draw event handler has the opportunity to abort the draw at that point. Clients of the Draw Manager (such as the `LayoutWidget`) install a default draw event handler.

The Draw Manager provides services for hit testing and iterating the draw order as well as drawing. More information about all of its functions is available in the Draw Events chapter.

10.4.3.3. Drawing the Background

Once the `kLayoutWidgetBoss`' `IControlView` implementation has obtained a list of the visible spreads, it has to ask each spread to draw through InDesign's Draw Manager. This section describes the overall sequence for drawing the document hierarchy.

The collaboration for drawing the document hierarchy is shown in figure 10.4.3.a.. The `IControlView` implementation on the `kLayoutWidgetBoss` calls the Draw Manager once for each visible spread in the window's view. The Draw Manager is responsible for creating a `GraphicsData` object that describes the graphics context for the spread's draw. Specifically, it sets the transformation matrix in the graphics port to support drawing in the spread's parent coordinate system, which is the pasteboard. The Draw Manager then calls the spread's `IShape::Draw()` method to initiate the sequence of drawing that spread.

When an item's `IShape::Draw()` method is called, it has the responsibility to draw itself and then draw its children. This action is analogous to the mechanism used for the `IControlView` interface on widgets. The `IShape` implementation provides methods for drawing an object and iterating the object's children, asking each of them to draw. Before drawing, the `IShape` implementation sets the transformation matrix in the graphics port to the item's inner coordinates. This establishes the convention:

- Each drawing object expects to receive the graphics port set to its parent's coordinate system,
- Each drawing object sets the graphics port to its inner coordinates before drawing itself or calling its children to draw,
- Each drawing object reverts the graphics port to its parent's coordinate system before returning to the caller.

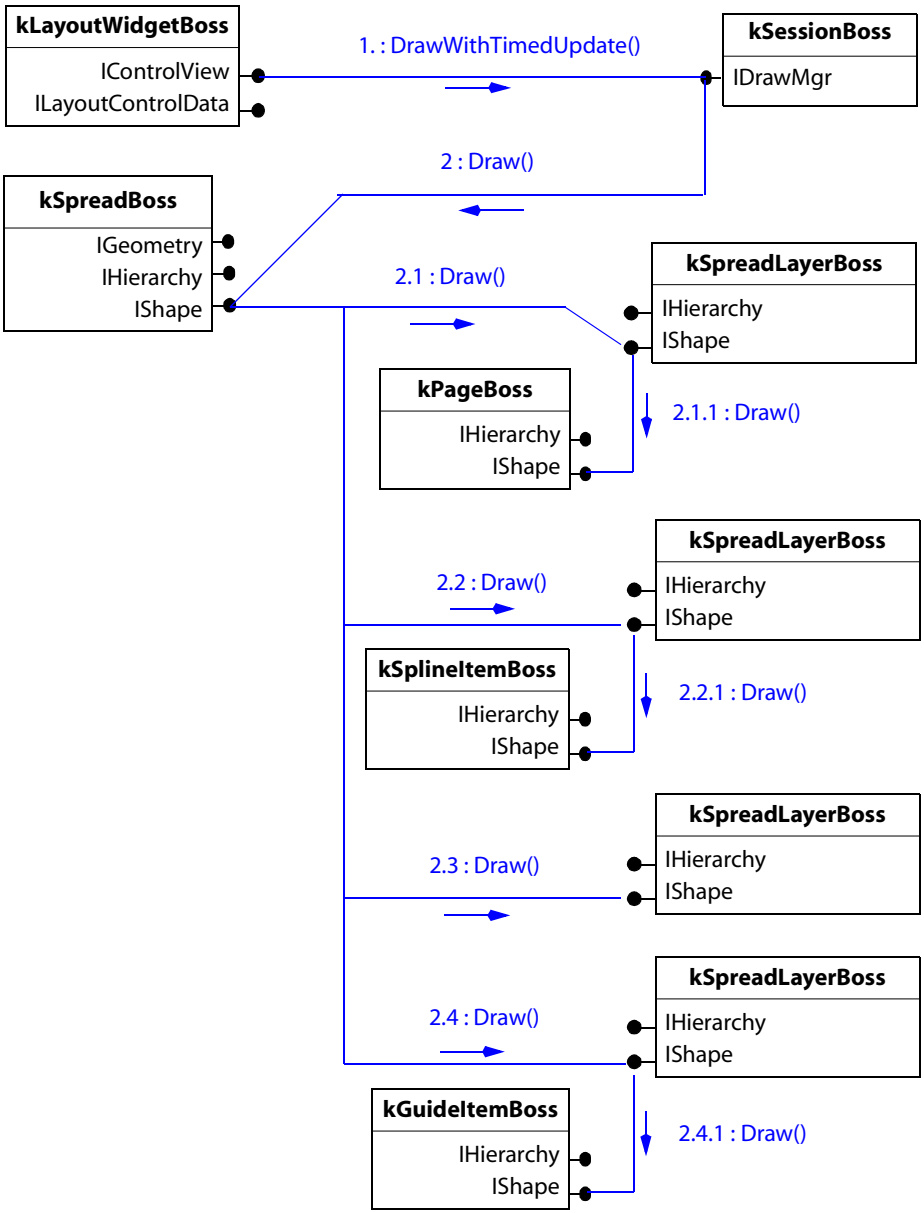
The `IShape` class, its methods for drawing, and the coordinate system manipulations are described in greater detail later in this chapter.

Iterating the object's children is accomplished by using the `IHierarchy` interface on each page item. This interface provides methods for iterating the document hierarchy. For more information about the `IHierarchy` interface, see the chapter about page items.

Once called by the Draw Manager, spread drawing always follows the document hierarchy. Users can control whether the guides appear in front of the content

or behind it and this affects the hierarchy. Assuming guides are behind the content: page layers are drawn first followed by the content layers, and then the guide layers. If the guide layers appear in front of the content, then the guides draw before the content. All of the content on a given layer is drawn before proceeding to the next layer. Embedded children of a page item are called to draw before that item completes its draw. For example, when the `kSplineItemBoss` is called to draw in step 2.2.1 of figure 10.4.3.a., if it had children they would be called to draw as step 2.2.1.1, 2.2.1.2, etc. before returning to the `kSpreadLayerBoss`.

figure 10.4.3.a. Boss Collaboration for Drawing the Layout



10.5. The Context for Page Item Drawing

When page items are called to draw, they receive two arguments that describe the context for their draw:

- `IShape` drawing flags stored in an `int32`
- A pointer to a `GraphicsData` object.

Page items use these inputs to perform their drawing operations.

10.5.1. IShape Flags

The `IShape` class defines an enumeration of flags that describe the requested mode of drawing. figure 10.5.1.a. shows these flags and their interpretation.

figure 10.5.1.a. IShape Drawing Flags

Flag	Use
kUseXOR	For wire frame drawing; used for dynamic updates. Set IRasterPort::SetXORMode(kTrue)
kDrawResizeDynamic kDrawRotateDynamic kDrawScaleDynamic kDrawMoveDynamic kDrawCreateDynamic	A dynamic draw is taking place. Page items may optionally draw abbreviated shapes during dynamic draws.
kPatientUser	Set if PatientUserMode timer has expired. (Trackers clear this bit when they restart their timers.) Abbreviate the draw if set.
kPrinting	Indicates PDF or Print. (Don't draw guides, grids or selection handles.)
kDrawFrameEdge	Reflects settings of Frame Edge Preferences. (Triggers TextFrameEdgesAdornment.)
kPreviewMode	Drawing a preview of the kPrinting mode.

10.5.2. GraphicsData Class

The `GraphicsData` class has pointers to the important bosses and interfaces for drawing. figure 10.5.2.a. shows a summary of the methods for the `GraphicsData` class when instantiated for screen drawing.

figure 10.5.2.a. Graphics Data Object Methods for Screen Drawing

Method	Use
GetGraphicsPort()	Returns the IID_IGRAPHICPORT interface on the kWindowViewPortBoss.
GetRasterPort()	Returns the IRasterPort interface on the kWindowViewPortBoss. May be nil if not drawing to the screen.
GetDrawEventDispatcher()	Returns IDrwEvtDispatcher interface on kSessionBoss

figure 10.5.2.a. Graphics Data Object Methods for Screen Drawing

Method	Use
GetDrawManager()	Returns IDrawMgr interface on kSessionBoss
GetView()	Returns IControlView interface on the boss that instantiated the graphics context. (For normal screen draws, this is kLayoutWidgetBoss.) May be nil if not drawing to the screen.
GetViewPort()	Returns IViewPort interface on the kWindowViewPortBoss
GetViewPortAttributes()	Returns IViewPortAttributes on the kWindowViewPortBoss
GetLayoutController()	Returns the ILayoutController interface on the kLayoutWidgetBoss for the window. May be nil, except during invalidation.
GetTransform() GetInverseTransform()	Returns the IGraphicsContext object transformation matrix
GetGraphicsContext()	Returns a pointer to the IGraphicsContext object for the view port boss

As the figure shows, the `GraphicsData` object can return pointers to important interfaces on the view port boss (see 10.3.3.1., page 327) and the current graphics context. In general, getting access to the `IGraphicsPort` interface, the draw event manager, and the transforms for the window are the most commonly used methods.

10.5.3. IGraphicsPort

The `IGraphicsPort` interface is *the* InDesign interface for drawing. It is used by all of the drawing interfaces on a page item, regardless of the output device.

The `IGraphicsPort` implementations provide methods that are very similar to PostScript graphics operators. The methods support drawing primitives, port transformation manipulation, and changing the port clip settings. The following sections describe how to acquire and use the port.

10.5.3.1. Getting IGraphicsPort from GraphicsData

The `GraphicsData` class provides the `GetGraphicsPort()` method to directly access the graphics port in preparation for drawing. figure 10.5.3.1.a. shows an example code snippet.

figure 10.5.3.1.a. Getting the Graphics Port from GraphicsData

```
void MyShape::DrawShape(GraphicsData* gd, int32 flags)
{
  // default DrawShape draws an XBox
  IGraphicsPort* gPort = gd->GetGraphicsPort();
  // Draw to port...
}
```

10.5.3.2. Drawing with IGraphicsPort

The methods of `IGraphicsPort` are very similar to PostScript graphics operators. A complete list of the methods are in `IGraphicsPort.h`. Line drawing methods such as `lineto()`, `moveto()`, `curveto()`, `closepath()`, `fill()`, and `stroke()` are available. If a path is currently defined in the port it can be discarded using the `newpath()` method. These methods are demonstrated in the page item drawing section. Control over the color space, color values, gradient, and blending modes is also available through `IGraphicsPort` methods.

10.5.3.3. Controlling the IGraphicsPort settings

The port settings can be modified using `IGraphicsPort` methods. The `gsave()` and `grestore()` methods effectively push the current port settings on a stack, and pop the old settings when desired. These methods are used to save the current port settings when setting the port's transform to a new space. For example, when a page item is called to draw, it should save the port settings, set the port to it's inner coordinate space, draw, then restore the port before returning.

The port's transform can be modified by translations, scale factors, rotations, or a new transform can be concatenated to the existing port. Concatenation is most commonly used when page items draw: it's how a page item sets the port to draw to its inner coordinates. figure 10.5.3.3.a. shows example code demonstrating this operation.

figure 10.5.3.3.a. Manipulating the Graphics Port Settings

```
// Get the graphics port from gd, a GraphicsData*
IGraphicsPort* gPort = gd->GetGraphicsPort();
if ( gPort == nil ) return;

// Save the current port settings
gPort->gsave();

// Get this page item's ITransform interface
InterfacePtr<ITransform> xform(this, IID_ITRANSFORM);

// Concatenate the inner to parent matrix to the port
gPort->concat(xform->CurrentMatrix());

// Draw a rectangle around the item
InterfacePtr<IGeometry> geo (this, IID_IGEOMETRY);
const PMRect r = geo->GetStrokeBoundingBox();
gPort->rectpath(r);
gPort->stroke();

// Restore the previous port settings
gPort->grestore();
```

10.5.4. Detecting the Device Context for Drawing

In theory, page items shouldn't care whether they are drawing to print, PDF, or screen. The fact that the graphics port is specialized for different devices in the three cases is transparent to the drawing code. However, there may be situations where the context determines how an item draws. For example, guides draw to the screen but not to print.

10.5.4.1. Detecting the Drawing Device Using Drawing Flags

The `IShape` class defines an enumeration of bit masks for the drawing flag argument supplied to `IShape::Draw()` from InDesign's Draw Manager. The `IShape::kPrinting` mask indicates that printing or PDF is taking place, as shown in figure 10.5.4.1.a..

figure 10.5.4.1.a. Detecting Drawing Device Using IShape Drawing Flags

```
void MyShape::DrawShape(GraphicsData* gd, int32 flags)
{
  if (flags & IShape::kPrinting)
  {
    // Device is PDF or print...
  }
}
```

10.5.4.2. Detecting the Drawing Device Using the View Port Boss

The GraphicsData class can provide finer detail about the drawing device. As figure 10.5.4.2.a. indicates, the graphics data class provides an accessor to the view port attribute interface, which resides on the view port boss associated with the current drawing operation. From the view port attribute interface the code queries for the IPDFDocPort interface. Its presence means the view port boss is a kPDFViewPortBoss, indicating PDF output. If it's not PDF output, the next step is to test for printing. This is done using a method on the view port attribute interface of the window port boss. The GetViewPortIsPrintingPort() method will reflect the value of the IShape drawing flag value for printing. If it is printing, the IPrintObject interface verifies that it is PostScript printing. Otherwise, the window port corresponds to a screen draw.

figure 10.5.4.2.a. Determining Port Type

```
// From a GraphicsData* gd, get an interface on the window port boss
IViewPortAttributes* iViewPortAtt = gd->GetViewPortAttributes();
// Is this a PDF?
InterfacePtr<IPDFDocPort> pdfDocPort(iViewPortAtt, IID_IPDFDOCPORT);
if (pdfDocPort != nil)
{
  // PDF export...
}
else
{
  // Is it printing?
  if (iViewPortAtt->GetViewPortIsPrintingPort())
  {
    // Ok, it's printing. But what kind? Ask the print object.
    // See PrintID.h, GraphicsExternal.h
    IGraphicsPort* gPort = gd->GetGraphicsPort();
    InterfacePtr<IPrintPort> iPrintPort (gPort, IID_IPRINTPORT);
    InterfacePtr<IPrintObject> iPrtObj
      (iPrintPort->GetPrintObject(), IID_IPRINTOBJECT);
    AGMDeviceType devType = kAGMPPostScript;
    iPrtObj->GetObject(kAGMPrtObjectItmsDeviceType, nil, &devType);
    if (devType == kAGMPPostScript)
    {
      // PS output
    }
  }
  else
  {
    // Screen drawing...
  }
}
```

10.6. Page Item Drawing

Ultimately, it is every page item's responsibility to draw itself and call it's children to draw. This responsibility falls on a handful of interfaces, each tailored to draw in a particular circumstance. This section describes these interfaces and provides greater detail about the expected sequence during the draw.

10.6.1. Overview of Page Item Interfaces for Drawing

The relevant interfaces for basic page item drawing are shown in Table 10.6.1.a. The first three interfaces in the table are directly involved in drawing a page item. The `IShape` interface is the main interface for drawing the page item, and is called when the entire page item needs to be rendered. The `IHandleShape` interface is called when a page item is in the selected state and is used for drawing the decorations that denote selection. Path-based items such as spline bosses also have the `IPathPageItem` interface to handle the details of drawing their paths.

table 10.6.1.a. page item interfaces for drawing

Interface	Function
IShape	Renders path, fill, stroke. Called during background drawing.
IHandleShape	Renders selection handles, called during foreground drawing
IPathPageItem	Low-level draws for path, fill, stroke
IGraphicStyleDescriptor	Graphics Attributes
IPageItemAdornmentList	List of Adornments for Page Item

The `IPageItemAdornmentList` maintains a list of adornments for the page item. The `IGraphicStyleDescriptor` interface is one of several that maintain the graphics attributes for the page item. The details of these two interfaces are covered in separate chapters. However, they are mentioned here because of their important role in drawing.

Other, more specialized page items have additional interfaces for drawing. However, those more specialized cases are deferred to their own chapters.

10.6.2. IShape Interface

The `IShape` interface is responsible for providing the drawing, hit testing, draw order iteration, and invalidation functions for page items. This interface is

defined in the abstract base class **IShape.h**. This section will describe the drawing responsibilities of the class. The Draw Events chapter discusses the other functions.

The IShape class is responsible for rendering a page item. It is used during background draws to create the path, fill, and stroke of an object.

10.6.2.1. Shape Class Structure

The InDesign API provides the IShape abstract base class as well as the CShape concrete implementation. New implementations of a shape class can be based on CShape. The CGraphicFrameShape implementation is used by kSplineItemBoss, and serves as a good example of how to extend the CShape default implementation.

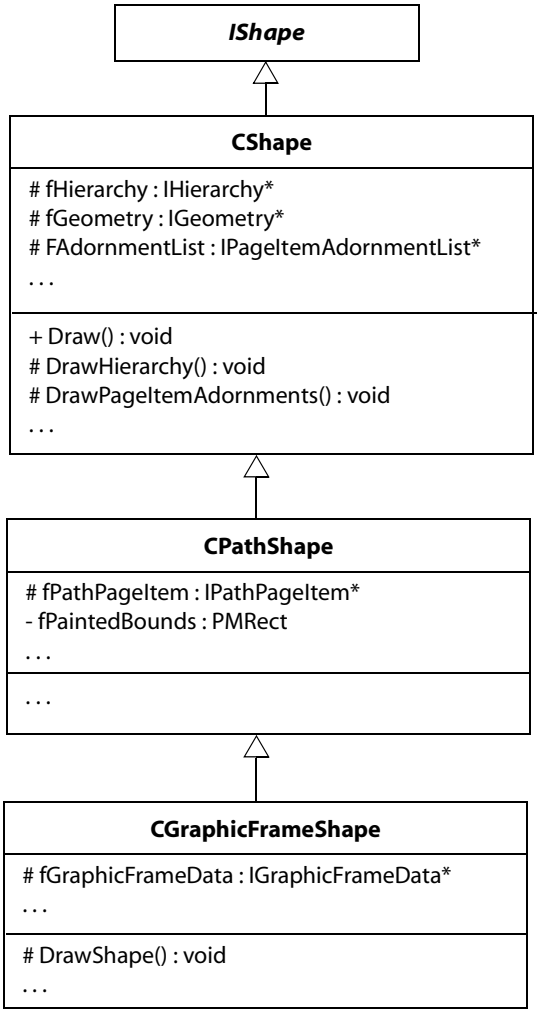
The class structure for the concrete shape classes used by a kSplineItemBoss is shown in figure 10.6.2.1.a.. The implementation (*.cpp) files for all the classes shown in this figure are included in the SDK API directory. The CShape class provides the default implementations for the drawing functions, such as the Draw() method. The CShape class also adds protected methods that should be specialized in the child classes. The CPathShape class specializes CShape for page items that have only a path but are not filled. The CPathShape class is then further specialized to produce the CGraphicFrameShape class, which is a more general class for splines that supports both stroke and fill.

The CShape class has a default implementation of Draw() that calls the protected method DrawShape(). Specializing a shape class for drawing is done primarily through the DrawShape() method. The CGraphicFrameShape class specializes DrawShape() to set the path, fill it, then call CShape::DrawHierachy(). The DrawHierachy() method simply iterates the children of the page item, calling the IShape::Draw() method for each. When DrawHierachy() is finished, CGraphicFrameShape::DrawShape() completes drawing the spline.

The CGraphicFrameShape class queries for and attempts to cache a pointer to its IGraphicFrameData interface. This interface is used to determine if the page item is a graphic frame. Some of the details of drawing a spline are delegated from the CGraphicFrameShape::DrawShape() method to methods on the IPathPageItem interface of the page item. The CPathShape class caches a pointer to this interface. The methods on this interface are discussed below. The CShape

class also caches pointers to the `IHierarchy`, `IGeometry`, and `IPageItemAdornmentList` interfaces of the page item.

figure 10.6.2.1.a. Class Diagram for CGraphicFrameShape



10.6.2.2. Shape Class Drawing Sequence

The `IShape` class drawing sequence involves more than just the drawing instructions. Extensibility points are built into the sequence in the form of draw

events and adornments. As mentioned in the previous chapter, adornments are a way to enhance or decorate a page item's appearance. A second extensibility option is to use draw events, which are briefly introduced in this section for the purposes of explaining their role in the shape class drawing sequence.

More detailed information about draw events and adornments is left to other chapters. The remainder of this section describes the activities expected of a shape class implementation during drawing.

10.6.2.2.1. Draw Event Primer

Draw events are messages that are broadcast at specific points in the draw order. Each signals the beginning or end of a phase of drawing. Draw events provide extensibility points in that drawing operations can be modified or cancelled in response to the event.

Draw event types are defined in **DocumentContextID.h**. Some of the generic draw event types associated with shape drawing are shown in Table 10.6.2.2.1.a. There are other, more specific event types that signal the beginning and end of spread, layer, and page drawing.

table 10.6.2.2.1.a. generic draw events

Draw Event	Use
kAbortCheckMessage	Opportunity to abort entire item draw
kFilterCheckMessage	Opportunity to filter draw based on object type
kDrawShapeMessage	Shape drawing is about to begin.
kBeginShapeMessage	Start of shape drawing
kEndShapeMessage	End of shape drawing

Draw event handlers can be a type of service provider. If so, they are automatically registered at startup. Draw event handlers register their prioritized interest in particular types of draw events. If a draw event handler returns `kTrue` in response to a draw event, the drawing at that step ceases. If it returns `kFalse` the drawing event is considered as not handled, and the drawing step proceeds. A draw event handler that modifies or decorates the drawing of an object, but does not replace it, would return `kFalse`.

10.6.2.2.2. Shape Class Drawing Sequence

figure 10.6.2.2.a. shows the activity in `Draw()` and `DrawShape()` for drawing a page item. When a page item begins drawing, three draw events are broadcast. No `IShape` drawing activities occur between the broadcasts.

In preparation for drawing the graphics port state is saved, then set to draw in the page item's inner coordinate system. A `kBeginShapeMessage` drawing event is broadcast. As before, if any draw event handler returns `kTrue` the activity ends. The next step is an example of the second type of extensibility: the `kBeforeShape` page item adornments are asked to draw.

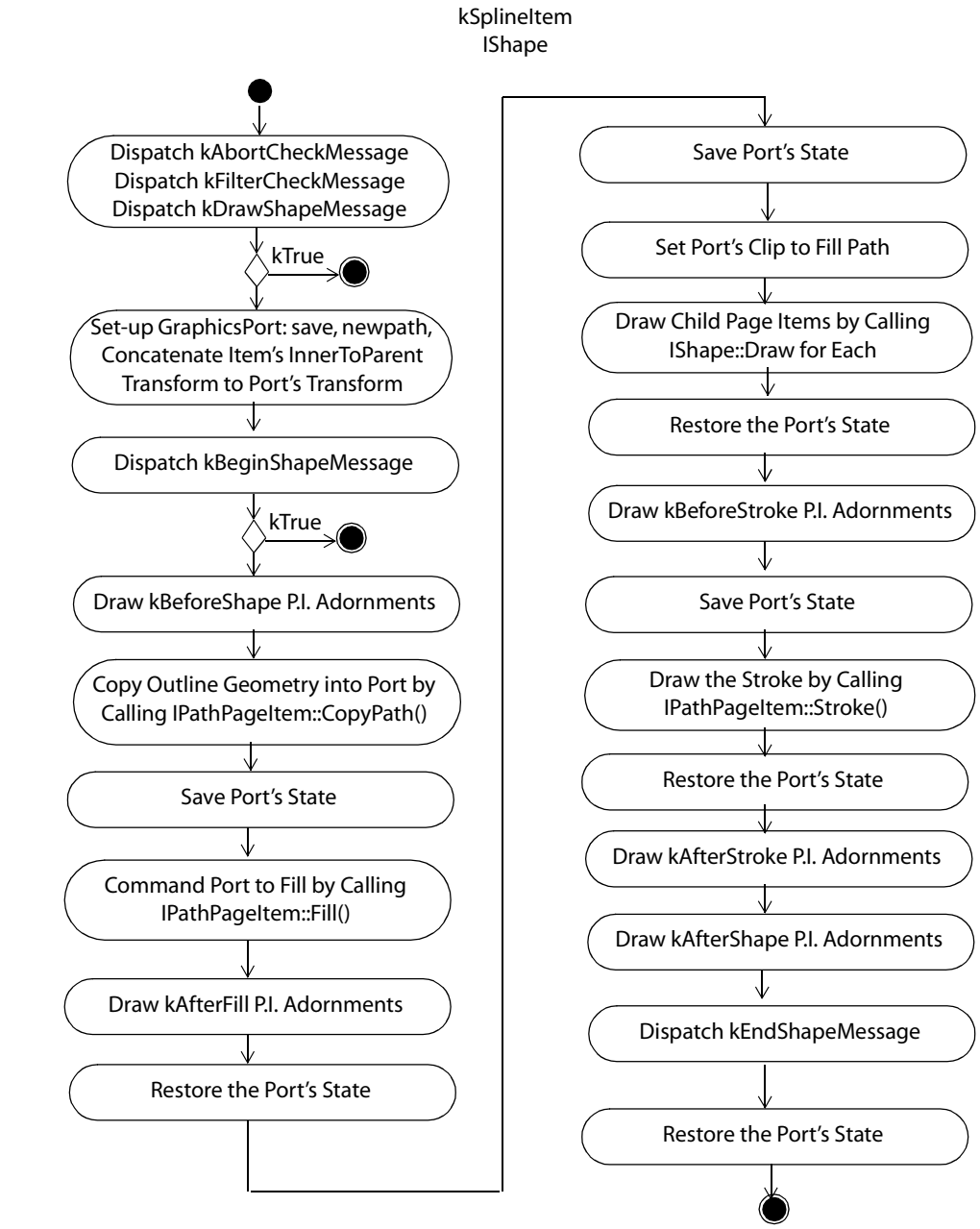
The next step in the sequence is shows the standard AGM imaging model for graphics operators:

- define the item's path
- fill the path
- set the port to clip to the path
- draw the item's children
- stroke the path

Note the use of port saves and restores in the diagram. Their use allows the adornments and child drawing routines to modify the port as needed and still have it return to a known state for the next drawing step. As an example, adornments that draw subsequent to the definition of the path have the opportunity to redefine the path in the port.

From figure 10.6.2.2.a. we can see that the details of drawing a `kSplineItemBoss` are delegated to the `IPathPageItem` implementation. Behind the scenes, the `IPathPageItem` methods make use of the graphics attributes defined for the page item in order to draw the details of the path, fill, and stroke. The figure also shows the step for drawing the children of the page item. In the case of a `kSplineItemBoss`, the child might be a `kMulticolumnItemBoss` for a text frame or a `kImageItem` for a graphic.

figure 10.6.2.2.a. IShape::Draw Activity for Spline Items



10.6.2.2.2. Drawing Example

The default implementation of `CShape::DrawShape()` provides an example of using `GraphicsData` and `IGraphicsPort` to draw a simple figure. This brings together the drawing activity discussed in "10.4. Drawing the Layout" and the drawing context concepts from "10.5. The Context for Page Item Drawing" .

As an example, we can create a new type of page item called `kMyPIBoss` that is based on `kSplineItemBoss`. As shown in figure 10.6.2.2.a., this new page item will simply override the `IShape` implementation with one called `MyShape`.

figure 10.6.2.2.a. Overriding the IID_ISHAPE implementation of kSplineItemBoss

```
Class
{
  kMyPIBoss,
  kSplineItemBoss,
  {
    IID_ISHAPE, kMyShapeImpl,
  }
},
```

The `MyShape` implementation is a subclass of `CGraphicFrameShape`, and overrides only the `DrawShape()` method. The `MyShape::DrawShape()` method will be based on the `CShape::DrawShape()` method. As figure 10.6.2.2.b. shows, this implementation simply draws a rectangle and cross. The `DrawShape()` method assumes the `IGraphicPort` interface has been set to Inner coordinates by the `Draw()` method.

First, a pointer to the `IGraphicsPort` interface on the view port boss is acquired from the `GraphicsData` pointer. Next, a rectangle describing the stroke bounding box is acquired from the page item's `IGeometry` interface. This bounding box is returned in Inner coordinates.

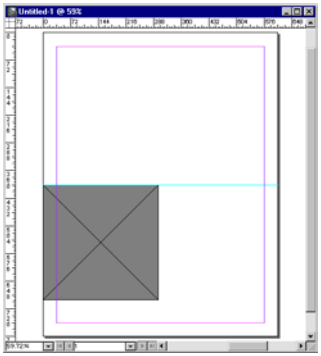
Using the stroke bounds and `IGraphicsPort`, the remainder of the code draws a rectangle with an X through it. The fill operations write the rectangular path to the port, set a grey color, and command a fill. The X is drawn with discrete line segments. The final operation is to stroke the path.

figure 10.6.2.2.b. Drawing Example

```
void MyShape::DrawShape(GraphicsData* gd, int32 flags)
{
  // default DrawShape draws an XBox
  IGraphicsPort* gPort = gd->GetGraphicsPort();

  // Get the geometry for this item in inner coords
  const PMRect r = fGeometry->GetStrokeBoundingBox();

  // Fill the item boundary and draw kAfterFill adornments
  gPort->rectpath(r);
  gPort->gsave();
  gPort->setgray(Ø.5);
  gPort->fill();
  DrawPageItemAdornments(gd, flags, IAdornmentShape::kAfterFill);
  gPort->grestore();

  // Skip drawing child items, draw the 'X' instead
  gPort->moveto(r.Left(), r.Top());
  gPort->lineto(r.Right(), r.Bottom());
  gPort->moveto(r.Right(), r.Top());
  gPort->lineto(r.Left(), r.Bottom());

  // Draw kBeforeStroke Adornments
  DrawPageItemAdornments(gd, flags, IAdornmentShape::kBeforeStroke);

  // Stroke the boundry and 'X'
  gPort->setlinewidth(Ø);
  gPort->stroke();

  // Draw kAfterStroke Adornments
  DrawPageItemAdornments(gd, flags, IAdornmentShape::kAfterStroke);
}
```

If this page item is created to be 300 points square at (0,396) in page coordinates, it will appear as shown in figure 10.6.2.2.c..

figure 10.6.2.2.c. Simple Drawing Example - Results



10.6.3. The IPathPageItem Interface

The `IPathPageItem` interface encapsulates the specialized drawing functions for path-based page items. The class provides methods for operations such as stroke, fill, clip, and copying a path to the graphics port. The `CGraphicFrameShape` class (discussed above) delegates these specific draw operations to the `IPathPageItem` class.

Behind the scenes in this class, graphics attributes are used to control the appearance. The `PathPageItem::Stroke()` method first calls `PathPageItem::Setup()` which initializes a set of default stroke properties, then attempts to get the stroke graphic attributes such as stroke weight and a `ClassID` for a path stroker. The path stroker is a service provider that delivers the `kPathStrokerService`. The `PathPageItem::Stroke()` method then uses the stroke graphic attributes and path stroker to actually create the stroke.

10.6.4. The IHandleShape Interface

The `IHandleShape` interface is responsible for drawing and hit-testing for a page item's selection handles. This interface is defined in the abstract base class `IHandleShape.h`. The drawing responsibilities are described in this section.

10.6.4.1. The IHandleShape Class Structure

The InDesign API provides the `IHandleShape` base class and the `CHandleShape` concrete implementation. The `CHandleShape` class provides a public `Draw()` method that is called by the `LayoutWidget`'s `IControlView` implementation during a foreground draw. The `Draw()` method calls two protected methods of

the class: `DrawPathImmediate()` and `DrawHandlesImmediate()`. The former strokes a selection highlight and the latter draws the selection handles. Specializing the drawing functions of the class is done through these two methods.

10.6.4.2. The IHandleShape Drawing Sequence

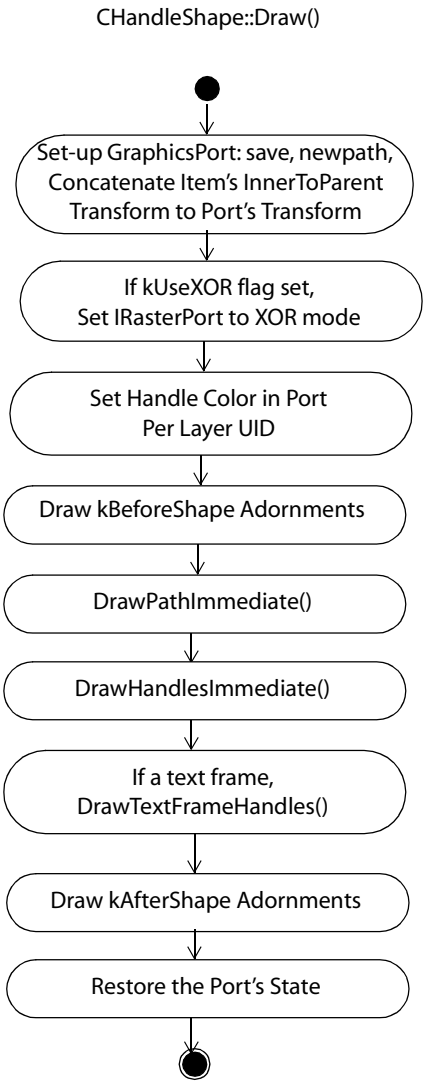
As with the `IShape` class, the `IHandleShape` drawing sequence includes extensibility points in the form of adornment calls.

figure 10.6.4.2.a. shows the activity involved in the `CHandleShape::Draw()` method, and it follows a familiar pattern from the `IShape` class. The graphics port is acquired, saved, and set to draw in the page item's inner coordinates. The `IShape` drawing flag `kUseXOR` is tested, and if set the IRasterPort interface is commanded to draw in XOR mode to produce wire frame outlines. Next, the port's color is set to one corresponding to the page item's layer. This will highlight the selected items in colors that correspond to their layer. Then the `kBeforeShape` adornments are called to draw. The selection path, handles, and possible text frame handles are then drawn by other methods of `CHandleShape`. The `kAfterShape` adornments are called to draw, and the port is restored.

The `IHandleShape::DrawPathImmediate()` method is conceptually very simple. It's job is to stroke the object with a line that denotes selection. figure 10.6.4.2.b. illustrates example code for this function. As always, the first step is to acquire the graphics port from the `GraphicsData` object. Once acquired, the object's stroke bounding box is used to set a new path in the graphics port. Here the cached pointer `CHandleShape::fGeometry` is used to simplify getting the bounding box, which is returned in Inner coordinates. Now that the geometry is defined, the only remaining operations are to set the line width and stroke the path.

The `IHandleShape::DrawHandlesImmediate()` method simply adds symbols to the selection path. figure 10.6.4.2.c. demonstrates the code for adding these symbols. The first step is to use the `GraphicsData` object to get access to the `IGraphicsPort` interface of the view port boss. In this case the `IRasterPort` interface is acquired as well.

figure 10.6.4.2.a. CHandleShape::Draw() Activity



The existing path in the port is cleared, and a nine new paths are generated using the `GraphicsUtils` method `CreateAnchorPointPath()`. The loop creates a rectangular path centered on each location obtained from the bounding box data: each corner and midpoint. The ninth point is generated at the midpoint of the bounding box. Once created, the paths are filled using the port's existing color.

figure 10.6.4.2.b. DrawPathImmediate() Method

```
void MyHandleShape::DrawPathImmediate(GraphicsData *gd, int32 )
{
  // Get the graphics port from GraphicsData
  IGraphicsPort* gPort = gd->GetGraphicsPort();

  // Set the path in the port to the item's bounding box
  gPort->rectpath(fGeometry->GetStrokeBoundingBox());

  // Stroke the bounding box path to the color in the port
  gPort->setlinewidth(0);
  gPort->stroke();
}
```

figure 10.6.4.2.c. DrawHandlesImmediate() Method

```
void MyHandleShape::
DrawHandlesImmediate(GraphicsData *gd, IPathSelection* , int32 flags)
{
  PMPoint point;

  // Get pointers to the ports
  IGraphicsPort* graphPort = gd->GetGraphicsPort();
  IRasterPort* rasPort = gd->GetRasterPort();

  // Get the item's bounding box
  PMRectmyBounds = fGeometry->GetStrokeBoundingBox();

  // Create the handle paths: corners, mid points, center
  graphPort->newpath();
  for (int32 i = 0; i < 8; i++)
  {
    point = myBounds.GetPoint(PMRect::IndexToPointIndex(i));
    GraphicsUtils::CreateAnchorPointPath(rasPort,
        graphPort, point, 4, kFalse);
  }
  point = myBounds.GetCenter();
  GraphicsUtils::CreateAnchorPointPath(rasPort,
      graphPort, point, 4, kFalse);

  // Fill the handles
  graphPort->fill();
}
```

The `DrawHandlesImmediate()` code for `kSplineItemBoss` adds a bit fancier handles based on whether or not the spline contains any content. It tests for the

presence of content using the `CHandleShape::HasContent()` method. If so, it makes the handles 5 points in size. After the fill operation it uses `IGraphicsPort::moveto()` and `lineto()` instructions to add a white pixel in the middle of each handle. It sets the white color with the `IGraphicsPort::setrgbcolor()` method, and restores the selection color using the `CHandleShape` handle color properties.

The `kSplineItem` code also handles some special cases. Vertical and horizontal lines are handled by choosing only the endpoints and midpoints of the line for selection handles. Rectangles of zero height and width are handled by placing only one handle at the center of the rectangle.

10.7. Summary

Documents are displayed in InDesign windows, which are cross-platform representations of the underlying platform windows. InDesign windows use view port bosses to define the graphics port for drawing in the window.

Page items have the responsibility to draw themselves and to call their direct children to draw. Screen draws only call the page items that are visible in a window.

During a draw, page items receive calls to their `IShape` and `IHandleShape` interfaces. The former is used for drawing the object, the latter for drawing the decorations for selection. Page items are called through their `IShape` interface as part of a sequence that follows the document hierarchy. If a page item is part of the current selection, it will be called again on its `IHandleShape` interface.

The `GraphicsData` object provides information about the graphics context to the methods of a page item's drawing interfaces. It is passed into the drawing methods as an argument, and contains pointers to the relevant interfaces in the graphics context.

10.8. Review

You should be able to answer the following questions:

1. What is the function of an InDesign window? ("Window Bosses" on page 319)
2. What items comprise the layout hierarchy? ("The Layout Hierarchy" on page 322)

3. What is the sequence of drawing in InDesign? (“Drawing the Background” on page 336)
4. How is the `GraphicsData` object used in drawing? (“GraphicsData Class” on page 339)
5. What is the draw sequence for a page item? (“Shape Class Drawing Sequence” on page 346)
6. What methods are responsible for drawing the features that denote an item is selected? (“The IHandleShape Interface” on page 352)

10.9. Exercises

1. Derive a new `IShape` class based on `CShape` that only draws a circle of diameter equal to its smallest bounding box dimension.
2. Add code to the example in figure 10.6.4.2.c. to handle the special case of drawing selection handles on a line.

11.

Page Item Adornments

11.0. Overview

The adornment is for customizing the appearance of the page item on the page. A page item adornment is associated with a page item. It gets drawn based on the drawing order you specified for the adornment when a page item is being rendered. There are two adornment types in the application, for text and page items. This chapter will cover the details about page item adornments. The chapter "Adding Text Attributes and Adornments" will cover text adornments.

11.1. Goals

The questions this chapter addresses are:

1. What is a page item adornment? When do you need it?
2. What are the necessary interfaces to define a page item adornment?
3. How do you create a page item adornment?
4. How do you add or remove a page item adornment?

You should already know what a page item is and how page item drawing works in the application. Please refer to the "Page Item" and "Page Item Drawing" for more information.

11.2. Chapter-at-a-glance

"11.3.Page Item Adornments" on page 360 explains page item adornments and the relation with page items.

"11.4.Adornment Interfaces" on page 362 introduces the interfaces related to page item adornments.

table 11.1.a. version history

Rev	Date	Author	Notes
2.0	18-Oct-02	Paul Norton	Update for the 2.x SDK
1.0	11-Sep-00	Jane Zhou	Initial draft

"11.5.Creating Custom Page Item Adornments" on page 365 shows an example how to create custom page item adornments.

"11.6.Add Or Remove Adornments" on page 370 describes how to add or remove a page item adornment.

"11.7.Summary" on page 372 provides a summary of the content covered in this chapter.

"11.8.Review" on page 372 provides questions to test your understanding of the material in this chapter.

"11.9.Exercises" on page 372 provides suggestions for further study.

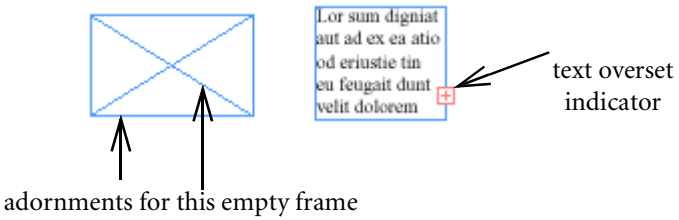
11.3. Page Item Adornments

Page item adornments customize the appearance of a page item. They give a plug-in the chance to add additional drawing when the page item is rendered. For example, you want to add a drop shadow or label for specified page items, page item adornment is one way to add those extra drawings.

The page item draws itself, and in the process calls each adornment's `IAdornmentShape::Draw()` method based on their drawing order. You need to add the custom adornment to the page item adornment list attached to the page item in order for this to happen.

Examples of page item adornments in InDesign are the text overset indicator for text frames, the graphic frame outline path and empty graphic frame indicator (The X inside the frame). See figure 11.3.a. for illustrations.

figure 11.3.a. Adornments Example In InDesign



11.3.1. IPageItemAdornmentList

`IPageItemAdornmentList` manages a list of the page item's adornments. This interface is aggregated on the page item boss (i.e. `kDrawablePageItemBoss`)

Each adornment in the list is called to draw, in order, according to the `AdornmentDrawOrder` value. For page item adornments, there are nine oportunities within the draw order to draw. The order of events within the draw order are defined in IAdornmentShape.h. These values represent when the adornment is to be drawn. Upon calling the `AddPageItemAdornmentCmd`, the adornment is inserted into the list based on the drawing order. Think about the page item adornment list as nine linked lists.

figure 11.3.b. AdornmentDrawOrder For Page Item Adornment

```
enum AdornmentDrawOrder
{
  // kBeforeShape and kAfterShape are for graphic frames
  kBeforeShape = 1,
  // kAfterFill, kBeforeStroke and kAfterStroke are for spline items
  kAfterFill = 2,
  // the following four flags are for text frames only
  kBeforeTextBackground = 4,
  kBeforeText= 8,
  kBeforeTextForeground = 16,
  kAfterTextForeground = 32,
  // for spline items
  kBeforeStroke = 64,
  kAfterStroke = 128,

  kAfterShape = 256,
  kAllAdornmentFlags = 511
};
```

To add an adornment to a page item, you need to first define the adornment as a boss that aggregates the `IAdornmentShape` interface. In a more complex case, you might want to use more than one adornment to adorn a single page item. The implementation for interface `IAdornmentShape` will vary. You can choose to provide hit testing and invalidating the view if needed. However, you are required to draw the adornment.

11.3.2. Adornments vs. DrawEventHandlers

Basically, page item adornments add extra visual information for the page items they decorate. **DrawEventHandlers** provide the similar functionality. A DrawEventHandler is a boss that aggregates IDrwEvtHandler.

The DrawEventHandlers do their work in response to drawing event messages. You can find all the messages in `DocumentContextID.h`. The handlers can be built as service providers, or can register and unregister themselves directly with the session (`IDrwEvtDispatcher` is on the `kSessionBoss`.) This will require more work, but is also more flexible.

The DrawEventHandlers are typically registered at start-up, before any drawing is done. The adornments are 'attached' to specific page items while draw event handlers are tied to the action of drawing and are not particular to an individual item.

PageItemAdornments enhance the way an item is drawn. A DrawEventHandler can completely replace the drawing of a page item.

11.4. Adornment Interfaces

11.4.1. Interface Diagram

figure 11.4.1.a. Adornment Interface Diagram

11.4.2. IAdornmentShape

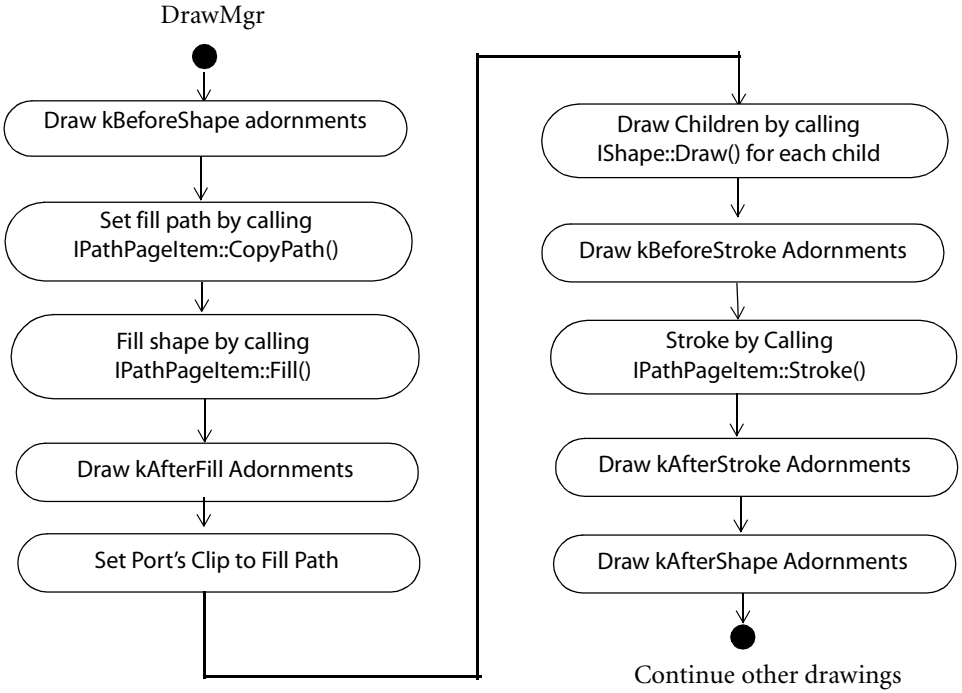
Bosses that aggregate `IAdornmentShape` are considered page item adornments. figure 11.4.2.a. shows the native page item adornments used by InDesign.

figure 11.4.2.a. Application Page Item Adornments

Adornment ClassID	Drawing Order	Description
kGraphicFrameEdgeAdornmentBoss	kAfterStroke	Draws graphic frame edges, draws "X" for empty graphic frames, draws overset marker for text on path
kTextFrameEdgesAdornmentBoss	kBeforeShape	Draws the gutters between columns
kTextOversetMarkerAdornmentBoss	kAfterShape	Invalidates the overset marker for last column of the text frame when the number of columns is changed or multi-column item is created

Page item adornments are bosses that are attached by ClassID to individual page items they adorn. When a page item is drawn, each attached adornment is called to draw via the interface `IAdornmentShape`. A page item adornment tells the drawing manager whether it should be drawn after the frame shape (kAfterShape), or before the text foreground (kBeforeTextForeground), or at one of the other events defined in the adornment objects. The drawing order controls when the adornment is called to draw. The following diagram shows the drawing sequences for a single rectangle spline item. From this diagram, you can see when the adornments drawing methods get called depending on the draw order. For detailed information on page item drawing, please refer to the "Page Item Drawing" chapter.

figure 11.4.2.b. Drawing Sequences For A Rectangle Spline Item



IAdornmentShape not only handles drawing the adornment for the page item, it also handles the hit testing and invalidation of the adornment, when it is needed.

figure 11.4.2.c. Major IAdornmentShape Methods

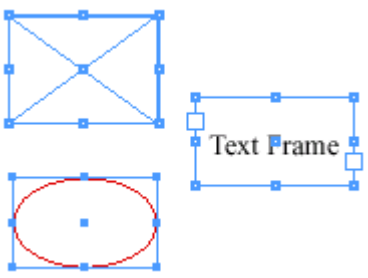
```
virtual AdornmentDrawOrder GetDrawOrderBits() = 0;

virtual void Draw (
  IShape* iShape,// owning page item
  AdornmentDrawOrderdrawOrder,// for items that registered for more
  than one order
  GraphicsData*gd,
  int32flags
);

virtual PMRect GetPaintedBBox
(
  IShape*iShape,
  AdornmentDrawOrderdrawOrder,
  const PMRect&itemBounds, // This is the painted bounds of the owing
  page item
  const PMMatrix&innertoview// NOTE: this is inner to view not pb to
  view
);

// AddToContentInkBounds:
// Takes as input a rectangle representing the bounds of some content
which
// has changed its inkinkg in some way.  The adornment will modify that
bounds
// if necessary to reflect the change in inking that it would want as
a result.
// This is only used by adornments for which the inking bounds are
based on
// the content.  Adornments for which inking bboxes are based solely on
the
// frame do not need to implement this routine.
// Note: The bounds are based on inner coordinates.
virtual void AddToContentInkBounds(IShape* iShape, PMRect*
inOutBounds) = 0;

virtual PMReal GetPriority() = 0;

// This method is provided for completeness.  When the owning shape is
inval'd it
// includes the adornment in it's bounding box.   Under most
circumstances the
// adornment need do nothing in its inval method.
```

```
// There are times, however, when specific page items will get a
specific reasonFoInval,
// and an adornment may want to know about that inval.  This provides
a mechanism
// to respond to such an event.
virtual void Inval
(
  IShape*iShape,
  AdornmentDrawOrderdrawOrder,
  GraphicsData*gd,
  ClassID reasonForInval,
  int32 flags
);

virtual bool16 WillDraw
(
  IShape* iShape,// owning page item
  AdornmentDrawOrderdrawOrder,// for items that registered for more
  than one order
  GraphicsData*gd,
  int32flags
) ;
```

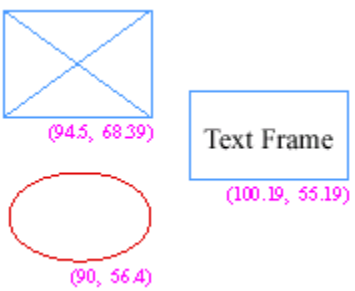
11.5. Creating Custom Page Item Adornments

A boss that aggregates `IAdornmentShape` is considered to be a page item adornment. For example, suppose you want to show the width and height of each selected page item, you could provide an adornment for the selected page items to do that. See the screen shot in figure 11.5.a. The adornment which is the dimension string was drawn in magenta for each selected item.

figure 11.5.a. Add Adornment To The Selected Page Items



Before add adornments



After add adornments

11.5.1. Adornment Definition

The class definition for the above custom adornment, `FrameDimensionAdornment`, is shown in figure 11.5.1.a.

figure 11.5.1.a. Definition For FrameDimensionAdornment

```
class FrameDimensionAdornment : public IAdornmentShape
{
public:

  FrameDimensionAdornment(IPMUnknown *boss);
  ~FrameDimensionAdornment();

  virtual AdornmentDrawOrder GetDrawOrderBits();
  virtual void Draw(IShape* iShape, AdornmentDrawOrder drawOrder,
  GraphicsData* gd, int32flags);

  virtual PMRect GetPaintedBBox(IShape* iShape, AdornmentDrawOrder
  drawOrder, const PMRect& itemBounds, const PMMatrix& innertoview);

  virtual bool16 HitTest(IShape* iShape, AdornmentDrawOrder drawOrder,
  GraphicsData* gd, const PMRect& r, int32 flags, UIDRef*thingsHit)
  { return kFalse; }

  virtual bool16 HitTest(IShape* iShape, AdornmentDrawOrder drawOrder,
  GraphicsData* gd, const PMRect& r, int32 flags, UIDList* thingsHit)
  { return kFalse; }

  virtual void Inval(IShape* iShape, AdornmentDrawOrder drawOrder,
  GraphicsData* gd, ClassID reasonForInval, int32 flags);

private:
  DECLARE_HELPER_METHODS()
};
```

The adornment, as defined above, is not persistent, and it is generic to the page items (i.e. it doesn't cache information about the page item it is attached too.)

There is a macro that recycles non-persistent bosses. That means unreferenced instances of these bosses are not deleted. They are collected in a repository. When the boss's factory is asked to construct a new instance, it will first look in it's repository if there is a reusable instance. See BossRecycler.h for details. In our example, we are going to create `FrameDimensionAdornment` as a recycle boss. In fact, all the native page item adornment bosses are recyclable bosses.

```
// Here the maximum, minimum and chunk size are 1 set to 1, the
// instance check proc is set to nil.
RECYCLE_BOSS(kFrameDimensionAdornmentBoss, 1, 1, 1,
"FrameDimensionAdornment", nil)
```

11.5.2. Adornment Boss Implementation

In providing the implementation on the adornment boss, you determine how the adornment is drawn and how the painted bounding box is calculated.

Adornments are supplied with a `GraphicsData` object from which you can get the graphics port. The graphics port allows you to call the AGM drawing primitives (see IGraphicsPort.h). The following code snippet shows the `Draw()` code for our example. This custom adornment intentionally doesn't print. Most page item adornments in the application do not print. The passed in `flags` value defines the drawing context. You can find the different values for `flags` in IShape.h.

(Note: Supporting methods have been left out of this example, for a compilable working sample take a look at FrameLabel in the InDesign SDK.)

figure 11.5.2.a. Implementation For FrameDimensionAdornment

```
// Implementation for Draw()
void FrameDimensionAdornment::Draw(IShape* shape,
AdornmentDrawOrder drawOrder, GraphicsData* gd, int32 flags)
{
  // The graphics port is the port that the page item is currently
  // drawing to. That could be the screen, a printer, a PDF, or some
  // other port.
  if (!gd)
    return;

  if (!(flags & IShape::kDrawFrameEdge))
    return;

  if (flags & IShape::kPrinting)
    return;

  do {

    // use the default font for dimension string
    InterfacePtr<IFontMgr> fontMgr(gSession, IID_IFONTMGR);
    if (fontMgr == nil)
      break;
```

```
InterfacePtr<IPMFont> theFont(fontMgr->QueryFont(fontMgr
->GetDefaultFontName()));
InterfacePtr<IGeometry> itemGeometry(shape, IID_IGEOMETRY);
if (!theFont || !itemGeometry)
  return;

IGraphicsPort * gPort = gd->GetGraphicsPort();
if (gPort == nil)
  return;
PMRect dimension = Utils<IPageItemUtils>()-
>GetStrokeDimensions(UIDList(shape));

// Create the frame dimension string
PMReal width = dimension.Width();
PMReal height = dimension.Height();

PMString label;
label.SetTranslatable(kFalse);
label.Append("(");
label.AppendNumber(width, 2, kFalse, kTrue);
label.Append(",  ");
label.AppendNumber(height, 2, kFalse, kTrue);
label.Append(")");

// Calculate the width & height of the label string. We chose 12 as
// the font size for example here.
PMMatrix matrix(12, 0.0, 0.0, 12, 0.0, 0.0);
InterfacePtr<IFontInstance> fontInst(fontMgr
->QueryFontInstance(theFont, matrix));
Fixed labelWidth, labelHeight;
fontInst->MeasureWText((const textchar*) label.GrabWString(),
label.WCharLength(), &labelWidth, &labelHeight);

gPort->gsave();
// Set the color to magenta
gPort->setrgbcolor(255, 0, 255);
// The font size is fixed, 12 points in this example.
gPort->selectfont(theFont, 12);

PMRect fontBB = theFont->GetFontBBox();
PMReal fontHeight = fontBB.Height();
// 12 is the font size
PMReal heightOfText = fontHeight * 12;

PMRect bBox = itemGeometry->GetPathBoundingBox();
// The label (adornment) is shown at the lower right corner
PMReal x, y;
x = bBox.Right() - ::ToPMReal(labelWidth);
y = bBox.Bottom() + heightOfText;
```

```
    gPort->show(x, y, label.Length(), label.GrabWString());
    gPort->grestore();

  } while (0);
}

// implementation for GetPaintedBBox
PMRect MyFrameAdornment::GetPaintedBBox(IShape* shape,
AdornmentDrawOrder drawOrder, const PMRect& itemBounds,
const PMMatrix& innertoview)
{
  PMRect dim = Utils<IPageItemUtils>()-
  >GetStrokeDimensions(UIDList(shape));
  PMReal frameWidth = dim.Width();
  PMReal frameHeight = dim.Height();

  PMString label;
  label.SetTranslatable(kFalse);
  label.Append("(");
  label.AppendNumber(frameWidth, 2, kFalse, kTrue);
  label.Append(",  ");
  label.AppendNumber(frameHeight, 2, kFalse, kTrue);
  label.Append(")");

  // 12 is the font size
  PMMatrix matrix(12, 0.0, 0.0, 12, 0.0, 0.0);
  InterfacePtr<IFontMgr> fontMgr(gSession, IID_IFONTMGR);
  InterfacePtr<IPMFont> font(fontMgr->QueryFont(fontMgr->
  GetDefaultFontName()));
  InterfacePtr<IFontInstance> fontInst(fontMgr->
  QueryFontInstance(font, matrix));

  Fixed labelWidth, labelHeight;
  fontInst->MeasureWText((const textchar*) label.GrabWString(),
  label.WCharLength(), &labelWidth, &labelHeight);
  if(labelHeight == 0)
    // in order to have some gap between the frame bounds and the
    // adornment, we multiply the font size with 1.2 (heuristic number)
    labelHeight = ::ToFixed(1.2 * 12);

  PMRect adornRect;
  adornRect.Right(itemBounds.Right());
  adornRect.Top(itemBounds.Bottom());
  adornRect.Left(adornRect.Right() -  ::ToPMReal(labelWidth));
  adornRect.Bottom(adornRect.Top() + ::ToPMReal(labelHeight));

  innertoview.Transform(&adornRect);
  return adornRect;
}
```

11.6. Add Or Remove Adornments

Adornment is part of the drawing for the decorated page items, so to add or remove an adornment for the specified page item, using appropriate commands is required. Any page item onto which an adornment may be attached has interface IPageItemAdornmentList. This interface provides the methods for adding and removing adornments.

11.6.1. AddPageItemAdornmentCmd

This command adds the adornment's ClassID to the page item's adornment list.

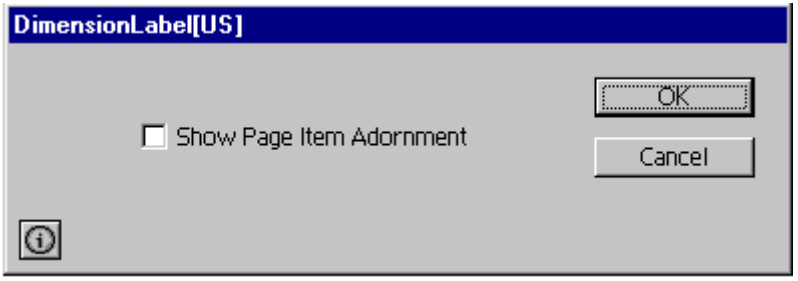
11.6.2. RemovePageItemAdornmentCmd

This command removes the adornment's ClassID from the page item's adornment list.

11.6.3. Example

In the example showed above, a dialog was used to choose adding or removing adornments for the selected page items.

figure 11.6.3.a. Dialog For Adding & Removing Adornment



When the OK button is clicked, in the dialog controller `ApplyFields()`, the following code is executed.

figure 11.6.3.b. Adding & Removing Adornment Commands

```
// Here we assume the selectUIDList is the selected page item list.
// If the check box is checked, fchecked = kTrue.
int32 itemCount = selectUIDList.Length();
if (fchecked)
{
  // add the adornment to the items that don't already have one
  while (itemCount-- > 0)
  {
```

```
        InterfacePtr<IPageItemAdornmentList> iPageItemAdornmentList
        (selectUIDList.GetRef(itemCount), IID_IPAGEITEMADORNMENTLIST);
        iPageItemAdornmentList->ResetIterator(
        IAdornmentShape::kAfterShape);
        while (kTrue)
        {
          InterfacePtr<IAdornmentShape> adornShape(iPageItemAdornmentList
          ->QueryNextAdornment());
          if (!adornShape)
            // does not have the adornment, leave it in the list for adding
            break;
          if (::GetClass(adornShape) == kFrameDimensionAdornmentBoss)
          {
            // this item has the adornment, remove it from the list
            selectUIDList.Remove(itemCount);
            break;
          }
        }
      }
      InterfacePtr<ICommand>cmd((ICommand*)
      ::CreateObject(kAddPageItemAdornmentCmdBoss, IID_ICOMMAND));
      cmd->SetItemList(selectUIDList);
      InterfacePtr<IClassIDData>classIDData(cmd, IID_ICLASSIDDATA);
      classIDData->Set(kFrameDimensionAdornmentBoss);
      CmdUtils::ProcessCommand(cmd);
    } else {
      // the check box is unchecked, remove the adornment from the page
      // items that have it
      while (itemCount-- > 0) //take them off the back of the list
      {
        InterfacePtr<IPageItemAdornmentList> iPageItemAdornmentList
        (selectUIDList.GetRef(itemCount), IID_IPAGEITEMADORNMENTLIST);
        iPageItemAdornmentList->ResetIterator(
        IAdornmentShape::kAfterShape );
        while (kTrue)
        {
          InterfacePtr<IAdornmentShape> adornShape(iPageItemAdornmentList
          ->QueryNextAdornment());
          if (!adornShape)
          {
            // no adornment for this item, so remove it from the list since
            // there is no adornment for removing
            selectUIDList.Remove(itemCount);
            break;
          }
          if (::GetClass(adornShape) == kFrameDimensionAdornmentBoss)
            // it has the adornment, keep it in the list for removing cmd
            break;
        }
      }
```

```
    // create removing page item adornment cmd
    InterfacePtr<ICommand>cmd((ICommand*)
    ::CreateObject(kRemovePageItemAdornmentCmdBoss, IID_ICOMMAND));
    cmd->SetItemList(selectUIDList);
    InterfacePtr<IClassIDData>classIDData(cmd, IID_ICLASSIDDATA);
    classIDData->Set(kFrameDimensionAdornmentBoss);
    CmdUtils::ProcessCommand(cmd);
}

Again, for a complete sample, see
{SDK}\samplecode\graphics\framelabel\
```

11.7. Summary

This chapter described how to create a page item adornment, attach and detach the adornment to the specified page items using the commands. The bosses and interfaces relevant were described. We also provides an example on how to create a custom page item adornment.

11.8. Review

You should be able to answer the following questions:

1. Why might you want to add an adornment to a page item?
2. Why is the adornment a preferred way to draw the extra information for page items?
3. What is a page item adornment? How do you create a custom adornment?
4. What are the drawing orders for the adornment?
5. How do you add or remove an adornment?

11.9. Exercises

11.9.1. Implement Your Own Custom Page Item Adornment

Figuring out how to draw the extra information for specified page items and implement your own custom adornment using AGM drawing primitives provided in `IGraphicPort` interface.

11.9.2. Add Two Or More Adornments To Multiple Page Items

Moving beyond the previous exercise, enhance the example we showed in this chapter so it can add two adornments to a set of selected page items.

11.9.3. Use Context Menu To Turn On & Off The Dimension Label

Currently, we have to invoke the plugin dialog to turn on and off the dimension label for the selected page items. It would be more convenient if this could be done through a right click context menu to toggle the label on and off.

12. Text

12.0. Introduction

This chapter introduces the text architecture. It provides a roadmap of the sub-systems that implement the text API and directs you to the programming guide chapters related to text.

12.1. Goals

The questions this chapter answers are:

1. What are the different sub-systems that implement the text architecture?
2. What is the text model?
3. What is text layout?
4. What is the wax?
5. What is text composition?
6. What is text import/export?

12.2. Chapter-at-a-glance

"12.3.Terminology and Definitions" on page 376 describes the terminology and definitions used throughout the chapters that are related to the Text Architecture.

table 12.1.a. version history

Rev	Date	Author	Notes
1.1	16-Oct-2002	Ken Sadahiro	Incorporated Review Comments from Lee Huang.
1.0	30-Sep-2002	Ken Sadahiro	Updated contents for InDesign 2.0 SDK.
0.3	14-Jul-2000	Seoras Ashby Adrian O'Lenskie	Third Draft
0.2	15-May-2000	Seoras Ashby Adrian O'Lenskie	Second Draft
0.1	01-May-2000	Seoras Ashby Adrian O'Lenskie	First Draft

"12.4.Class Diagram" on page 377 describes the major objects in the text architecture and shows their associations.

"12.5.Roadmap" on page 380 describes the sub-systems that implement the text architecture.

"12.6.Features" on page 383 describes major features provided by the text API.

"12.7.Interface Diagram" on page 385 shows the major interfaces in the text API.

"12.8.Navigation Diagram" on page 386 shows the major navigation paths between objects.

"12.9.Data Types" on page 387 describes the core data types that are related to text.

"12.10.Utilities" on page 388 describes utility classes related to text.

"12.11.Summary" on page 391 provides a summary of the material covered in this chapter.

"12.12.Review" on page 392 provides questions to test your understanding of the material covered in this chapter.

12.3. Terminology and Definitions

This section describes some terms that are used in the InDesign Text Architecture.

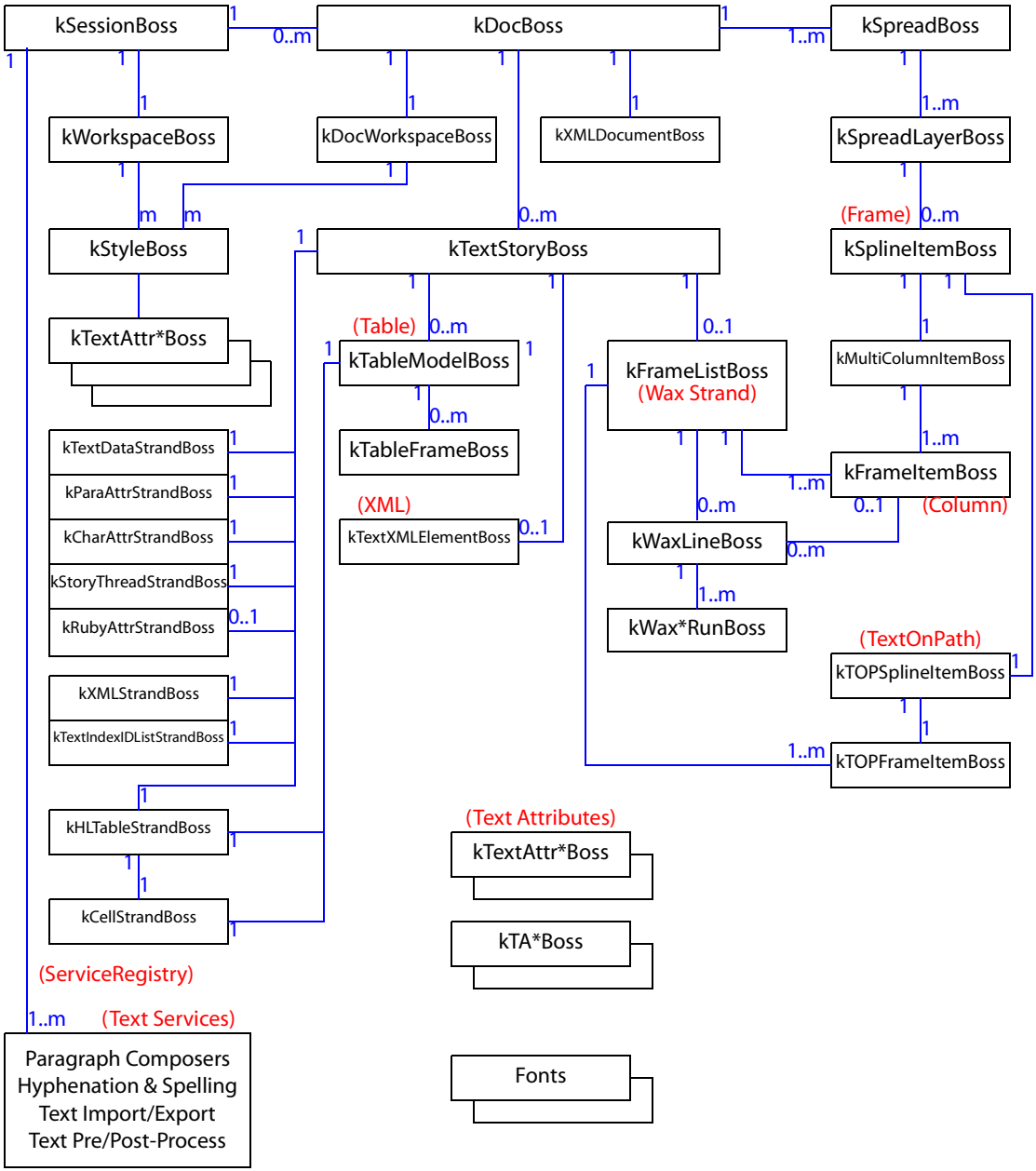
- **Text Model**: Holds the textual content of a story, i.e. the character codes, their formatting and other associated data, as separate but related strands.
- **Story**: A piece of textual content.
- **Story Thread**: A range of text in the text model that represents a flow of text content. With the introduction of tables there are multiple flows of text content stored in the text model, the main flow and a flow per table cell for the tables embedded in the story.
- **Primary Story Thread**: The main flow of text that is not for table cells or other features that store text in the story.

- **Text Attribute**: A property of text such as point size, font, color, left indent. Identified by ClassID (e.g. `kTextAttrPointSizeBoss`)
- **Style**: A collection of text attributes. There are two types (paragraph and character). Defined as a hierarchy. The root style contains a value for all attributes. Leaf styles define differences from their parent.
- **AttributeBossList**: Handy container for text attributes that allows lookup by index or ClassID.
- **Text composition**: Flows textual content in story threads into a layout represented by parcels in a parcel list, creating the wax as output.
- **Wax**: The output of text composition that draws text.
- **Parcel**: A light weight container associated with at most one text frame, into which text can be flowed for layout purposes. Think of it as a lightweight text frame. It has geometry information, however, it is not a page item, nor is it UID-based.
- **Parcel List**: The parcels associated with the story thread.
- **Text Frame**: A container in which parcels of text can be displayed.
- **Frame List**: Lists the text frames that are displayed.
- **Strand**: Parallel sets of information that, when combined, provided a complete description of the text content in a story.
  - **Text Data Strand**: Stores characters in Unicode encoding.
  - **Paragraph Attributes Strand**: Stores paragraph boundaries and formatting information for ranges of paragraphs.
  - **Character Attributes Strand**: Maintains formatting information for ranges of characters.
  - **Owned Item strand**: Maintains information on objects inserted into the text flow (i.e. inline frames).
  - **Wax Strand**: Stores the composed representation of text that can be drawn and selected. The wax strand is the result of composition.
  - **Story Thread Strand**: Stores the content boundaries of story threads within a story.
- **Run**: Strands are subdivided into runs. Run lengths are different dependent on the strand. For example, the text data strand uses runs to split the character data into manageable chunks, the character attribute strand uses runs to indicate formatting changes.

12.4. Class Diagram

Figure 12.4.a shows the associations between the major objects concerned with text.

figure 12.4.a. Text Class Diagram



The session (kSessionBoss) has documents (kDocBoss) which have stories (kTextStoryBoss) and spreads (kSpreadBoss).

Stories have strands that describe different properties of the text: characters (kTextDataStrandBoss); text attributes (kParaAttrStrand, kCharAttrStrand) in-line objects (kOwnedItemStrand, which may refer to kTableFrameBoss, kInlineBoss, kIndexPageEntryBoss, kHyperlinkTextMarkerBoss, kHyperlinkTextSourceEndMarkerBoss, or kHyperlinkTextDestinationMarkerBoss), story threads (kStoryThreadStrandBoss), table related content (kCellStrandBoss, kHLTableStrandBoss), XML tags (kTextIndexIDListStrandBoss, kXMLStrandBoss), and ruby attributes (kRubyAttrStrandBoss, created only when the first ruby attribute is applied).

Both the session and the document have a workspace (kWorkspaceBoss and kDocWorkspaceBoss) that contains paragraph and character styles. Styles (kStyleBoss) are collections of text attributes that are collectively applied to text to give its appearance. A text attribute describes a single property of the text such as point size or colour. There are many different text attributes denoted here as kTextAttr*Boss, where * is replaced with the specific attribute name for example kTextAttrPointSizeBoss or kTextAttrColorBoss. The paragraph and character attribute strands refer to the styles and text attributes (this relationship has not been modelled in the diagram).

Spreads have layers (kSpreadLayerBoss) and layers have frames (kSplineItemBoss). All content is contained inside a spline. When a spline contains text, it has a multi-column (kMultiColumnItemBoss) object. The multi-column object is the column controller that manages the columns (kFrameItemBoss) of text in the frame. When a text-on-a-path (TOP) item contains text, it has a kTOPSplineItemBoss, with a kTOPFrameItemBoss as a child in the hierarchy. The ITextFrame interface is aggregated in kFrameItemBoss and kTOPFrameItemBoss.

The story and the parcels in which it is displayed are the inputs that drive text composition to create the composed representation of the text, the wax. The wax draws, hit-tests and selects text.

A story, its layout and the process of text composition connect at the frame list (kFrameListBoss). The wax (kWaxLineBoss and kWaxRunBoss), is owned by and

managed by the wax strand (the wax strand is an interface on `kFrameListBoss`). The frame list references the columns that display the text of the story. The columns reference the lines they display.

The story also may own 0 or more tables (`kTableModelBoss`, introduced in InDesign 2.0). Each table is laid out as 0 or more table frames (`kTableFrameBoss`). The contents of the tables are managed by a cell content boss (`kTextCellContentBoss` - InDesign 2.0 tables only support text content).

The story may also have a reference to an XML element boss (`kTextXMLElementBoss`), which provides a connection to the XML tags that are applied to parts of the story. You can access the XML element boss for the text story via the `IXMLReferenceData` interface.

The type faces in which characters are displayed are provided by fonts. The boss objects involved in fonts and their various associations have not been modelled in figure 12.4.a.

The session also has a service registry that contains various service providers required by text, such as paragraph composers, hyphenation and spelling providers, import/export providers, etc.

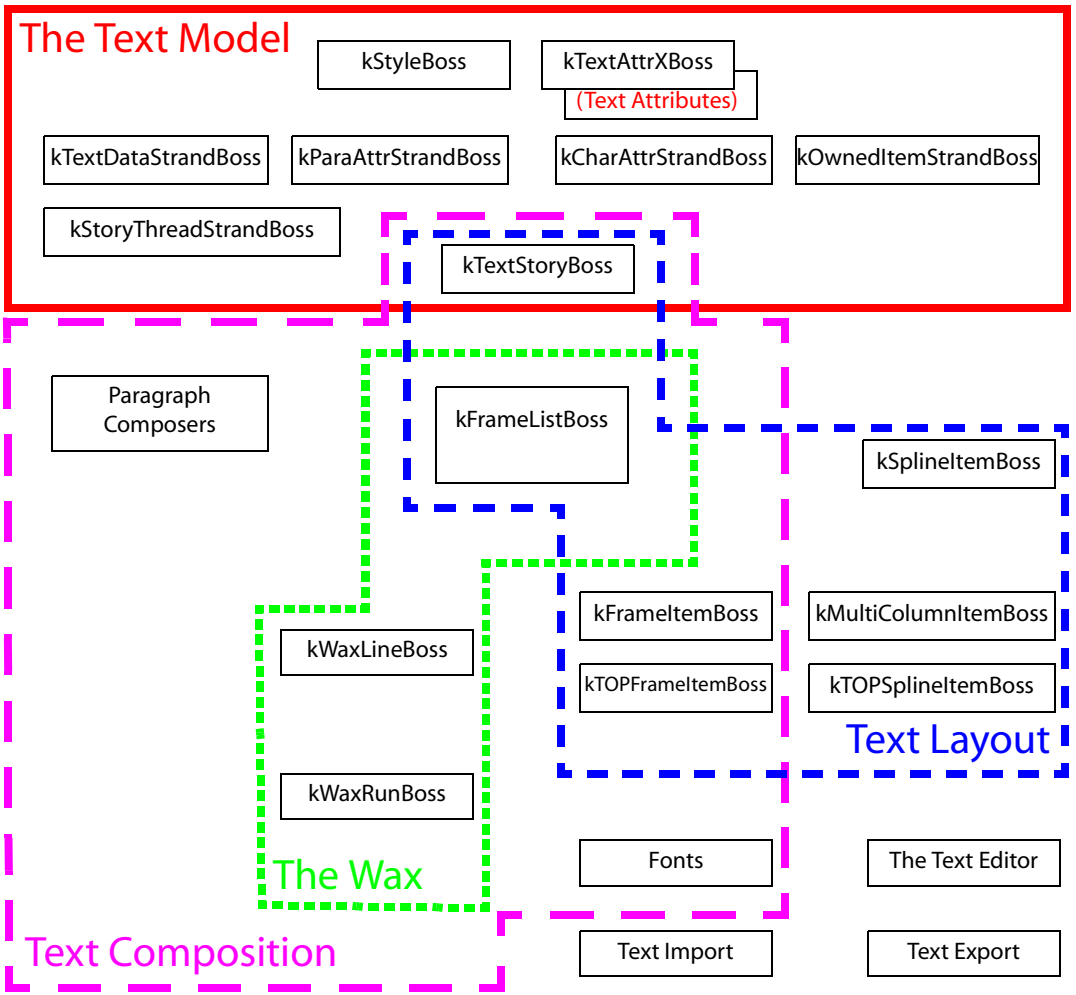
These objects will be described in more detail and new objects will be revealed as each sub-system is explored in subsequent chapters.

12.5. Roadmap

The text architecture can be divided into the sub-systems listed below. The roadmap in figure 12.5.a shows the sub-systems that the text objects lie within:

- The Text Model,
- Text Layout,
- The Wax,
- Text Composition,
- Fonts,
- Text Import and Export, and
- The Text Editor.

figure 12.5.a. Text Sub-system Roadmap



The **text model** manages the content of a story. It stores the characters and the text attributes that control their appearance. "The Text Model" chapter describes this sub-system and explains how your plug-ins can manipulate the content of a story. The "Working with Text Styles" chapter describes how you can program text styles.

Text layout manages the frames that display a story. A frame is a visual container for text. Visually, a story is displayed through a linked set of one or more frames. (Internally, the text content is presented in parcels in a parcel list,

which are associated with a frame list. This allows for text cells to act as if they are mini text frames, each with its own story direction.) The frames have properties, such as the number of columns, column width and text inset, that control where text flows. Text wrap settings on overlapping frames may affect this flow. The "Text Layout" chapter describes this sub-system and explains how your plug-ins can manipulate text frames. The SDK plug-ins **FrameGridJ** (`{SDK}/SampleCode/Text/FrameGridJ`), and **VerticalTextFrameJ** (`{SDK}/SampleCode/Text/VerticalTextFrameJ`),provide examples of how to add extra frame grid data and to change story direction.

The wax is used to draw text. "The Wax" chapter describes this sub-system and how your plug-ins can scan the wax for information on composed text.

Text composition flows text in story threads into a layout represented by parcels in a parcel list. Fonts provide text composition with the glyph dimensions it needs to arrange glyphs into lines of a given width. The "Text Composition" chapter describes this sub-system and explains how your plug-ins can recompose text or add new typographical features. The SDK plug-ins **SingleLineComposer** (`{SDK}/SampleCode/Text/SingleLineComposer`),and **ComposerJ** (`{SDK}/SampleCode/Text/ComposerJ`) are examples of custom composers.

Fonts provide the various type faces in which characters are displayed. To avoid confusion the term glyph is used to indicate a member of a font instead of the term character which normally denotes a member of an alphabet or character set.

The **text editor** manages the input and editing of text from the keyboard. On the Japanese version of InDesign, this involves an extra component called the Input Method Editor (IME), which allows for inline editing of multibyte (Japanese) text.

A **text import provider** brings text from an external format into the application and allows you to control the translation process. A **text export provider** exports text from the application's internal representation to an external format and allows you to control the translation process. There are three examples on the SDK that can be used as a guide: **TextImportFilter**, **CHMLImportFilter** and **TextExportFilter** (all located in `{SDK}/SampleCode/ServiceProviders`.)

12.6. Features

There are a number of text features that are of particular interest to you as a plug-in developer.

Your plug-in can add new **text attributes** either to control the appearance of text or to store data that it needs to associate with a range of characters. Text attributes are introduced in "The Text Model" chapter. A description of how to add new text attributes is given in the "Text Attributes and Adornments" chapter. In addition, you can refer to the **BasicTextAdornment** sample plug-in (`{SDK}/SampleCode/Text/BasicTextAdornment`), which adds a boolean text attribute (to help enable/disable a regular text adornment), and the **CHDataMerger** sample plug-in (`{SDK}/SampleCode/Text/CHDataMerger`), which adds a text attribute for storing hidden text. There are also several plug-ins in the `{SDK}/SampleCode/Text` folder (such as **TextStyler** , **PointSizeMutator**, **KentenCreatorJ** and **RubyModifyJ**), and code snippets in the `{SDK}/SampleCode/CodeSnippets` folder that show how to get and set a variety of text attributes.

Your plug-in can add a **text adornment** to highlight or adorn the text in some other way. Text adornments provide a hook that calls your plug-in when text is drawn. A description of how to add text adornments is given in the "Text Attributes and Adornments" chapter. In addition, you can refer to the **BasicTextAdornment** sample plug-in (`{SDK}/SampleCode/Text/BasicTextAdornment`), which adds a regular text adornment.

Your plug-in can implement new typographical features by implementing a **paragraph composer**. A paragraph composer takes up to a paragraph worth of characters along with the attributes that define their appearance and arranges the characters into lines of glyphs that fit the layout. It is responsible for the positioning of glyphs and deciding where lines should be broken. The "Text Composition" chapter describes this. In addition, you can refer to the **SingleLineComposer** sample plug-in (`{SDK}/SampleCode/Text/SingleLineComposer`) and the **ComposerJ** sample plug-in (`{SDK}/SampleCode/Text/ComposerJ`).

You can add hyphenation and spelling services by implementing a **linguistic plug-in**. The **CHLinguistic** sample plug-in (`{SDK}/SampleCode/Text/CHLinguistic`) shows how to implement a spelling service, and the

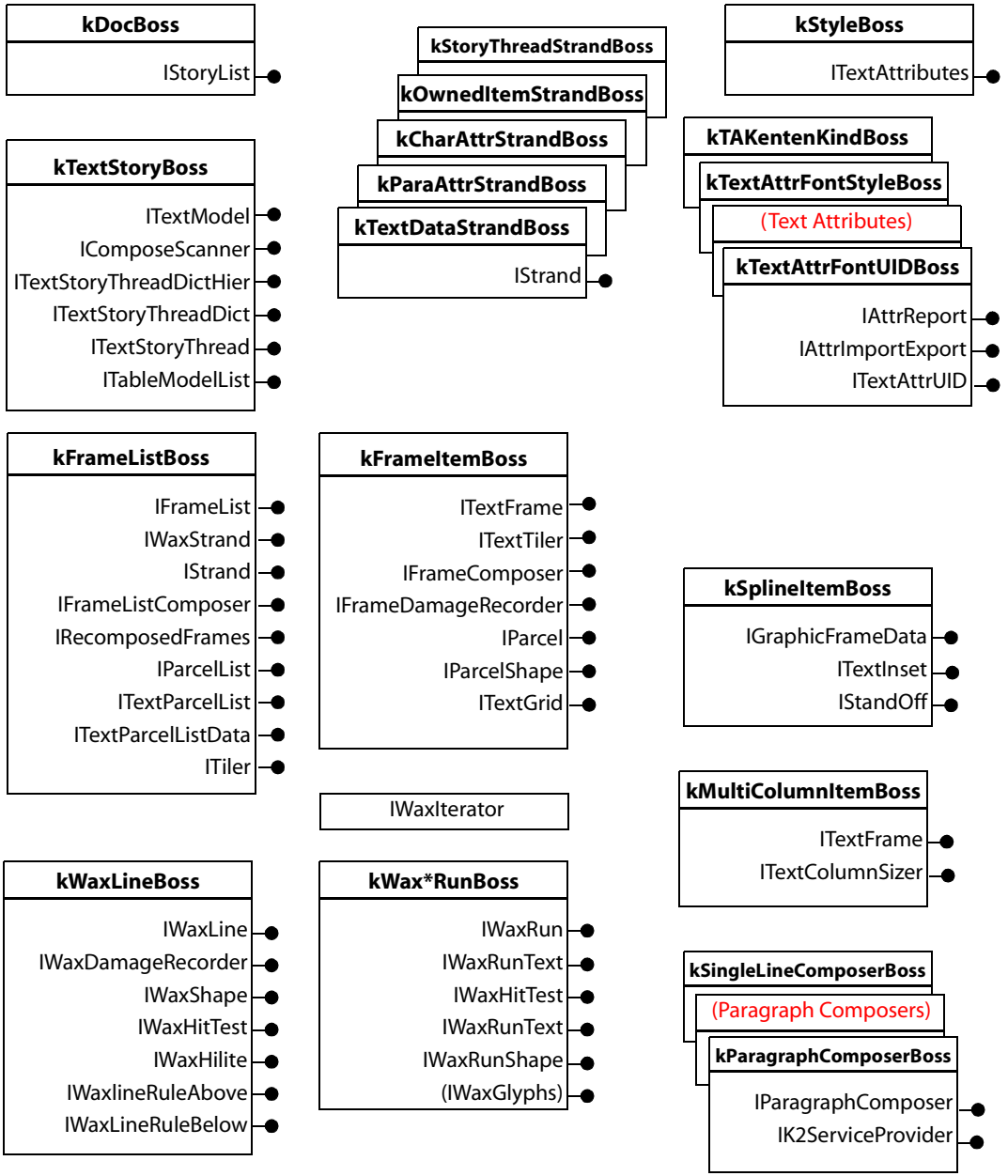
Hyphenator sample plug-in (`{SDK}/SampleCode/Text/Hyphenator`) shows how to implement a hyphenation service.

Text-on-a-Path (or "TOP", available from Adobe InDesign 1.5 and 2.0J) flows text along a spline (a path made up of a number of straight line or curved segments). This feature integrates a number of new bosses and interfaces into the core text architecture described in figure 12.4.a.

12.7. Interface Diagram

Figure 12.7.a shows the major interfaces involved with text. The interfaces are described in the following text chapters.

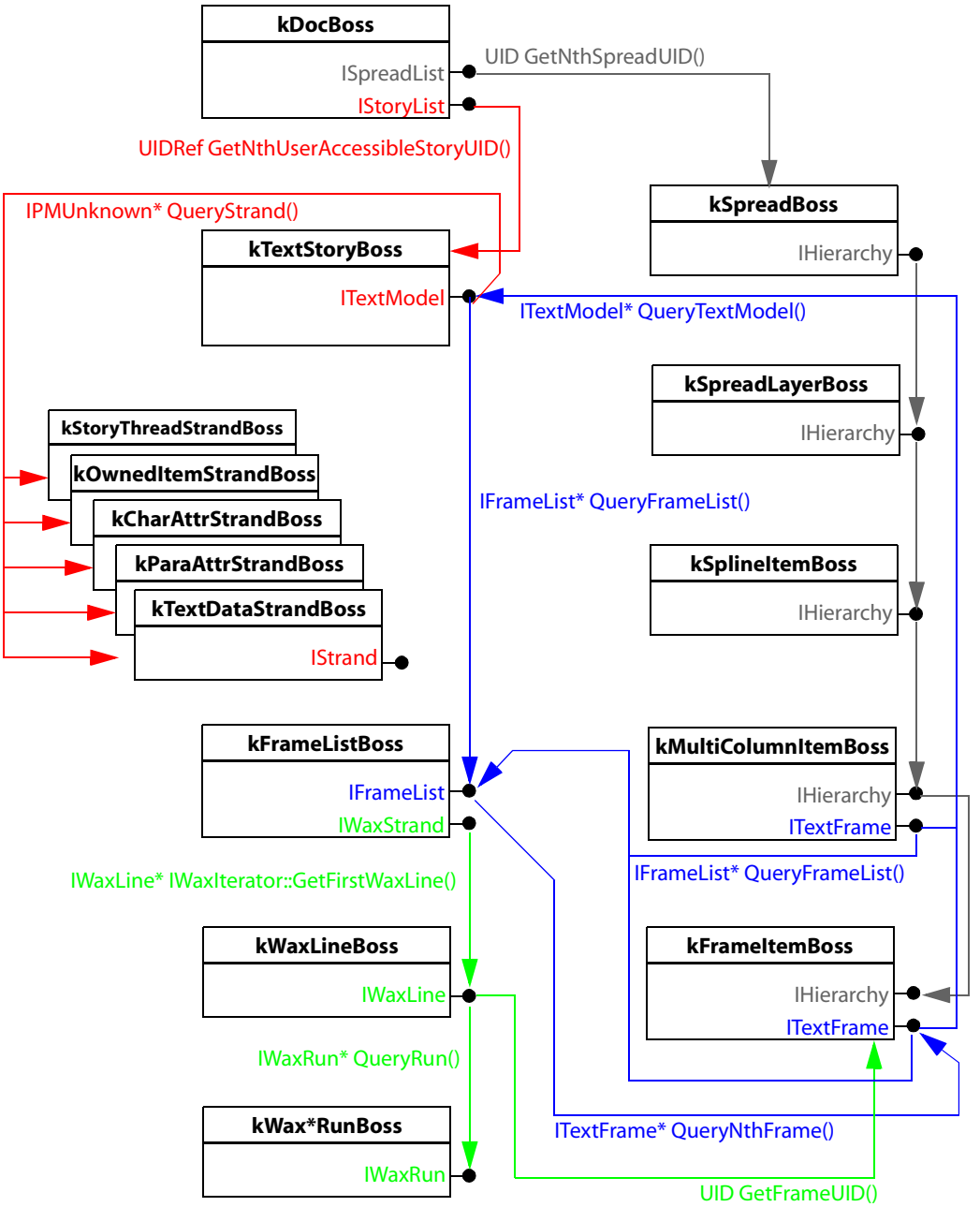
figure 12.7.a. Text Sub-system Interface Diagram



12.8. Navigation Diagram

Figure 12.7.a shows interfaces used to navigate between key text objects.

figure 12.8.a. Navigation



12.9. Data Types

12.9.1. Basic Types

BaseType.h . . . . . **{SDK}/API/Includes**
CTextEnum.h . . . . . **{SDK}/API/Includes**

The basic text data types shown in figure 12.9.1.a are defined in `BaseType.h` and `CTextEnum.h`. Refer to the actual header files for comments.

figure 12.9.1.a. Basic Text Data Types & Constants

```
typedef uchar16 textchar;
typedef int32 TextIndex;
const TextIndex kInvalidTextIndex = -1;
typedef int32 GlyphID;
const Text::GlyphID kInvalidGlyphID = -1;
```

12.9.2. Unicode Character Constants

TextChar.h . . . . . **{SDK}/API/Includes**

`TextChar.h` defines 16 bit Unicode character constant definitions as well as special control characters, such as `kTextChar_ReplacementCharacter`, `kTextChar_Inline`, and `kTextChar_PageNumber`.

figure 12.9.2.a. TextChar.h Unicode Character Constant Definition File

```
const textchar kTextChar_Null= 0x0000;
const textchar kTextChar_IndentToHere= 0x0007;
const textchar kTextChar_RightAlignedTab= 0x0008;
const textchar kTextChar_Tab= 0x0009;
const textchar kTextChar_LF= 0x000A;
const textchar kTextChar_CR= 0x000D;
const textchar kTextChar_SoftCR=kTextChar_LF;
const textchar kTextChar_Space= 0x0020;
// other constants...
```

12.9.3. WideString

WideString.h . . . . . **{SDK}/API/Includes**

`WideString` supports dynamic strings of 16-bit characters and is used to insert and access characters stored in the text model.

12.9.4. RangeData

RangeData.h. . . . . . **{SDK}/API/Includes**

RangeData is a class that is used to hold a range of text indices. It is used in a variety of interfaces where you specify a range of text (selection, model, etc.). This class is often used in places where you not only need to specify a start and an end TextIndex, but also need to determine if there is overlap with another range of text specified in a RangeData object. RangeData does not keep a reference to the text model it refers to, so it is a light weight container.

12.9.5. TextRange

TextRange.h . . . . . {SDK}/API/Includes

Unlike RangeData, TextRange keeps the reference to the text object for which it is maintaining the range. Use this in tandem with RangeData. TextRange is defined in the namespace "InDesign".

12.10. Utilities

The text API is complicated. However, there are a number of utilities designed to make programming with it simpler.

12.10.1. TextIterator

TextIterator.h . . . . . {SDK}/API/Includes

TextIterator is a useful API that makes accessing characters in the text model of a story very easy. TextIterator is pretty much as efficient for character acces as you can get. It keeps track of text runs in the text strand, and only gets a new run when necessary. Also, unlike IComposeScanner, itdoesn't involve the other strands.

You can iterate through text in a story like this, one character at a time:

```
TextIterator iter(textModel, startIndex);
TextIterator end(textModel, startIndex + length);
while(iter != end) {
  TextChar tc = *iter;
  // examine tc...
iter++; }
```

Or you can use it to grab a chunk of text as a WideString.

```
WideString ws;
TextIterator begin(textModel, startIndex);
TextIterator end(textModel, startIndex + length);
ws.reserve(length);
std::copy(begin, end, std::back_inserter(ws));
```

To convert the `WideString` to a platform specific encoding (e.g. ShiftJIS), you can use the `WideString::GetAsSystemString()` method.

The `TextIterator operator++` is very fast and trivial until you cross a run boundary. See the code snippet `SnipInspectStoryCharacters.cpp` for an example of how it can be used to examine a range of characters from a text model.

12.10.2. TextCharBuffer

TextCharBuffer.h . . . . . {SDK}/API/Includes

`TextCharBuffer` is a light weight container class for `textchar`. Initialize it with a `WideString` or a pointer to a `textchar` with a length, and you can use the `begin` and `end` methods for boundary checks:

```
const textchar* textCharArray = {... /* fill this out */};
TextCharBuffer buf(textCharArray, sizeof(textCharArray)/
  sizeof(textchar));
for(const textchar *iter = buf.begin(); iter < buf.end(); ++iter)
{
  // *iter is the current textchar
}
```

12.10.3. RunToString

TextIterator.h . . . . . {SDK}/API/Includes

`RunToString` can be used under the **debug build** of InDesign to verify the text model contains character data you expect:

```
void CheckString(
  InterfacePtr<ITextModel> textModel, const TextIndex& startTextIndex,
  const TextIndex& endTextIndex, const WideString& expectedString)
{
#ifdef DEBUG
  std::auto_ptr<WideString> text(RunToString(textModel,
    startTextIndex, endTextIndex));
  ASSERT(*text == expectedString);
#endif
}
```

Note that `RunToString` is not available under the release build of InDesign.

12.10.4. TextAttributeRunIterator

TextAttributeRunIterator.h . . . . . {SDK}/API/Includes

`TextAttributeRunIterator` can iterate over multiple ranges of text and find a given set of text attributes. It can also apply attributes to its current text range. Before you can use it you need two things:

- You need to have a `K2Vector<InDesign::TextRange>` identifying the ranges of text to be searched.
- You need a `K2Vector<ClassID>` identifying the text attribute(s) to be searched for.

Once you have these you use a TextAttributeRunIterator something like this:

```
K2Vector<InDesign::TextRange> TextRanges; //use push_back to add items
K2Vector<ClassID> attributeClasses; // use push_back to add items
TextAttributeRunIterator runIter(textRanges->begin(),
  textRanges->end(), attributeClasses.begin(),
  attributeClasses.end());
while (runIter)
{
  // add code to get text attribute(s) out of runIter.
  ++runIter;
}
```

`TextAttributeRunIterator` is an unusual iterator. To access its results you can dereference the iterator, which gives you the `AttributeBossList` object that contains the results you asked for. You can also use the `->` operator to get a pointer to the `AttributeBossList`. You might use it like this if searching for point size:

```
InterfacePtr<const ITextAttrRealNumber>(static_cast
   <const ITextAttrRealNumber*> (
     runIter->QueryByClassID(
       kTextAttrPointSizeBoss, ITextAttrRealNumber:: kDefaultIID)));
```

You can learn more about Text Attributes in the "Text Attributes and Adornments" chapter.

12.10.5. Character Set Conversion

CTUnicodeTranslator.h . . . . . **{SDK}/API/Includes**
IEncodingUtils.h . . . . . **{SDK}/API/Interfaces/Utils**

`CTUnicodeTranslator` and IEncodingUtils provide translation services that map other character encodings schemes onto Unicode. You can use it to bring text encoded in another character set into the application or to export text from the application into a different character set.

12.10.6. ITextUtils

ITextUtils.h . . . . . {SDK}/API/Interfaces/Text

`ITextUtils` provides mechanism that:

- Create stories.
- Generate commands to copy stories.
- Generate commands to move stories.
- Determine whether a selection is a text selection.
- Return the current view's text editor.
- Return the text caret (the icon representing the cursor point).
- Return the raw text from the model.
- Return the frames over which a selection applies.
- Mechanisms for defining what a word is.

See the header file for more details. Use this with the `Utils` (`{SDK}/API/Includes/Utils.h`) adapter class to invoke the methods.

12.10.7. ITextAttrUtils

ITextAttrUtils.h . . . . . {SDK}/API/Interfaces/Text

`ITextAttrUtils` provides higher level mechanisms to manage text attributes, specifically, a method to build commands for the application of attributes to a range of text within a story, and a method to build a command that clears the attributes from a range of text within a story.

See the header file for more details. Use this with the `Utils` (`{SDK}/API/Includes/Utils.h`) adapter class to invoke the methods.

12.10.8. IWaxIterator

IWaxIterator . . . . . {SDK}/API/Interfaces/Text

An iterator class, `IWaxIterator`, is provided to simplify access to wax lines. It is described fully in "The Wax" chapter. Note that the name does start with a capital "I", however, this is not an interface.

12.11. Summary

This chapter introduced the text architecture and gave you a roadmap of the programming guide chapters related to text. It also described the core data types and utility classes used for text.

12.12. Review

You should be able to answer the following questions:

1. Which programming guide chapter would you read to find out how to insert text into a story? (12.5., page 380)
2. Which programming guide chapter would you read to find out how you can change the layout of a story? (12.5., page 380)
3. Which programming guide chapter would you read to find out more about the composed representation of text? (12.5., page 380)
4. Which programming guide chapter would you read to find out more about how text is composed? (12.5., page 380)

13.

The Text Model

13.0. Overview

The text architecture separates text content (the characters and the formatting that describes their desired appearance) from the containers that display text in its composed form. This chapter describes how text content is represented and explains how plug-ins can access, insert, delete and alter the appearance of text.

13.1. Goals

The goals for the section:

1. To introduce the fundamentals of the text model, specifically:
   - stories.
   - story threads.
   - strands.
   - text attributes.
   - styles.
2. To describe the mechanisms available for the manipulation of text:
   - inserting text.
   - deleting text.
   - replacing text.
   - altering the appearance of text
3. To show the different mechanisms for data retrieval:
   - extracting character codes and information regarding the formatting applied to text.
4. To describe how text information is stored.

table 13.0.a. version history

Rev	Date	Author	Notes
2.0	18-Dec-02	Seoras Ashby	Update content for InDesign 2.x API
0.3	14-Jul-00	Adrian O'Lenskie Seoras Ashby	Third Draft

13.2. Chapter-at-a-glance

"Key concepts" on page 394 begins with a description of the structure of the text model.

"Interfaces" on page 423 describes the APIs used to program with the text model.

"Frequently asked questions(FAQ)" on page 432 provides some practical insights of programming with the text model.

"Summary" on page 452 provides a summary of the topics covered in this chapter.

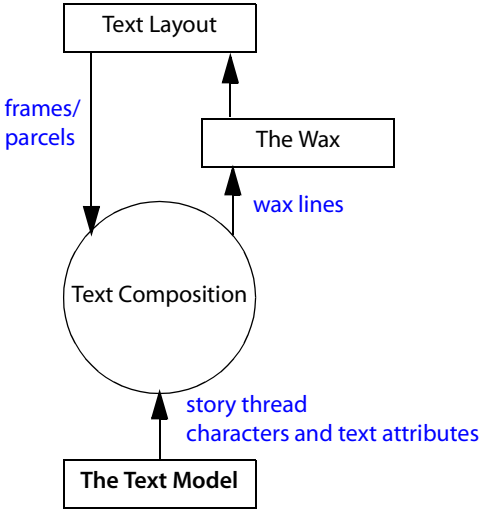
"Review" on page 452 provides questions to test your understanding of the material covered in this chapter.

"Exercises" on page 453 provides suggestions for other tasks you might want to attempt.

13.3. Key concepts

13.3.1. Introduction

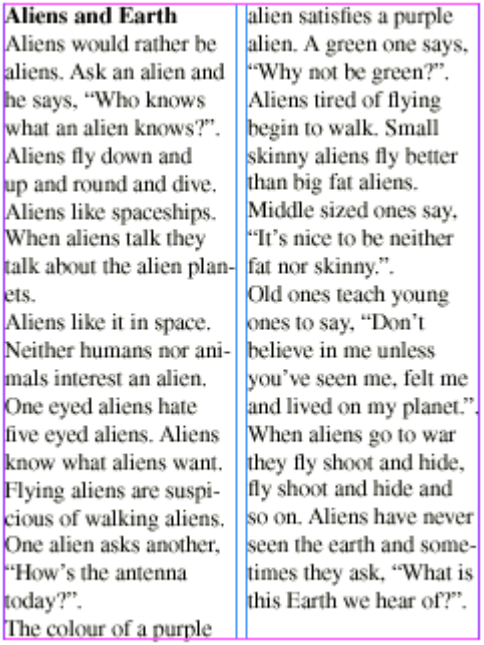
figure 13.3.1.a. The Text Model



The **text model** maintains the character and formatting information for a story. This information is split into one or more story threads that each repesent an independent flow of text content. Text layout defines the shape and form of the visual containers in which text is composed and displayed. Text composition flows text content from a story thread into its visual containers creating wax that fits their layout. Text layout in turn displays the wax. This is depicted in figure 13.3.1.a. The key concepts described in this chapter explain the structure of the text model.

For example, figure 13.3.1.b shows an example of some text within a document.

figure 13.3.1.b. Example text frame with two columns



The characters and the formatting information applied to the them (for example, the font and the fact that the words "Aliens and Earth" are **bold**) are text content that is maintained through the text model and is described in this chapter.

The position on the page, the number of columns, size of text frame and other properties to do with the layout of the text is described in the "Text Layout" chapter. The composition of text is described in the "Text Composition"

chapter. The composed "ready to draw" representation of text is described in "The Wax" chapter.

13.3.2. Stories

Text in a document is maintained as a list of stories (see interface `IStoryList`). A **story** (`kTextStoryBoss`) represents the textual content. A document can contain several stories, usually a story contains text associated with a particular topic.

For example, figure 13.3.2.a shows a document containing two stories, each displayed in its own frame. Text manipulations in one frame do not affect the other frame.

figure 13.3.2.a. Two stories over two frames

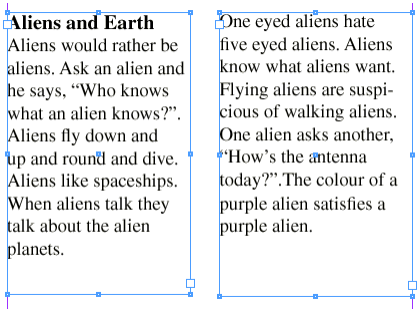
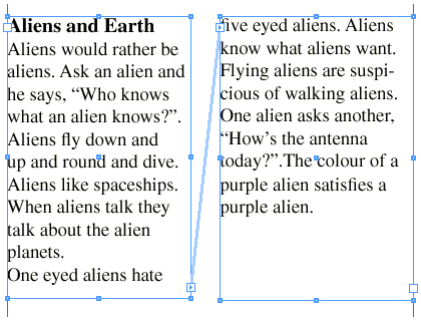


Figure 13.3.2.b shows the same text, but now it is part of the same story. The two frames have been linked (the **out port** of the first frame is connected to the **in port** of the second - as we have selected the "Show text threads" option of the drop down "View" menu, we can see the connection by the line between outport and inport). The characters have automatically flowed from the first frame to the second, this shows us that there is a flexible relationship between the individual characters and the frame they are contained in. To put this a different way, the frame a particular character ends up in can be affected by the other characters within the story.

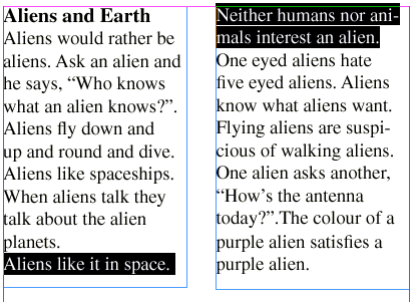
figure 13.3.2.b. One story over two linked frames



Now manipulations on the text within the first frame are likely to have a chain reaction on the text in the second frame (figure 13.3.2.c). The text that has been added not only automatically overflows from the first text frame into the second, it also re-positions the text following (which would either overfill the frame, or flow into any linked text frame).

The story abstraction has responsibility for managing the text content. Although, as we will see, the architecture is split into several components, most of the interactions will occur through this abstraction. It also provides facilities for the management of text foci, and external links to imported text files.

figure 13.3.2.c. Story updates over two frames



13.3.3. Lifecycle of a story

In general, stories are not created or deleted directly, but as a side effect of some other action. If a text frame is created, a story is created as part of this process. If two text frames are linked (as in figure 13.3.2.b), one of the stories is deleted leaving one story shared between the two frames. If the last text frame

associated with a story is deleted, the story itself is then deleted as a direct consequence.

It is possible to control the existential behaviour of a story directly. Commands exist that allow the creation and deletion of a story, however if you wish to do this, you must be aware that these stories are still subject to the usual side effects of text frame manipulations.

13.3.4. Story accessibilty

Some stories in a document are not accessible to the user. For example the XML feature creates a story for its own use that is never displayed in a frame. Stories are said to be user accessible or not user accessible as identified by their `TextStory_StoryAccess` in the story list (`IStoryList`). User accessible stories are scanned by features like Find/Change and Spelling and they are considered when the fonts and colours used by a document needs to be determined. Non user accessible stories are ignored by these types of operation. Note that both types of stories are updated when colours or styles are deleted since they may reference them internally.

13.3.5. The text model

Every story in a document is represented by an instance of the **text model** (see interface `ITextModel`). The **length** of the text model is the number of characters in the story and is given by method `ITextModel::TotalLength`. When a story is created a terminating `kTextChar_CR` character is inserted in its text model. The text model therefore has a minimum length of one and its final character is always a `kTextChar_CR` character.

The text model comprises several strands that hold the various components of the story such as the character code data, character formatting, paragraph organisation and formatting. Each strand in the text model has the same overall length equal to the number of characters in the story.

13.3.6. Strands

The text model is further decomposed into individual **strands** - parallel sets of information that each hold a component of the story. The strand paradigm is based on the idea of a rope consisting of intertwined strands. The strands of the text model intertwine to give a complete description of the text in a story.

Each strand in the text model has the same overall length equal to the number of characters in the story. As characters get added or removed from the story each strand is notified by the text model and they expand or contract to stay the same length. The major strands are:-

- Text (`kTextDataStrandBoss`) - holds character code data for the story encoded in Unicode,
- Story thread (`kStoryThreadStrandBoss`) - represents the story threads in the story,
- Paragraph attributes (`kParaAttrStrandBoss`) - maintains length and formatting information that is applicable to paragraphs,
- Character attributes (`kCharAttrStrandBoss`) - maintains formatting information that is applicable to ranges of characters,
- Owned items (`kOwnedItemStrandBoss`) - maintains information on objects inserted into the text stream (e.g. inline frames, table frames).
- Wax (`kFrameListBoss`) - composed representation of text that can be drawn, hit-tested and selected. The wax strand is the result of composition. It is discussed in full detail in "The Wax" chapter and the "Text Composition" chapter. However, it displays the properties that are common to all strands in a story.

13.3.7. Runs

A strand is further decomposed into **runs**. A run represents something about a range of text in the text model. On the text data strand runs are used to divide the character code data into chunks of a manageable size (the number of characters in a story is potentially very large). On the character attribute strand runs signify a change in character formatting. The semantics of the information represented by a run is defined by the strand.

13.3.8. Story threads

A **story thread** (see interface `ITextStoryThread`) represents a flow of text content and is associated with range of text in the text model. A story can contain multiple flows of text content that can be composed independently or not composed at all. Story threads have a minimum length of 1 and their last character is always a `kTextChar_CR` character.

Prior to InDesign 2.x there was one flow of text content in a story. All of the text was flowed through the frames that displayed the story. InDesign 2.x introduced the ability to store multiple flows of text content in a story. This

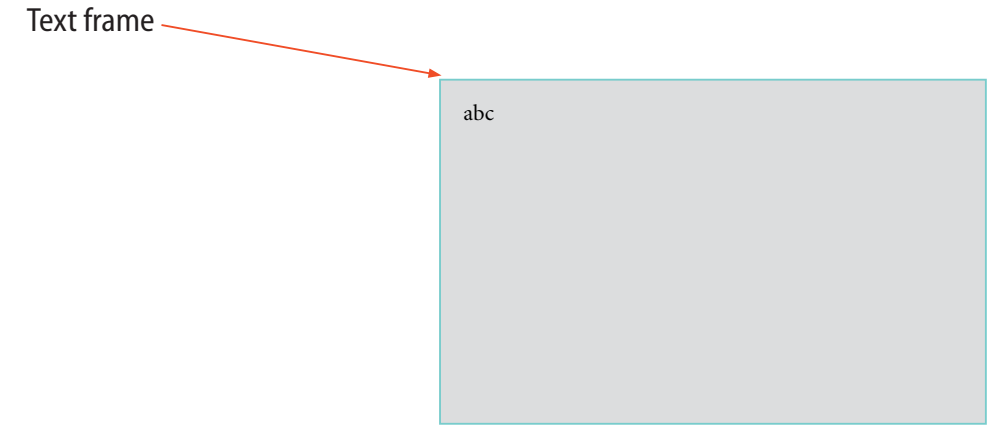
allows features such as tables to embed text that gets flowed into table cells inside a story.

The **primary story thread** is the main flow of text that is displayed by the frames associated with the story. Within the text model the text for the primary story thread is stored starting from a text index of zero up to `ITextModel::GetPrimaryStoryThreadSpan-1`. A story always has a primary story thread.

Text content for features that embed text in the story is stored after the primary story thread. It is the text in the range `ITextModel::GetPrimaryStoryThreadSpan..ITextModel::TotalLength-1`. Other story threads are present only if the story has a feature that has embedded its text, such as a table.

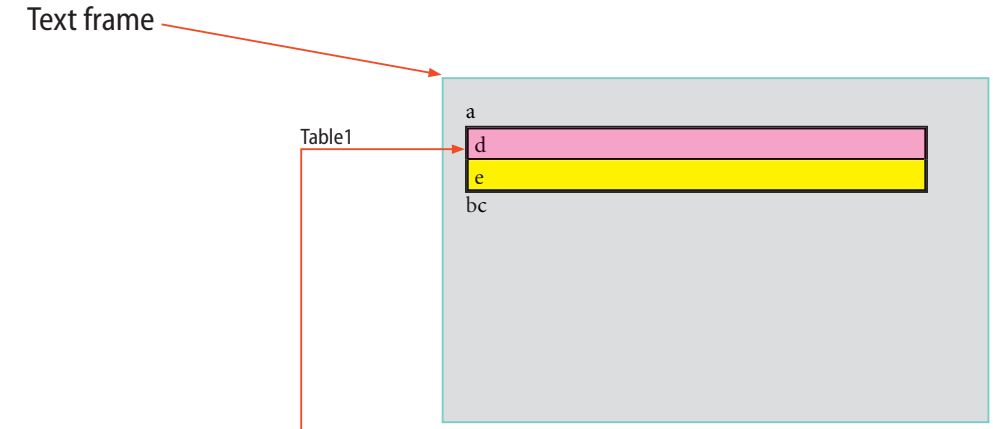
For example a text frame displaying the characters "abc" is shown in figure 13.3.8.a along with the underlying text model that stores the text content. The text data strand (`kTextDataStrandBoss`) stores the character codes. The range of text in each story thread is represented by runs on the story thread strand (`kStoryThreadStrandBoss`). Since there are no tables or other features present that embed their text in a story there is only one story thread, the primary story thread. The total length of the story and the length of the primary story thread are the same, 4 characters.

figure 13.3.8.a. Sample primary story thread



If a table with two rows and one column is inserted between the a and the b characters in the text frame shown in figure 13.3.8.a the displayed text frame and underlying text model would be as shown in figure 13.3.8.b. The first table cell contains the character "d" and the second cell contains the character "e". Notice that some extra characters required by the tables feature are added to the primary story thread and two new story threads are added to the story thread strand, one for the flow of text in each table cell. The story threads for the table are held after the primary story thread. The frame and table cell background color has been color coded to indicate the story thread in the underlying text model that stores the text.

figure 13.3.8.b. Sample primary story thread and table cell story threads



Text Model Representation

Text Index	kTextDataStrandBoss ITextStrand	kStoryThreadStrandBoss IStrand	kOwnedItemStrandBoss IItemStrand
0	a	Primary story thread, story thread [0]	kInvalidUID
1	kTextChar_Table		UID=0x195 kTableFrameBoss
2	kTextChar_TableContinued		kInvalidUID
3	b		kInvalidUID
4	c		kInvalidUID
5	kTextChar_CR		kInvalidUID
6	d	Table1, cell 0,0 story thread [1]	kInvalidUID
7	kTextChar_CR		kInvalidUID
8	e	Table1, cell 1,0 story thread [2]	kInvalidUID
9	kTextChar_CR		kInvalidUID

ITextModel::TotalLength = 10
ITextModel::GetPrimaryStoryThreadSpan = 6

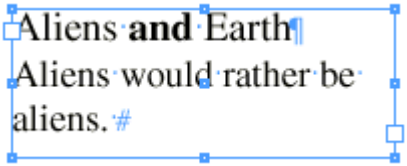
The text model method `ITextModel::QueryStoryThread` is a helper method that returns the story thread (see interface `ITextStoryThread`) associated with any index in the text model(`TextIndex`). Under the hood this method uses runs on the story thread strand `kStoryThreadStrandBoss` to locate the range of text in the story thread.

13.3.9. The paragraph and character attribute strands

Th paragraph attribute strand (`kParaAttrStrandBoss`) holds the range of text in each paragraph and paragraph formatting. The character attribute strand (`kCharAttrStrandBoss`) holds character formatting.

For example, the text shown in figure 13.3.9.a has two paragraphs and the second word of the first paragraph is in a bold typeface. We will use this to describe the runs that represent this internally.

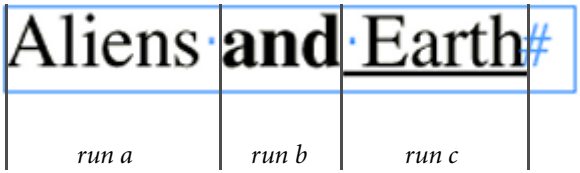
figure 13.3.9.a. Paragraph and character runs



The text in figure 13.3.9.a is maintained as one run on the text data strand that holds the character codes for all 48 characters present. The character formatting is maintained as three runs on the character attribute strand. The first is the word “Aliens ” (including the space), the second is the word “and” being set to a bold face. The third run is the rest of the text starting with the space after the “and” and ending with the return character that all stories have hard coded in them (this is represented by the “#” character found at the end of the story which you can view by turning on hidden characters). This third run is set to have a normal face again. The paragraph information is maintained as two runs in the paragraph attribute strand’s `IStrand` interface and one run in its `IAttributeStrand` interface. The runs given by its `IStrand` interface represents the range of text in each paragraph. The runs given by its `IAttributeStrand` interface represent paragraph formatting changes and since ther are no changes there is only one run.

Figure 13.3.9.b shows a single text frame that has formatting information applied. We will use this to describe the way internal formatting works in more detail.

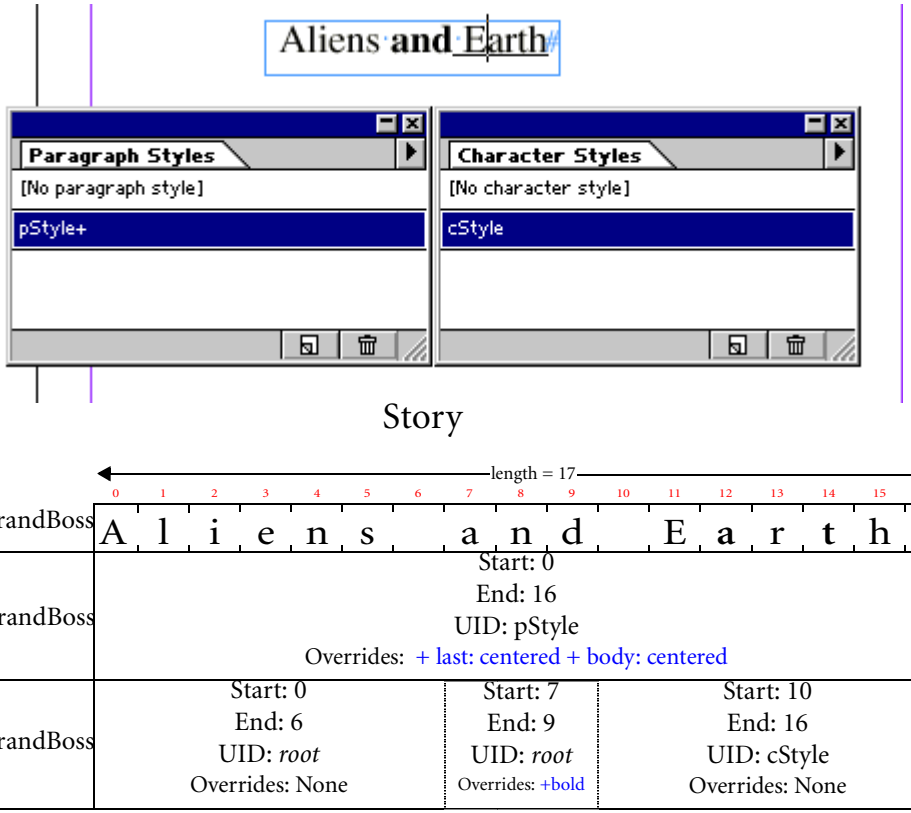
figure 13.3.9.b. Sample text



The text model that backs this text has 17 characters in it, one for each of the characters contained within the frame, and another for the hard coded return character all stories have. There is a single paragraph, with the paragraph style "`pStyle`" applied. This style merely sets the point size to some value. There is also extra formatting information applied to the whole paragraph that sets the justification to be centered (this is actually maintained as two attributes, one controlling the justification of the body, and the other controlling the justification of the last line). The first six characters (*run a*) do not have any other extra formatting information. The next 3 characters (*run b)* have been set to bold, and the remaining characters (*run c*) have the character style `cStyle` applied (which underlines the text).

Without exposing the internal mechanisms of styles, what does the model look like? Figure 13.3.9.c gives an abstract view.

figure 13.3.9.c. The text model representation of formatting



The story is maintained as strands. The character data is maintained on the `kTextDataStrand` boss. The `kParaAttrStrandBoss` holds paragraph formatting information. It does this as a set of **runs**. Overall this strand contains objects that hold a collection a paragraph lengths (in interface `IStrand`) along with a collection of paragraph formatting runs (in interface `IAttributeStrand`). There is only one paragraph, so there is only one run on the paragraph attribute strand. The `kCharAttrStrandBoss` holds character formatting information. As with the paragraph attribute strand, it does this as a set of runs. Each set of text with the same contiguous formatting information is represented by a different run. In this case three runs are needed, from position 0 to 6 to indicate that no extra formatting information is being applied, then from 7 to 9 to indicate there is a local override (`bold` is applied), and finally from position 10 to the end to indicate that there is no extra formatting, and a character style (`cStyle`) is applied.

It is interesting to consider the *direction* formatting information is applied to the text. As we may apply character formatting information to whole paragraphs (via paragraph styles), then to ranges of text within paragraphs (via character styles) and finally, locally to text, overriding any formatting currently set, there is room for confusion.

Again, with reference to figure 13.3.9.c the formatting information is applied in a top down approach. Imagine there is a set of formatting information that will be applied to the text (we'll call it the **effective value** of formatting). First, the current paragraph style makes up the effective value of the list of attributes to be applied (we will discuss styles more later). If there are any paragraph formatting overrides specified, these *override* the formatting information currently defined in the effective value. Any formatting information defined by the character style will *override* that defined in the effective value, before any character attribute strand formatting information is taken into account. This will also *override* the formatting information specified in the effective value. We now have the set of formatting information that is applicable for a particular point in the text.

To give a more concrete example, by default no underline is applied to text. If the current style being applied indicates there is to be a single underline, this replaces the default setting for underline. If there is a local (paragraph attribute) override indicating for underline to be off again, this *overrides* the paragraph style for underline. If the current character style being used turns underline back on, this *overrides* the paragraph override. Finally, if there is a local character override of turning underline off, this *overrides* the setting defined by the character style.

The story in figure 13.3.9.c is maintained using `kTextStoryBoss`. This boss provides a reference to each of the strand bosses, and facilities for manipulating the model. This is described in more detail in the practical section below.

13.3.10. Text attributes

A **text attribute** (see interface `IAttrReport`) describes a single text property. Attributes define all aspects of how the text should appear when composed.

Text attributes can apply either to a range of characters (such as the colour or point size of characters) or to a paragraph (such as paragraph alignment or the drop-cap being applied). Paragraph attributes are applied to the paragraph

strand and character attributes are applied to the character attribute strand. For a list of many of the currently supported attributes see figure 13.3.11.a.

Figure 13.3.10.a shows two text attribute bosses. The `kTextAttrPointSizeBoss` is an example of a boss that represents a character attribute, while the `kTextAttrAlignBodyBoss` represents a paragraph attribute.

figure 13.3.10.a. Text attribute boss classes

Attributes are implemented as boss classes that support the `IAttrReport` interface. This interface describes the attribute to the application. It also has the ability to describe their value in text (see `AppendDescription()` of `IAttrReport`), so the attribute for the middle run in the character attribute strand (figure 13.3.9.c) which sets the text to bold, describes itself as "+bold".

Not all attributes have this behaviour; there are a number defined to be internal to the application and are never represented to the user through the UI. They have no need to describe themselves (for example attributes defined by the composition mechanisms to control the scaling of hyphens).

The role of composing text so that it gets drawn as described by its text attributes is the job of a paragraph composer (see the "Text Composition" chapter).

You can add your own custom text attributes. For details on how to do this see the "Text Attributes and Adornments" chapter. However you should be aware that Adobe's paragraph composers will be ignorant of your custom text attribute. It will therefore not affect where lines are broken or characters are positioned unless you implement a custom paragraph composer aswell.

13.3.11. Text attribute catalogue

Figure 13.3.11.a shows the main text attributes used in the application. The example setting given is that for the *root style*. The type of attribute details whether the attribute is a character or paragraph attribute. There are other

attributes within the application, however these are intended for internal use for the composition subsystem so we do not describe them here.

figure 13.3.11.a. Text attribute catalogue

Class Name	Example Setting	Type	Description
kTextAttrColorBoss	+ color: [Black]	Char	The Colour applied to text
kTextAttrFontStyleBoss	+ Regular	Char	The face given to text (I.e. bold, regular etc)
kTextAttrPointSizeBoss	+ size: 12 pt	Char	The point size of text
kTextAttrXGlyphScaleBoss	+ char width: 100%	Char	The scale of the glyph (width) as a percentage
kTextAttrPairKernMethodBoss	+ pair kern method: Metrics	Char	Method of kerning, optical, metrics or none
kTextAttrLigaturesBoss	+ ligatures	Char	Use ligatures or not
0x1b09 (null) kTextAttrPageNumberTypeBoss	current	Char	Defines the style of page number
kTextAttrOutlineBoss	+ stroke: 1 pt	Char	Defines the stroke of the text
kTextAttrTrackKernBoss	+ tracking: 0	Char	Defines the value of the tracking/ kerning of the text
kTextAttrBLShiftBoss	+ not shifted	Char	Indicates whether there is a baseline shift or not
kTextAttrCapitalModeBoss	- caps	Char	Defines whether caps mode is on or not
kTextAttrStrokeColorBoss	+ stroke color: [None]	Char	Defines the stroke colour for text
kTextAttrPairKernBoss	+ pair kern: auto	Char	Defines the type of kerning used (automatic or manual)
kTextAttrYGlyphScaleBoss	+ char height: 100%	Char	The scale of the glyph (height) as a percentage
kTextAttrLeadBoss	+ leading: auto	Char	Autoleading mode
kTextAttrLanguageBoss	+ language: English: USA	Char	Language currently being used
kTextAttrNoBreakBoss	- no break	Char	Whether line breaks are allowed over the range of the attribute or not
kTextAttrUnderlineBoss	- underline	Char	Underline on or not
kTextAttrFontUIDBoss	+ font: Times	Char	Font being used
kTextAttrOldStyleFiguresBoss	- old style figures	Char	Determines if old style figures are used
kTextAttrILGShiftBoss	(null)	Char	TBD
kTextAttrPositionModeBoss	+ position: normal	Char	Position of text (subscript, superscript, normal)
kTextAttrStrikethruBoss	- strikethrough	Char	Strikethrough on or off
kTextAttrCharacterHangBoss	-	Char	Hanging punctuation?
kTextAttrAlternateCharBoss	+ alt: 0%	Char	TBD
kTextAttrStrokeTintBoss	+ stroke tint: 100%	Char	Stroke tint
kTextAttrTintBoss	+ tint: 100%	Char	Character tint
kTextAttrStrokeOverprintBoss	- stroke overprint	Char	Overprint character stroke or not
kTextAttrOverprintBoss	- overprint	Char	Overprint character fill or not
kTextAttrStrokeGradAngleBoss	+ stroke gradient angle: 0°	Char	Stroke gradient angle
kTextAttrGradAngleBoss	+ gradient angle: 0°	Char	gradient angle

figure 13.3.11.a. Text attribute catalogue

Class Name	Example Setting	Type	Description
kTextAttrStrokeGradLengthBoss	+ stroke gradient length: -1 pt	Char	stroke gradient length
kTextAttrGradLengthBoss	+ gradient length: -1 pt	Char	gradient length
kTextAttrStrokeGradCenterBoss	(null)	Char	Stroke gradient center
kTextAttrGradCenterBoss	(null)	Char	Gradient center
kTextAttrSkewAngleBoss	+ skew angle: 0°	Char	Skew angle
kTextAttrSpecialGlyphBoss	+ special glyph	Char	TBD
kTextAttrHiliteAngleBoss	+ highlight angle: 0°	Char	Highlight angle
kTextAttrHiliteLengthBoss	+ highlight length: 1 pt	Char	Highlight length
kTextAttrStrokeHiliteAngleBoss	+ stroke highlight angle: 0°	Char	Stroke highlight angle
kTextAttrStrokeHiliteLengthBoss	+ stroke highlight length: 1 pt	Char	Stroke highlight length
kTextAttrRotateGlyphBoss	+ rotate glyph	Char	Rotate glyph or not
kTextAttrStrikeoutBoss	+ strikeout	Char	Strikeout value
kTextAttrGotoNextXBoss	(null)	Char	Next style to goto on return
kTextAttrAlignLastBoss	+ last: flush left	Para	The alignment of the last line of a paragraph (center, right, left, justified)
kTextAttrAlignBodyBoss	+ body: flush left	Para	The alignment of all bar the last line of a paragraph (center, right, left, justified)
kTextAttrComposerBoss	+ composer: Adobe Multi-line Composer	Para	Specifies which composer to use for the composition of text
kTextAttrDropCapCharsBoss	+ drop cap characters: 0	Para	Indicates the number of characters affected by a drop cap
kTextAttrDropCapLinesBoss	+ drop cap lines: 0	Para	Indicates the number of lines a drop cap will extend by
kTextAttrBaselineGridBoss	- align to grid	Para	Defines whether the text is aligned to a baseline grid or not
kTextAttrHyphenLadderBoss	+ consecutive hyphens: 2	Para	Sets hyphen limit
kTextAttrIndentBLBoss	+ left indent: 0p0	Para	Amount of left indent
kTextAttrIndentBRBoss	+ right indent: 0p0	Para	Amount of right indent
kTextAttrIndent1LBoss	+ first indent: 0p0	Para	Indent applied to the first line
kTextAttrAutoLeadBoss	+ autoleading: 120%	Para	Setting for autoleading
kTextAttrAutoQuadBoss	- auto quad:	Para	TBD
kTextAttrHyphenModeBoss	+ hyphenation	Para	Hyphenation on or off
kTextAttrMinBeforeBoss	+ min before: 3	Para	Minimum characters to hyphenate before
kTextAttrMinAfterBoss	+ min after: 3	Para	Minimum characters to hyphenate after
kTextAttrHyphenCapBoss	+ hyphenate capitalized	Para	Hyphenate capitalised words or not
kTextAttrShortestWordBoss	+ shortest word: 7	Para	Minimum word length to hyphenate
kTextAttrHyphenZoneBoss	+ hyphenation zone: 3p0	Para	Size of the hyphenation zone
kTextAttrSpaceBeforeBoss	+ space before: 0p0	Para	Vertical space before the paragraph starts
kTextAttrSpaceAfterBoss	+ space after: 0p0	Para	Vertical space after the paragraph ends

figure 13.3.11.a. Text attribute catalogue

Class Name	Example Setting	Type	Description
kTextAttrTabsBoss	+ tabs: none	Para	Control of tabs
kTextAttrWordspaceDesBoss	+ desired wordspace: 100%	Para	Determines the desired wordspace to use
kTextAttrWordspaceMaxBoss	+ max. wordspace: 133%	Para	Determines the maximum wordspace to use
kTextAttrWordspaceMinBoss	+ min. wordspace: 80%	Para	Determines the minimum wordspace to use
kTextAttrLetterspaceDesBoss	+ desired letterspace: 0%	Para	Determines the desired letterspace to use
kTextAttrLetterspaceMaxBoss	+ max. letterspace: 0%	Para	Determines the maximum letterspace to use
kTextAttrLetterspaceMinBoss	+ min. letterspace: 0%	Para	Determines the minimum letterspace to use
kTextAttrGlyphscaleDesBoss	+ desired glyph scaling: 100%	Para	Specifies the desired glyph scaling to use
kTextAttrGlyphscaleMaxBoss	+ max. glyph scaling: 100%	Para	Specifies the maximum glyph scaling to use
kTextAttrGlyphscaleMinBoss	+ min. glyph scaling: 100%	Para	Specifies the minimum glyph scaling to use
kTextAttrBreakBeforeBoss	- start anywhere	Para	Defines where to start the paragraph, e.g. next column, frame page etc.
kTextAttrKeepTogetherBoss	+ keep at start/end of paragraph	Para	Whether lines should be kept together or not
kTextAttrKeepWithNextBoss	+ keep next: 0	Para	How many lines to keep together
kTextAttrKeepFirstNLinesBoss	+ keep first: 2	Para	Lines at start of paragraph to be kept together
kTextAttrKeepLastNLinesBoss	+ keep last: 2	Para	Lines at end of paragraph to be kept together
kTextAttrKeepLinesBoss	- keep lines	Para	Defines wether all lines of the paragraph are kept together
kTextAttrPRAColorBoss	+ rule above color: (Text Color)	Para	Paragraph rule above color
kTextAttrPRAStrokeBoss	+ rule above stroke: 1 pt	Para	Paragraph rule above stroke weight
kTextAttrPRATintBoss	+ rule above tint: -1%	Para	Paragraph rule above tint
kTextAttrPRAOffsetBoss	+ rule above offset: 0p0	Para	Paragraph rule above offset
kTextAttrPRAIndentLBoss	+ rule above left indent: 0p0	Para	Paragraph rule above left indent
kTextAttrPRAIndentRBoss	+ rule above right indent: 0p0	Para	Paragraph rule above right indent
kTextAttrPRAModeBoss	+ column width rule above	Para	Paragraph rule above mode boss (column or text)
kTextAttrPRBColorBoss	+ rule below color: (Text Color)	Para	Paragraph rule below color
kTextAttrPRBStrokeBoss	+ rule below stroke: 1 pt	Para	Paragraph rule below stroke weight
kTextAttrPRBTintBoss	+ rule below tint: -1%	Para	Paragraph rule below tint
kTextAttrPRBOffsetBoss	+ rule below offset: 0p0	Para	Paragraph rule below offset

figure 13.3.11.a. Text attribute catalogue

Class Name	Example Setting	Type	Description
kTextAttrPRBIndentLBoss	+ rule below left indent: 0p0	Para	Paragraph rule below left indent
kTextAttrPRBIndentRBoss	+ rule below right indent: 0p0	Para	Paragraph rule below right indent
kTextAttrPRBModeBoss	+ column width rule below	Para	Paragraph rule below mode boss (column or text)
kTextAttrPRAOverprintBoss	- rule above overprint	Para	Paragraph rule above overprint stroke or not
kTextAttrPRBOverprintBoss	- rule below overprint	Para	Paragraph rule below overprint stroke or not
kTextAttrPRARuleOnBoss	- rule above	Para	Paragraph rule above on or not
kTextAttrPRBRuleOnBoss	- rule below	Para	Paragraph rule below on or not
0x1b6b (null) kTextAttrAlignSingleBoss	+ single: force-justified	Para	TBD

13.3.12. AttributeBossList

An **AttributeBossList** is a persistent container for text attributes (you can consider them as a list of attribute `ClassIDs`) . An `AttributeBossList` is either referenced from a style (each style references a list of attributes that the style applies), or can exist within paragraph or character attribute strands directly (providing a list of local overrides).

An `AttributeBossList` references attributes by `ClassID`. This implies that an `AttributeBossList` can have at most one association with a particular attribute (for example `kTextAttrPointSizeBoss`), and hence one attribute value of that type (for example a point size of 12 points).

Attributes can exist within the `AttributeBossList` that corresponds to a specific run on the paragraph or character attribute strand. Attributes that exist here are termed **local attribute overrides**. However, they are more often found within the `AttributeBossList` that corresponds to a specific style.

13.3.13. Text styles

This section introduces the text style concepts you need to know to understand the text model. The "Working with Text Styles" chapter describes the practical aspects of programming text styles. As you are reading this section, you might find it useful to flip forward to the practical chapter for concrete examples of the styles API.

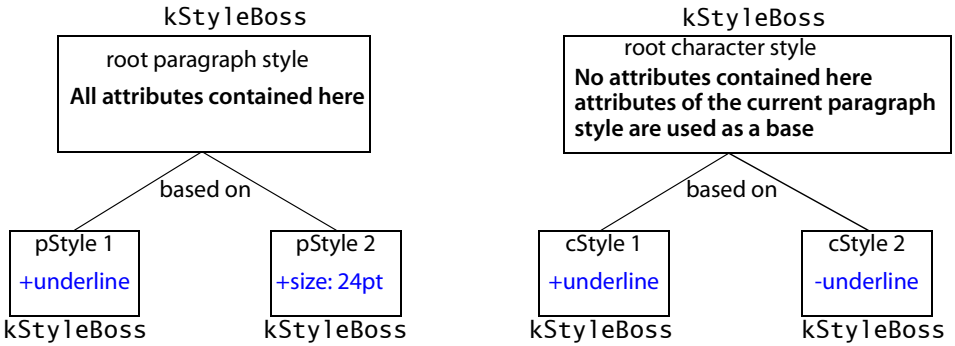
A **style** (see boss class `kStyleBoss`) is a collection of text attributes that are collectively applied to some text. The application supports **paragraph styles** and **character styles**, paragraph styles contain both paragraph and character attributes, while character styles only contain character attributes. All elements of formatting required for text can be described by a paragraph style. By default, all text has the **root paragraph style** applied to it. This is a hard coded style, with the full set of text attributes required for composition, each set to some predefined value. Paragraph styles apply to ranges of characters at the granularity of individual paragraphs.

There is also a **root character style** applied to text as the default. Character styles apply to ranges of characters at the granularity of individual characters. The root character style has no attributes associated with it. This indicates that composition should use the set of attributes defined by the current paragraph style (along with any *local overrides)* to fully describe the appearance of text.

The user can define their own styles, but they must be based on the root styles and only the difference from these root styles is recorded.

Paragraph styles can only be applied to complete paragraphs. Character styles contain only character attributes and may be applied to any range of characters. Figure 13.3.13.a shows a simple set of styles.

figure 13.3.13.a. Generating new styles



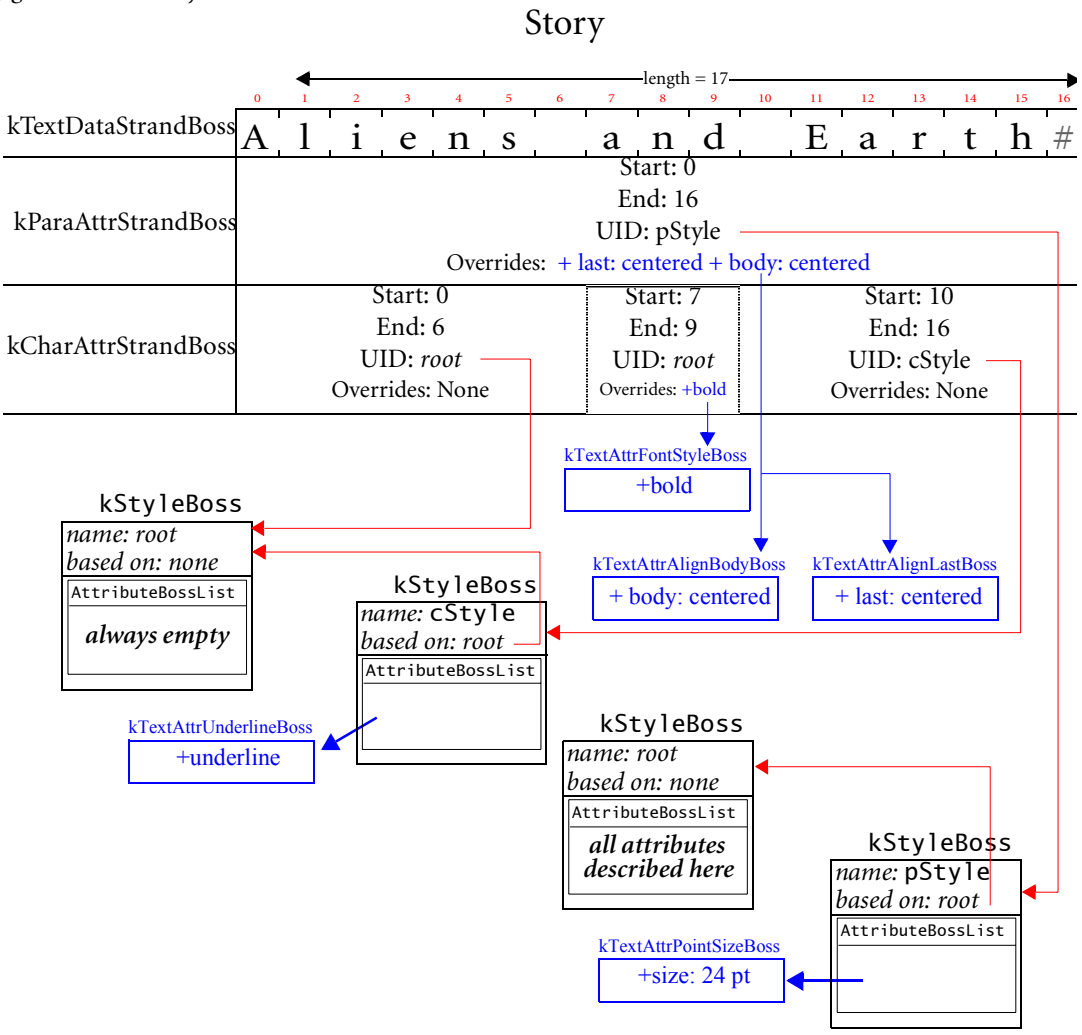
There are both character and paragraph root styles. The root paragraph style contains every attribute required to describe composition. The styles that are

based on this root (`pStyle1` and `pStyle2`) record only how they differ from it. `pStyle1` turns underline on, and `pStyle2` sets the point size of text to 24.

The root character style contains no formatting information. It exists to provide a root for a hierarchy of character styles. There are two character styles defined here (`cStyle1` and `cStyle2`). These styles indicate how the formatting should differ from the current set of styles that are being applied (as the parent of these styles is root, we are only really concerned with the current paragraph style being applied).

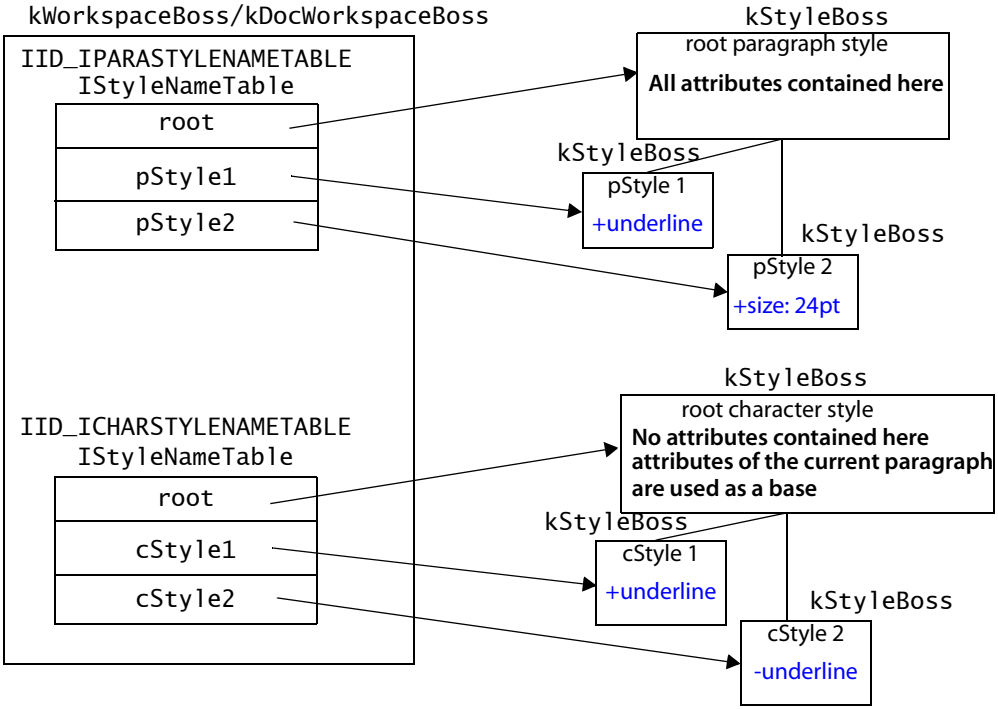
We can expand figure 13.3.9.c to give a more complete picture of the formatting that applies to text. Figure 13.3.13.b shows how the information on the attribute strands relate to the style and attribute bosses that maintain the formatting information. Each attribute strand run maintains a reference to the style applicable. Each style maintains a reference to the style it is based on. As well as the character style information, the character attribute strand maintains a reference to the `kTextAttrFontStyleBoss` that provides the local override that sets the text to bold. We have also shown the existence of the attribute bosses that each of the two derived styles use. Although each attribute is shown individually within the styles and strands, they exist as part of an `AttributeBossList`.

figure 13.3.13.b. Styles and text attribute boss classes



Within each workspace (either the global workspace or document workspaces) there exists a nametable (see interface `IStyleNameTable`) for both the paragraph and character styles. These nametables provide easy and convenient access to all styles within the application. An example of this is shown in figure 13.3.13.c.

figure 13.3.13.c. Style name tables (style sheets)



13.3.14. Text formatting overview

Text attributes give us the basic building block for maintaining formatting information for text. Each attribute describes a particular aspect of text. Some attributes are designed to operate on individual paragraphs (for example, those controlling justification) while others are designed for use over specific ranges of text (for example the `kTextAttrPointSizeBoss` which controls the point size of text).

Text attribute bosses are unlikely to be found on their own, they exist in `AttrributeBossLists` which provide persistence. The `AttributeBossList` is the collection class used for attributes.

All text has both a paragraph and character style associated with it. Unless otherwise specified, these styles will be the roots maintained within the application. The root paragraph style defines all the formatting information

required to drive composition. Character styles operate over ranges of characters, paragraph styles operate over ranges of paragraphs. Character styles can only contain character attributes, while paragraph styles can contain both paragraph and character attributes.

Note that a story also provides a helper interface, `ITextReferences`, that lets you ascertain the styles, colors and fonts it uses without having to delve into the text model.

13.3.15. Owned items

Owned items (see interface `IOwnedItem`) allow objects to be associated with a character in the text model. Owned items are held on the owned item strand (`kOwnedItemStrandBoss`) and are referenced by `UID` via its `IItemStrand` interface. The in-line frame, table, hyperlink and index features all create and associate owned items.

For example when an in-line frame (`kInlineBoss`) is embedded in the text flow it behaves as if it were a single character of text and moves along with the flow when the text is recomposed. The character `kTextChar_ObjectReplacementCharacter` in inserted into the text data strand to anchor the owned item in the flow. Similarly table frames (`kTableFrameBoss`) are owned items that are anchored on a `kTextChar_Table` character.

Some features insert a special character in the text to anchor the owned item on. Others associate the owned item with an existing character. Examples of the approach used by some features is shown in figure 13.3.15.a. Note that when a special character is inserted that character must have significant meaning to the paragraph composer.

figure 13.3.15.a. Types of owned items and their use of special anchor characters

Owned Item	Boss Class	Special characters
Inline	kInlineBoss	kTextChar_ObjectReplacementCharacter
Table	kTableFrameBoss	kTextChar_Table
Hyperlink	kHyperlinkTextMarkerBoss kHyperlinkTextSourceEndMarkerBoss	None (uses the first and last characters of the hyperlink)
Index	kIndexPageEntryBoss	kTextChar_ZeroSpaceNoBreak

13.3.16. Story thread dictionaries

Story threads were introduced on page 399. In this section we will examine how they are organised in a little more detail for those interested in developing a custom feature that, like tables and notes (InCopy), embeds text inside a story using story threads. A complete description of how this is done is beyond the scope of this chapter.

To implement a feature that embeds text in a story using a custom story thread you need to provide boss classes that implement interfaces `IITextStoryThreadDict` and `ITextStoryThread`. To allow your embedded text to be anchored on a character in the text model you must also implement interfaces `IOwnedItem` and `ITextModelMemento`. You will also need to implement commands that manage your boss classes and insert story threads into the text model.

Story threads are managed by a persistent (`UID` based) boss class that aggregates a story thread **dictionary** (see interface `ITextStoryThreadDict`). Currently dictionary implementations are provided by stories (`kTextStoryBoss`), tables(`kTableModelBoss`) and notes(`kNoteDataBoss`/InCopy). You may wish to study the organisation of these boss classes. The interface `ITextStoryThreadDictHier` aggregated on a story (`kTextStoryBoss`) is a collection of all the dictionaries embedded in the story. A story has a story thread dictionary for the primary story thread, a dictionary per table and a dictionary per other feature that embeds story threads.

The story thread (`ITextStoryThread`) implementation can be aggregated on a boss class that is not persistent. This is possible because text flow it represents is kept persistently by the text model and because the dictionary that manages the story threads is persistent.

Dictionaries can be anchored into the text model or not. For example the primary story thread dictionary is not anchored but the dictionary for a table is anchored. An **anchor** is created by associating an owned item at a text index. Anchored dictionaries can interact with copy and paste thus allowing the text represented by the dictionary to be copied and pasted.

All the story threads managed by a dictionary must be stored contiguously in the text model. This is known as the dictionary's **thread block**. The location of this thread block must be consistent with the hierarchical location of where the

dictionary is anchored. For example, if you insert a table, the embedded table's thread block will follow the thread block in which the table has been anchored. `ITextStoryThreadDictHier` on the story (`kTextStoryBoss`) is used to determine what the dictionary next to the one being inserted is. You determine where your thread block should go by inserting it at the beginning of the next dictionary's thread block or at the end of the story (`ITextModel::TotalLength`) if there is no next dictionary.

The story has a dictionary (`ITextStoryThreadDict`) that describes the primary story thread. Its thread block starts at a text index of zero and spans to `ITextModel:GetPrimaryStoryThreadSpan-1`.

To explore the arrangement of thread blocks in more detail we will look at an example relating to tables.

Figure 13.3.16.a shows a text frame containing the text "abc" and three embedded tables. A table (labelled Table 1) with two cells lies between the "a" and the "b" character. A second table (labelled Table 2) also with two cells lies between the "b" and the "c" character. A third table (labelled Table3) containing a single cell has been embedded in the lower cell in Table 1. A diagram showing how this arrangement is represented in the underlying text model is shown below the frame. The frame and table cell background color has been color coded to indicate the story thread in the underlying text model that stores the text.

figure 13.3.16.a. Sample text frame with three tables

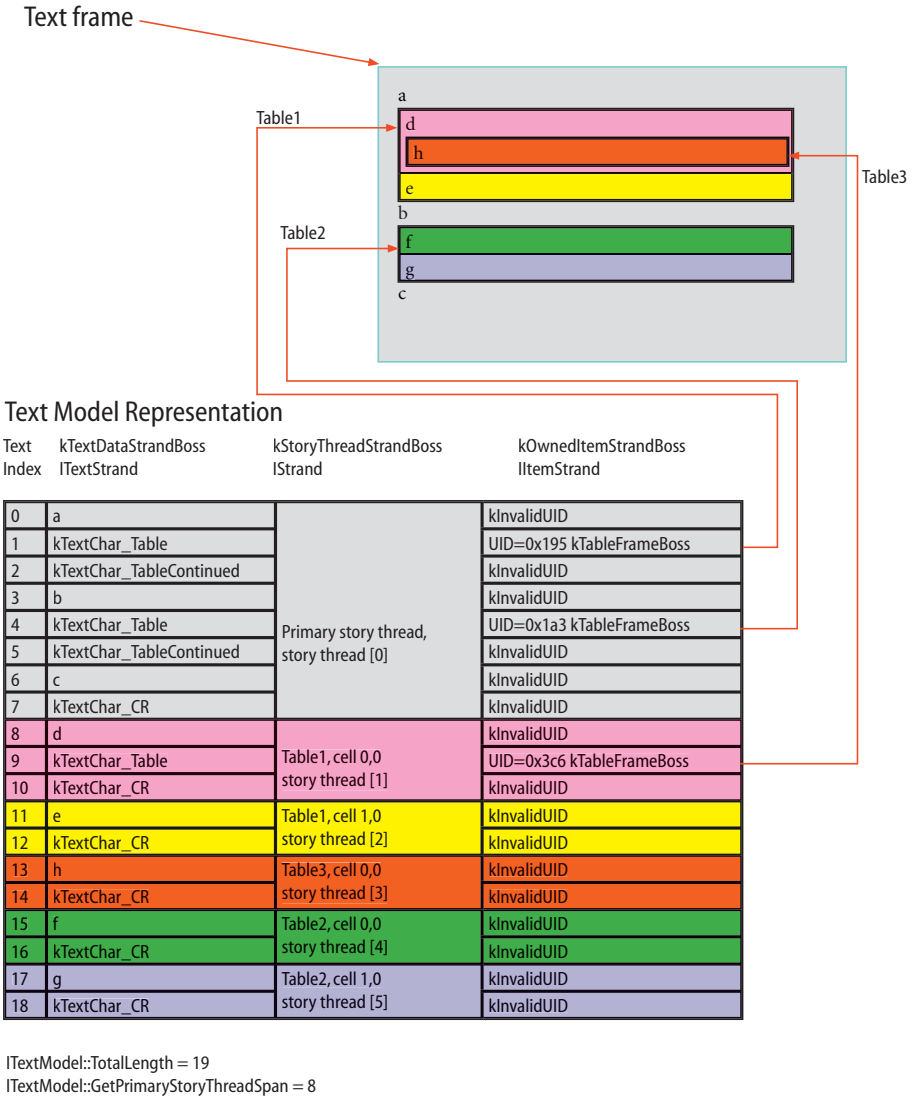
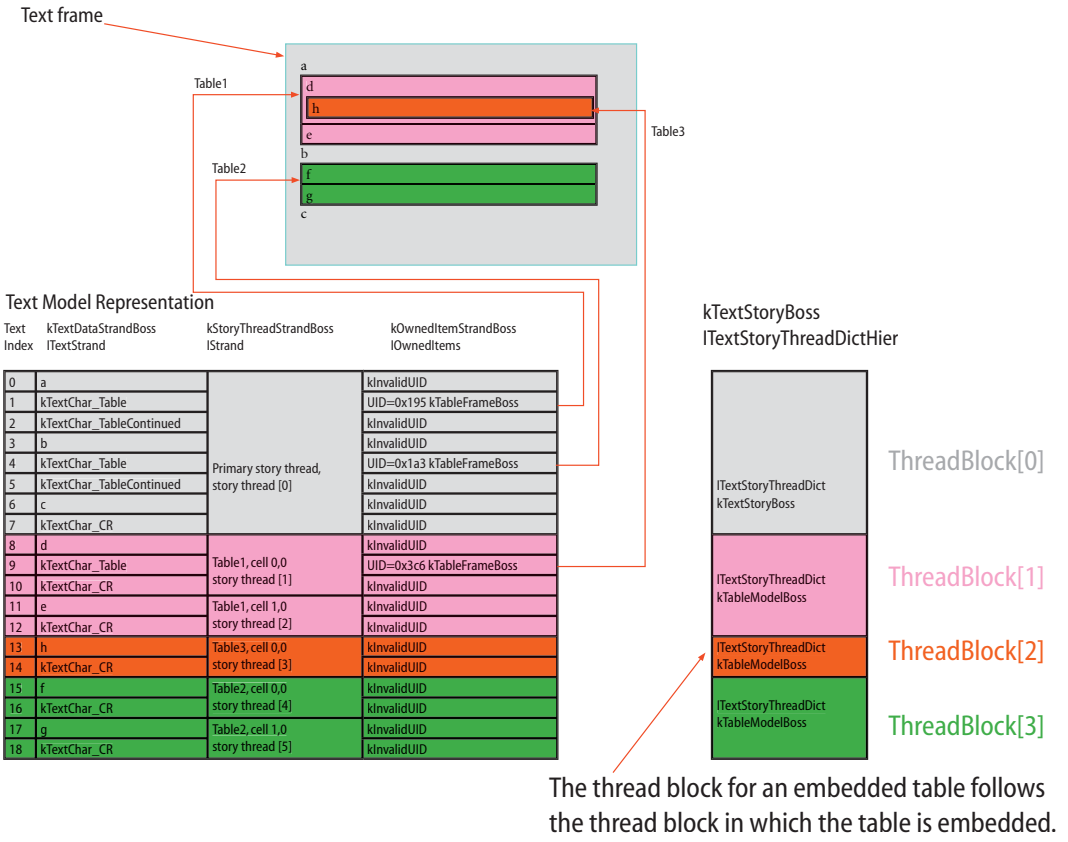


Figure 13.3.16.b shows the organisation of the dictionary thread blocks for the sample introduced in figure 13.3.16.a. There is a dictionary (`ITextStoryThreadDict`) maintained by the story (`kTextStoryBoss`) for the primary story thread. There is a dictionary maintained by each table (`kTableModelBoss`) for the story threads that represent each cell's text. The diagram shows the thread block for the primary story thread and the thread

block for each of the three tables, giving four thread blocks in total. Notice that because table 3 is embedded inside table1 its thread block follows table 1's. The collection of all dictionaries embedded in the story is managed by `ITextStoryThreadDictHier` on `kTextStoryBoss`. The frame and table cell background color has been color coded to indicate the dictionary and thread block with which the characters are associated.

figure 13.3.16.b. Dictionary thread block organisation for sample text frame with three tables



13.3.17. Text focus

The application supports the notion of a **text focus**. This is an abstraction that represents a range of text in a story by the boss class `kTextFocusBoss`. There are two different types of text focus, **range** and **caret**.

A range focus encompasses one or more of the characters in a story, up to the maximum of the length of the story. The range focus has a start, end and

length. This focus can contain many different sets of formatting information as the style of the text changes across the range of the focus.

A caret focus is based on an **insertion point** only. You can view this type of focus as a subset of the range focus, it has a length of 0, the start is equal to the end and there is only one set of formatting information that applies.

13.3.18. Text selection

You get a handle on the current text caret or selected text range through the **selection** abstraction. InDesign 2.x introduced major changes to selection. Prior to InDesign 2.x the `ISelection` and `ISpecifier` interfaces were used to interact with selection. InDesign 2.x introduced a new layer known as suites. Suites decouple user interface code from knowledge of the underlying data model being manipulated. So instead of using the `ISelection` and `ISpecifier` to accessing the underlying text model, the user interface code uses a suite interface such as `ITextAttributeSuite` and `ITextEditSuite`.

The `ISelection` and `ISpecifier` interfaces remain available under InDesign 2.x and you can continue to use them. Code like that shown in figure 13.3.18.a still works. However you should be aware that this will change in the future. If you need to manipulate text from your user interface it is best to wrap your features in a custom suite. Please read Technical Note #10006 "InDesign 2.0 Selection Architecture" for more information.

figure 13.3.18.a. Discovering the text model from ISelection

```
// The ISelection and ISpecifier interfaces remain available under InDesign 2.x
// and you can continue to use them for now. However you should be aware that
// this will change in the future.
InterfacePtr<ISelection> selection(::QuerySelection());
if(selection==nil) {
  return;
}
InterfacePtr<ISpecifier> specifier(selection->QuerySpecifier());
if(specifier==nil) {
  return;
}
InterfacePtr<ITextFocus> textFocus(specifier, UseDefaultIID());
if(textFocus==nil) {
  return;
}
InterfacePtr<ITextModel> textModel(textFocus->QueryModel());
```

13.3.19. Virtual Object Store (VOS)

This section discusses the lower level mechanisms used to store text objects. **This is provided for information only, we strongly discourage developers from using these mechanisms directly.**

The text architecture stores and manages text differently from the normal mechanisms used with InDesign objects. Due to the large number of objects involved (characters and attributes), and the demands these objects would place on memory, the text model uses a virtual object store - an abstract layer that provides a virtual memory paging scheme to the text storage subsystem. The virtual object store maintains a strand as a list of VOS "disk page" objects (`kVOSDiskPageBoss`). Each of these disk page objects store a list of `VOSObjects` - abstract data classes that represent a single block of data - this is likely to be a **run**.

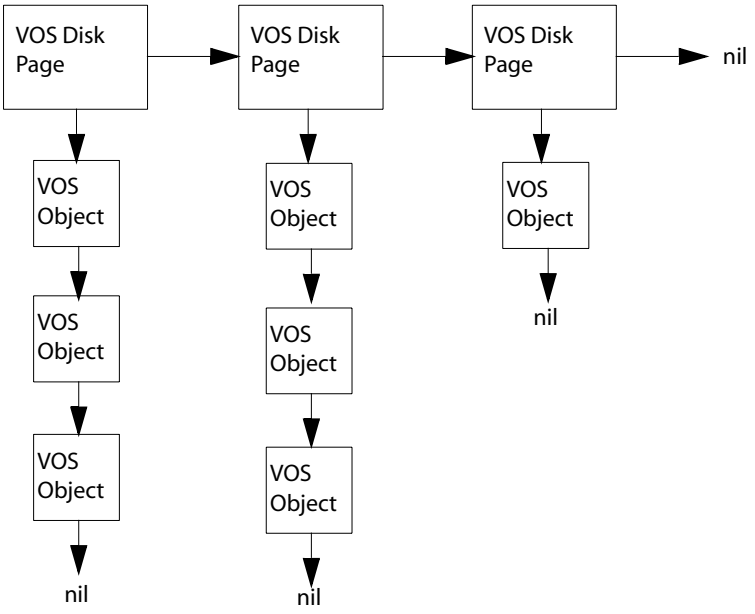
Figure 13.3.19.a shows an example of the VOS abstraction. A strand will maintain `VOSObjects` of only one type. Each `VOSObject` has a virtual length that indicates the number of characters the VOS object represents (so the summation of virtual lengths of all VOS objects will equal the number of characters held in a particular story). As with most virtual memory systems, there is a cache abstraction that maintains a view onto the memory sub-system, This is used with a `VOSCursor` abstraction that provides fast, convenient, sequential access to the objects maintained within the VOS structure.

The strand (which by its very definition is sequential) is maintained in a non-sequential manner allowing efficiency when manipulating the strand. Imagine what happens when updates are made near the beginning of a strand. There is a rippling effect, as these updates cause the elements through to the end of the strand to be disturbed. By implementing the strand in the manner shown, individual groups of data can be decoupled with the time taken to update the strand being more or less constant over the length of the strand. The `VOSCursor` abstraction translates this structure back into a sequential form. It provides the ability to iterate through the structure and perform certain operations on it.

Developers **should not** attempt to use the VOS subsystem directly. We provide higher level abstractions that allow the management and manipulation of the strand content.

The `Vos_SavedData` abstraction is a utility class that provides a buffering mechanism for the basic VOS objects. It is frequently used for copy and paste operations.

figure 13.3.19.a. VOS structure

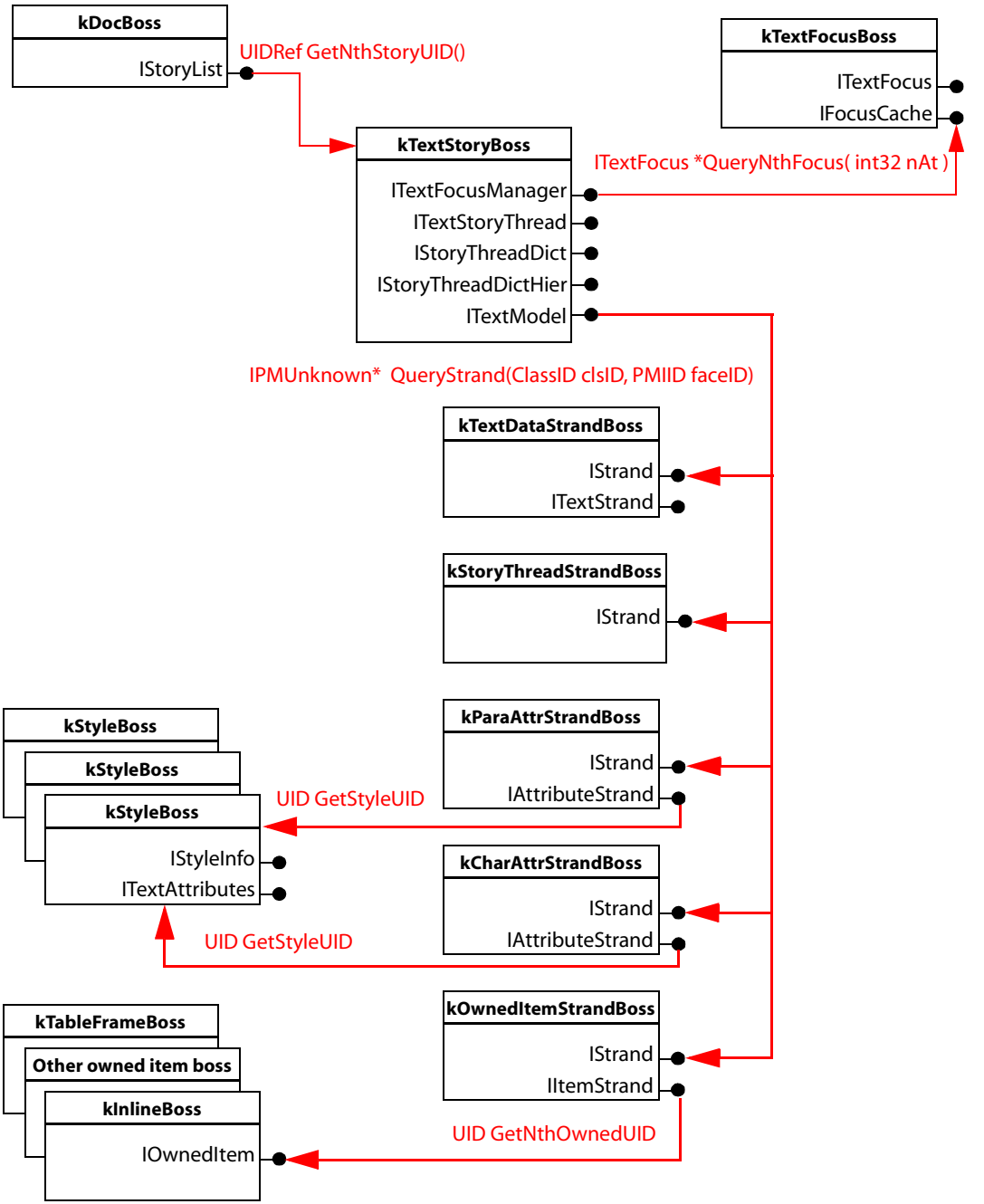


13.4. Interfaces

13.4.1. Class Diagram

The major boss classes in the text model and their relationships are shown in figure 13.4.1.a. Documents have stories (`kTextStoryBoss`). Stories have strands that describe different aspects of text. Attribute strands have styles (`kStyleBoss`) associated with them that describe the formatting context to be applied to the text. The owned item strand associates owned items that represent an object associated with a character in the text model. Ranges of text in the text model can be represented by a text focus (`kTextFocusBoss`).

figure 13.4.1.a. Text model class diagram



13.4.2. IStoryList

```
kDocBoss . . . . . . . . . . . . . . . . . . . . . . . . . IStoryList
```

The stories contained in a document are listed in interface `IStoryList`.

13.4.3. ITextModel

```
kTextStoryBoss . . . . . . . . . . . . . . . . . . . . . . ITextModel
```

`ITextModel` is the primary interface for manipulating the content of a story. It is used to generate commands that insert characters, delete characters, replace characters, apply text attributes to characters and to navigate to the underlying strands.

The methods that return the number of characters in the story and the number of characters in the primary story thread are shown in figure 13.4.3.a.

figure 13.4.3.a. ITextModel methods that return the number of characters stored

```
// Returns the total number of characters in the text model
// (including any characters in embedded tables or other features that embed text).
virtual int32 TotalLength() const = 0;
// Returns the total number of characters in the primary story thread.
// (excluding characters in embedded tables or other features that embed text).
virtual int32 GetPrimaryStoryThreadSpan() const = 0;
```

`ITextModel` provides convenient methods for a finding the associated frame list as shown in figure 13.4.3.b.

figure 13.4.3.b. ITextModel methods that navigate to the asociated frame list

```
virtual UID GetFrameListUID() const = 0;
virtual IFrameList * QueryFrameList() const = 0;
```

`ITextModel` supports the generation of commands that perform common tasks. The methods that perform this are listed in figure 13.4.3.c. Each of these methods, when called with the appropriate data, builds a command that will, when executed, update the text model.

figure 13.4.3.c. ITextModel methods that generate commands for common tasks

```
virtual ICommand* InsertCmd(TextIndex position, WideString* data,
  bool16 copyData, const ILanguage *language = nil ) = 0;
virtual ICommand* DeleteCmd(TextIndex start, int32 length) = 0;
virtual ICommand* ReplaceCmd(TextIndex start,
```

```
    int32 length,
    WideString *insert,
    bool16 copyData,
    const ILanguage *language = nil,
    bool16 clearNonContinuingAttrs = kTrue) = 0;
  virtual ICommand* ApplyCmd(TextIndex start, int32 length,
    const AttributeBossList *list, ClassID whichStrand) = 0;
  virtual ICommand* ApplyCmd( const RangeData& range,
    const AttributeBossList *list, ClassID whichStrand) = 0;
  virtual ICommand* ApplyStyleCmd(TextIndex start, int32 length,
    UID stylerefid, ClassID whichStrand,
    bool16 replaceOverrides = kTrue) = 0;
  virtual ICommand* UnapplyStyleCmd(TextIndex start, int32 length,
    ClassID whichStrand) = 0;
  virtual ICommand* ClearOverridesCmd(TextIndex start, int32 length,
    const AttributeBossList *these, ClassID whichStrand) = 0;
```

Figure 13.4.3.d shows the methods provided for strand navigation and figure 13.4.3.e shows how to use these to get to the paragraph attribute strand.

figure 13.4.3.d. ITextModel methods that navigate to strands

```
virtual UID GetStrandFromClass(ClassID klass) = 0;
virtual IPMUnknown *QueryStrand(ClassID clsID, PMIID faceID) = 0;
virtual IPMUnknown *QueryNthStrand(int32 n, PMIID faceID) = 0;
```

figure 13.4.3.e. Navigating to the paragraph attribute strand

```
InterfacePtr<IAttributeStrand> iAttributeStrand ((iTextModel-
>QueryStrand(kParaAttrStrandBoss, IID_IATTRIBUTESTRAND)));
```

13.4.4. ITextStoryThread

```
kTextStoryBoss . . . . . . . . . . . . . . . . . . . . . . ITextStoryThread
kTextCellContentBoss . . . . . . . . . . . . . . . . . . . ITextStoryThread
kNoteDataBoss . . . . . . . . . . . . . . . . . . . . . . . ITextStoryThread
```

`ITextStoryThread` represents a flow of text content. The interface provides access to the range of text in the text model that holds the actual text. It also links to the list of parcels (`IParcelList`) in which the text is displayed and to the dictionary (`ITextStoryThreadDict`) that manages the story thread.

The text model method `ITextModel::QueryStoryThread` is a helper method that returns the story thread associated with any index in the text model(`TextIndex`). Under the hood this method uses runs on the story thread strand `kStoryThreadStrandBoss` to locate the range of text in the story thread.

13.4.5. ITextStoryThreadDict

```
kTextStoryBoss . . . . . ITextStoryThreadDict
kTableModelBoss . . . . . ITextStoryThreadDict
kNoteDataBoss . . . . . ITextStoryThreadDict
```

The ITextStoryThreadDict interface manages a collection of associated story threads. A story's dictionary (kTextStoryBoss) only contains one story thread, the primary story thread. A table's dictionary (kTableModelBoss) contains a story thread per table cell. A note's (kNoteDataBoss/InCopy) dictionary contains one story thread for the note's text.

13.4.6. ITextStoryThreadDictHier

```
kTextStoryBoss . . . . . ITextStoryThreadDictHier
```

The ITextStoryThreadDictHier interface manages the collection of story thread dictionaries that are embedded in the story.

13.4.7. IStoryOptions

```
kTextStoryBoss . . . . . IStoryOptions
```

The IStoryOptions interface allows certain characteristics of the text to be controlled. Specifically:

- Whether the text is to flow horizontally or vertically.
- Optical alignment.

The SetEdgeAlignMethod(ClassID algo) is used to define whether optical margin alignment (otherwise known as hanging punctuation) is used for a story. This method call results in a direct change to the database, therefore it must be made within the scope of a command. The kOpticalMarginAlignmentCmdBoss has been provided for this purpose (see the command reference manual for more details).

The SetParagraphBodySize(PMReal b) method provides a mechanism to alter the amount of overhang present with optical margin alignment enabled. Ideally, this will be the same value as the font size that is being used, but as a story might have several fonts of different sizes, a compromise may have to be reached. As with the previous two methods, the manipulation of this value should be done through the provided kOpticalMarginAlignmentSizeCmdBoss (see the command reference manual for more details).

13.4.8. IComposeScanner

```
kTextStoryBoss . . . . . IComposeScanner
```

The `IComposeScanner` interface provides powerful, higher level mechanisms for the extraction of information from the text model. It is described in the "Paragraph composers" chapter.

13.4.9. ITextReferences

```
kTextStoryBoss . . . . . ITextReferences
```

Helper interface that provides information regarding to font, style and color usage within the story that saves you delving into the text model.

13.4.10. IDataLinkReference, ILinkState

```
kTextStoryBoss . . . . . IDataLinkReference
kTextStoryBoss . . . . . ILinkState
```

These two interfaces provide the mechanisms required to create a link to some external source (e.g. a file from the filesystem, or a database). Their use is not unique to text so we will discuss them no further here. For more information see the "Links" chapter.

13.4.11. ITextLockData

```
kTextStoryBoss . . . . . ITextLockData
```

See “Can I lock a story?” on page 451.

13.4.12. ITextFocus/ITextFocusManager

```
kTextFocusBoss . . . . . ITextFocus
kTextStoryBoss . . . . . ITextFocusManager
```

The text focus (`ITextFocus`) abstraction describes a range of text in story and was introduced in “Text focus” on page 420. Each story supports the `ITextFocusManager` interface which allows for the creation of text foci, and maintains a list of current text foci associated with a particular story.

The `ITextFocusManager` (`kTextStoryBoss`) contains methods to automatically update all text foci for that particular story. For example, if we had a text focus that encompassed a whole story (from first to last character), and we inserted text into the middle of the story we would like the length of the text focus to be

the new length of the story (i.e. the focus should still range from the first to the last characters).

The ITextFocusManager provides the mechanism to achieve this; in this case we indicate how many character we insert, and the insertion point (Inserted(TextIndex start, int32 count)). The implementation of ITextFocusManager takes care of updating the foci that are affected by an edit. The other mechanisms provided by the text model to manipulate text content will take care of the updating of text foci for you (i.e. by manipulating content through the ITextModel interface of the kTextStoryBoss, the updating of all text foci held for the story is automatically done).

13.4.13. IFocusCache

kTextFocusBoss . . . . . IFocusCache

For performance reasons, the kTextFocusBoss also implements a cache of formatting information associated with the focus, access to this cache is provided through the IFocusCache interface. Some methods are shown in figure 13.4.13.a.

figure 13.4.13.a. Some IFocusCache methods

```
virtual int32 CountParagraphStyles() = 0;
// Returns the number of  paragraph styles in this text focus
virtual int32 CountCharacterStyles() = 0;
// Returns the number of  character styles in this text focus
virtual UID GetNthParagraphStyle(int32 n) = 0;
// Returns the nth paragraph style
virtual UID GetNthCharacterStyle(int32 n) = 0;
// Returns the nth character style
virtual bool16 IsStyleOverridden(UID style) = 0;
// Returns kTrue if there are overrides to the style
```

Invalidation of the focus cache is handled through the text focus manager (ITextFocusManager) through the normal update actions on the kTextStoryBoss. Each focus cache is timestamped to indicate when the cache was built.

13.4.14. IStrand

kTextDataStrandBoss . . . . . IStrand
kParaAttrStrandBoss . . . . . IStrand
kCharAttrStrandBoss . . . . . IStrand

```
kOwnedItemStrandBoss . . . . . IStrand
```

The IStrand interface is supported by all boss objects implementing a strand. It provides lower level mechanisms for accessing and manipulating the text model information.

All strands support only one "type" of object (for example, paragraph attribute, character attribute, character code data or owned items). The type of object supported by a particular strand is reported through the GetObjectClass() method. The GetRunLength() method returns the length of the individual runs defined on the strand. The summation of all run lengths within a strand should equal the length returned by the TotalLength method supported by the ITextModel interface on the kTextStoryBoss.

The IStrand interface supports methods DoInsert, DoDelete and DoReplace, these methods return undo information to allow commands to be automatically undone. There are methods that allow for the copying and pasting of objects on the strand, along with the ability to generate a command that will delete the strand. There are also mechanisms for manipulating the *VOS* objects that are the fundamental storage mechanisms used for the text subsystem. **Manipulation of these structures by developers is strongly discouraged.**

Although the mechanisms provide manipulation of individual strand content, they do not help manage the overall story. Adding or removing information from a single strand is a difficult activity, the state of all other strands have to be considered, if each strand is not updated and synchronised against each other, the text model could become corrupt. It is hard for the application to recover from this. **Therefore it is strongly suggested that manipulations should occur through the mechanisms provided by ITextModel.**

13.4.15. ITextStrand

```
kTextDataStrandBoss . . . . . ITextStrand
```

The ITextStrand interface on the kTextDataStrandBoss provides a mechanism to retrieve character codes from the text model. Its prototype is given below.

figure 13.4.15.0.a. ITextStrand

```
class ITextStrand : public IPMUnknown
{
```

```
public:
  virtual DataWrapper<textchar> FindChunk(TextIndex begin,
    int32 *len, TextIndex *chunkstart = nil) = 0;
};
```

The `DataWrapper` template allows the persistent text objects that hold the raw text to be properly reference counted. It ensures that an `addref()` and `release()` are performed and a pointer to the raw data is returned.

13.4.16. IAttributeStrand

```
kParaAttrStrandBoss . . . . . . . . . . . . . . . . . IAttributeStrand
kCharAttrStrandBoss . . . . . . . . . . . . . . . . . IAttributeStrand
```

The attribute strand interface (`IAttributeStrand`) allows for management and manipulation of style information on the paragraph and character attribute strands. The character and paragraph attribute strand boss classes share this abstract `IAttributeStrand` interface although they employ different implementations.

The characters have a certain *style* applied - this style defines the way the text will appear. There is the concept of a root style (that is, text with no explicit style information added). For example, with no other style information added, the user may type text in an eight point Times New Roman font, with no underline, bold or italic face being applied. You can also define your own styles, for example for headlines or the main body of text. We will cover this in the styles section. As well as being able to define styles for text, you can allow for deviation from these styles, for example, although the headline style might be 18 point Times New Roman, you might want to underline the whole paragraph, or even just make a single word bold font.

The method `UnhookParagraphStyle` gives us the ability to disassociate a particular paragraph of text from its associated style. All style information for that text is maintained, but rather as a **style** it becomes a set of overrides from the root style, and will be maintained within a single `AttributeBossList`. The user can force this behaviour by selecting ranges of text then applying “No Paragraph Style” (or “No Character Style”) to it. The current style that is being applied is deselected but the formatting of text does not change. Everything is maintained as a list of overrides. The connection between the text and style is broken, altering the style will no longer have any effect on the text.

13.4.16.1. IItemStrand

`kOwnedItemStrandBoss . . . . . IItemStrand`

The owned item strand is used to maintain information on the objects that are placed directly into ("inline") the text model. Owned items are maintained as a list of uids, along with their type and the text index they are associated with.

13.4.17. IStyleInfo

`kStyleBoss . . . . . .IStyleInfo`

Styles are accessed and manipulated through the `IStyleInfo` interface on the `kStyleBoss`. This interface is described in figure 13.4.17.a. For further details of this interface, please see the "Working With Text Styles" chapter.

figure 13.4.17.a. Major IStyleInfo methods

```
// get the UID of the style this style is based on
virtual UID GetBasedOn() const = 0;
// Get the style we revert to on new paragraph
virtual UID GetNextStyle() const = 0;
//
virtual UID GetCharStyle() const = 0;
// get the name of the style
virtual const PMString& GetName() const = 0;
// are we a paragraph style
virtual bool16 IsParagraphStyle() const = 0;
```

13.4.18. ITextAttributes

`kStyleBoss . . . . . ITextAttributes`

The `ITextAttributes` interface allows control of the text attributes associated with a style. For further details of this interface, please see the "Working With Text Styles" chapter.

13.5. Frequently asked questions(FAQ)

13.5.1. What is a story?

See "Stories" on page 396.

13.5.2. What is the text model?

See "The text model" on page 398.

13.5.3. What is a strand?

See “Strands” on page 398.

13.5.4. What is a run?

See “Runs” on page 399.

13.5.5. What is a story thread?

See “Story threads” on page 399.

13.5.6. What is a text attribute?

See “Text attributes” on page 406.

13.5.7. What is an AttributeBossList?

See “AttributeBossList” on page 411.

13.5.8. What is a style?

See “Text styles” on page 411.

13.5.9. What is an owned item?

See “Owned items” on page 416.

13.5.10. What is text focus?

See “Text focus” on page 420.

13.5.11. What is text selection?

See “Text selection” on page 421.

13.5.12. How do I access the stories in a document?

A document is represented by boss class `kDocBoss`. Text within a document is maintained as a list of stories represented by the `IStoryList` interface on the `kDocBoss`. See the ReportStories method in code snippet SnipTextModel for sample code.

13.5.13. How do I create or delete a story?

Stories are rarely created and deleted in their own right. Normally they are created as a side effect of creating a text frame (See the "Text layout" chapter and the `kCreateMultiColumnItemCmdBoss` command). The same holds for deletion, normally the story is deleted as a side effect of deleting the last text frame that displays its text. See “Lifecycle of a story” on page 397 for more background information.

However should you really need to create or delete a story the API commands provided are `kNewStoryCmdBoss` and `kDeleteStoryCmdBoss`.

13.5.14. How do I navigate from the text model to a strand?

To navigate from a story to a strand use `ITextModel::QueryStrand` to get an interface on the strand boss class you are interested in. See code snippet SnipUpdateCurrentParaStyle for sample code.

13.5.15. How do I access the characters in a story?

If you only require access to character code data of a story use is the `TextIterator` class to iterate over each character. See the code snippet SnipInspectStoryCharacters for sample code.

To process the character data in larger chunks rather than character by character you can use `IComposeScanner::QueryDataAt`. See the SDK plug-in TextExportFilter for sample code.

Alternatively you can directly access the `ITextStrand` interface on `kTextDataStrandBoss` that actually stores the character data. Figure 13.5.15.a extracts character data from the strand and dumps it to trace.Each text "chunk" that is returned relates to the raw text as held by an underlying `VOS_Object`, described in “Virtual Object Store (VOS)” on page 422.

figure 13.5.15.a. Direct access to character data in ITextStrand

```
// This is by far the hardest way to access the character data in a story.
// For an easier life use one of the other options described above instead.
void DumpTextStrand(ITextModel* iTextModel)
{
  int32 storyLength = iTextModel->TotalLength();
  InterfacePtr<ITextStrand> iTextStrand (((ITextStrand*)
    iTextModel->QueryStrand(kTextDataStrandBoss, IID_ITEXTSTRAND)));
  int32 chunkLength=0;
  int32 currentPoint = 0;
  while (currentPoint+1 < storyLength) {
    DataWrapper<textchar> textString(iTextStrand->FindChunk(
      currentPoint, &chunkLength));
    for (int32 i = 0; i < chunkLength; i++) {
       TRACE("0x%x", textString[i]);
    }
    currentPoint+=chunkLength;
  }
  TRACE("\n");
}
```

13.5.16. How do I count the number of paragraphs in a story?

For each paragraph a run will exist on the `IStrand` interface on the paragraph attritbute strand (`kParaAttrStrandBoss`). The number of runs is equal to the number of paragraphs. See code snippet SnipCountStoryParagraphs for sample code.

13.5.17. How do I find the point size at a given TextIndex in a story?

See "How do I access the text attributes for a story or a range of text?" on page 435.

13.5.18. How do I access the formatting of a story?

See "How do I access the text attributes for a story or a range of text?" on page 435.

13.5.19. How do I access the text attributes for a story or a range of text?

Styles and overrides that apply to paragraphs are found from the `IAttributeStrand` interface on `kParaAttrStrandBoss`. Styles and overrides that apply to characters are found from the `IAttributeStrand` interface on `kCharAttrStrandBoss`. You can access the information directly via these interfaces. See code snippet SnipUpdateCurrentParaStyle for sample code.

Resolving the value of a particular text attribute, the point size say, at a given index into the text model by direct strand access as described above can be hard. You need to account for the hierarchical nature of text styles and any overrides that apply. There are APIs that make this easier to deal with.

If you want to know the values of a particular set of text attributes that are present in a range of text the `TextAttributeRunIterator` class can be used. See code snippet SnipInspectStoryPointSizes for sample code. Alternatively you can use `IComposeScanner::QueryAttributeAt` yourself, it is the API `TextAttributeRunIterator` uses.

If you want to scan the styled runs in a range of text you can use `IComposeScanner::QueryDataAt` to determine the drawing style (interface `IDrawingStyle`). See the EstimateTextWidth sample code presented in the "Paragraph composers" chapter for an example of this.

Finally if you already have a text focus (interface `ITextFocus`) that describes a range of text or if you create a new new text focus you can query this interface

for its associated focus cache (interface `IFocusCache`). Then you can use `IFocusCache` to examine the formatting that applies to the text.

13.5.20. How do I access the text selection?

Please read "Text selection" on page 421 for background information.

If you are implementing a suite on the text concrete selection boss class (`kTextISuiteBoss`) you can use its interface `ITextTarget` interface. See the SDK sample plug-in TextInsetMutator for sample code.

If you are using `ISelection` and `ISpecifier` you can use them to find the text focus (`ITextFocus`) that describes the selection. The method `QueryTextFocus` in code snippet SnipOldSelection shows how to do this. Please note that the availability of the ISelection and ISpecifier interfaces will be subject to change in the future.

13.5.21. How do I create a text selection?

Please read "Text selection" on page 421 for background information.

A text selection can be created using one of the commands generated by interface `ISelectUtils`. See the SelectText method in code snippet SnipTextModel for sample code(included below).

figure 13.5.21.a. SnipTextModel::SelectText

```
// The ISelectUtils interface remains available under InDesign 2.x
// and you can continue to use it for now. However you should be aware that
// this will change in the future.
ErrorCode SnipTextModel::SelectText(ITextFocus* textFocus)
{
  ErrorCode status = kFailure;
  do {
    InterfacePtr<ITextModel> textModel(textFocus->QueryModel());
    ASSERT(textModel);
    if (!textModel) {
      break;
    }

    // Clear the current selection of necessary.
    ISelection* selection = Utils<ISelectUtils>()-
    >GetActiveSelection();
    if (selection) {
      InterfacePtr<ICommand> deselectAllCmd(Utils<ISelectUtils>()-
```

```
        >DeselectAll(selection, kTrue));
        ASSERT(deselectAllCmd);
        if (!deselectAllCmd) {
          break;
        }
        if (CmdUtils::ProcessCommand(deselectAllCmd) != kSuccess) {
          break;
        }
      }

      // To display a text selection the text tool must be active.
      // Change to the text tool if necessary.
      InterfacePtr<ITool> activeTool(Utils<IToolBoxUtils>()-
      >QueryActiveTool());
      if (activeTool == nil || activeTool->IsTextTool() == kFalse) {
        InterfacePtr<ITool> textTool(Utils<IToolBoxUtils>()-
        >QueryTool(kIBeamToolBoss));
        ASSERT(textTool);
        if (!textTool) {
          break;
        }
        if (Utils<IToolBoxUtils>()->SetActiveTool(textTool) == kFalse) {
          ASSERT_FAIL("IToolBoxUtils::SetActiveTool failed to change to
          kIBeamToolBoss");
          break;
        }
      }

      // Select text from the given text focus.
      InterfacePtr<ICommand> selectText(Utils<ISelectUtils>()-
      >SelectTextRange(textFocus->GetCurrentRange(),
      ::GetUIDRef(textModel)));
      ASSERT(selectText);
      if (!selectText) {
          break;
      }
      status = CmdUtils::ProcessCommand(selectText);
    } while(false);
    return status;
}
```

13.5.22. How do I insert text into a story?

To insert characters at the selection's text caret use `ITextEditSuite`.

To insert characters at an arbitrary position in a story use the command generated by `ITextModel::InsertCmd`. See the `InsertText` method in code snippet SnipTextModel for sample code(included below).

figure 13.5.22.a. SnipTextModel::InsertText

```
/**Insert text into a story using ITextModel::InsertCmd.
@param textModel of story to be changed.
@param position index at which insertion to be made.
@param text to be inserted.
@return kSuccess on success, other ErrorCode otherwise.
 */
ErrorCode SnipTextModel::InsertText(ITextModel* textModel,
  const TextIndex position, const WideString& data)
{
  ErrorCode status = kFailure;
  do {
    ASSERT(textModel);
    if (!textModel) {
      break;
    }
    if (position < 0 || position >= textModel->TotalLength()) {
      ASSERT_FAIL("position invalid");
      break;
    }
    InterfacePtr<ICommand> insertCmd(textModel->InsertCmd(position,
      const_cast<WideString*>(&data),
      kTrue)); // make a copy of the string.
    ASSERT(insertCmd);
    if (!insertCmd) {
      break;
    }
    status = CmdUtils::ProcessCommand(insertCmd);
  } while(false);
  return status;
}
```

Note if you have allocated the `WideString` to be inserted on the heap you can ask the command to assume ownership of the data by setting the `copyData` parameter to `kFalse`. The command will delete it when it is no longer required. Otherwise you should always set the `copyData` parameter to `kTrue` in which case the command will make a copy of the `WideString` you are inserting.

Typed characters can be inserted using the command generated by `ITextModel::TypeTextCmd` . A difference between this command and `ITextModel::InsertCmd` is that it respects text locking. If the text content is locked (see `ITextLockData`), the method returns nil, if it is not locked the method returns a valid command.

13.5.23. How do I delete text from a story?

To delete selected text use `ITextEditSuite`.

To delete an arbitrary range of text use the command generated by `ITextModel::DeleteCmd`. All strands are updated to reflect the deletion. See the `DeleteText` method in code snippet SnipTextModel for sample code(included below).

figure 13.5.23.a. SnipTextModel::DeleteText

```
/**Delete text from a story using ITextModel::DeleteCmd.
@param textModel of story to be changed.
@param position index first character to be deleted.
@param length number of characters to be deleted.
@return kSuccess on success, other ErrorCode otherwise.
 */
ErrorCode SnipTextModel::DeleteText(ITextModel* textModel,
  const TextIndex position, const int32 length)
{
  ErrorCode status = kFailure;
  do {
    ASSERT(textModel);
    if (!textModel) {
      break;
    }
    if (position < 0 || position >= textModel->TotalLength()) {
      ASSERT_FAIL("position invalid");
      break;
    }
    if (length < 1 || length >= textModel->TotalLength()) {
      ASSERT_FAIL("length invalid");
      break;
    }
    InterfacePtr<ICommand> deleteCmd(textModel->DeleteCmd(position,
    length));
    ASSERT(deleteCmd);
    if (!deleteCmd) {
      break;
    }
    status = CmdUtils::ProcessCommand(deleteCmd);
  } while(false);
  return status;
}
```

13.5.24. How do I replace a range of text in a story?

To replace selected text use `ITextEditSuite`.

To replace an arbitrary range of text use the command generated by `ITextModel::ReplaceCmd`. See the `ReplaceText` method in code snippet SnipTextModel for sample code.

13.5.25. How do I copy and paste text in and between stories?

To copy text around within and between stories the command `kCopyStoryRangeCmdBoss` can be used as shown by code snippet SnipCopyStory. Note that the utility interface `ITextUtils` provides a facade onto this command that can be used rather than programming the command directly.

At a lower level characters that are copied using `ITextModel::CopyRange` are pasted using the command generated by `ITextModel::PasteCmd`. See the `CopyAndPasteText` method in code snippet SnipTextModel for sample code.

13.5.26. How do I apply a style to text in a story?

To change the style of selected text use `ITextAttributeSuite::ApplyStyle`. See the TextStyler plug-in for sample code.

To change the style of an arbitrary range of text use the command generated by `ITextModel::ApplyStyleCmd`. Note that the `replaceOverrides` parameter indicates whether formatting overrides that exist on given range of text should remain or be removed. See code snippet SnipApplyParaStyle for sample code.

13.5.27. How do I apply text attribute overrides?

To apply text attribute overrides to selected text use `ITextAttributeSuite`. See code snippet SnipChangeTextAttr for sample code.

To apply text attribute overrides to an arbitratry range of text use the command generated by `ITextModel::ApplyCmd`. See the ApplyOverrides method in code snippet SnipTextModel for sample code (included below).

figure 13.5.27.a. SnipTextModel::ApplyOverrides

```
/**Apply paragraph alignment, the point size, leading and underline overrides
using ITextModel::ApplyCmd.
@param textModel of story to be changed.
@param position index of first character to be formatted.
@param length number of characters to be formatted.
@return kSuccess on success, other ErrorCode otherwise.
 */
```

```
ErrorCode SnipTextModel::ApplyOverrides(ITextModel* textModel, const
TextIndex position, const int32 length)
{
  ErrorCode status = kFailure;

  do {
    ASSERT(textModel);
    if (!textModel) {
      break;
    }
    if (position < 0 || position >= textModel->TotalLength()) {
      ASSERT_FAIL("position invalid");
      break;
    }
    if (length < 1 || length >= textModel->TotalLength()) {
      ASSERT_FAIL("length invalid");
      break;
    }

    // Wrap the changes to be made in a command sequence.
    CmdUtils::SequenceContext seq;

    // First set the paragraph alignment.

    // Create a container for the paragraph attribute to be applied.
    AttributeBossList* paraAttributeBossList = new
    AttributeBossList();
    ASSERT(paraAttributeBossList);
    if (!paraAttributeBossList) {
      break;
    }

    // Create an alignment attribute.
    InterfacePtr<ITextAttrAlign>
    textAttrAlign(::CreateObject2<ITextAttrAlign>(kTextAttrAlignBodyBo
    ss));
    ASSERT(textAttrAlign != nil);
    if(textAttrAlign==nil) {
      break;
    }
    textAttrAlign->Set(ICompositionStyle::kTextAlignCenter);
    paraAttributeBossList->ApplyAttribute(textAttrAlign);

    // Create a command to apply the attribute. We are applying a paragraph
    // attribute, so we indicate kParaAttributeStrand.
    InterfacePtr<ICommand> applyParaAttrCmd(textModel-
    >ApplyCmd(position,
    length,
```

```
paraAttributeBossList,
kParaAttrStrandBoss));
ASSERT(applyParaAttrCmd);
if(applyParaAttrCmd == nil) {
  break;
}

// Apply the paragraph attribute.
status = CmdUtils::ProcessCommand(applyParaAttrCmd);
if (status != kSuccess) {
  ASSERT_FAIL("ITextModel::ApplyCmd failed to apply paragraph
  attributes");
  break;
}


// Now set the point size, leading and underline for the characters.
status = kFailure;

// Create a container for the character attributes to be applied.
AttributeBossList* charAttributeBossList = new
AttributeBossList();
ASSERT(charAttributeBossList);
if (!charAttributeBossList) {
  break;
}

// Create a point size, leading and underline attributes.
InterfacePtr<ITextAttrRealNumber>
textAttrPointSize(::CreateObject2<ITextAttrRealNumber>(kTextAttrPo
intSizeBoss));
ASSERT(textAttrPointSize != nil);
if(textAttrPointSize==nil) {
  break;
}
textAttrPointSize->Set(PMReal(18.0));
charAttributeBossList->ApplyAttribute(textAttrPointSize);
InterfacePtr<ITextAttrRealNumber>
textAttrLeading(::CreateObject2<ITextAttrRealNumber>(kTextAttrLead
Boss));
ASSERT(textAttrLeading != nil);
if(textAttrLeading==nil) {
  break;
}
textAttrLeading->Set(PMReal(24.0));
charAttributeBossList->ApplyAttribute(textAttrLeading);
InterfacePtr<ITextAttrUnderlineMode>
textAttrUnderlineMode(::CreateObject2<ITextAttrUnderlineMode>(kTex
tAttrUnderlineBoss));
```

```
    ASSERT(textAttrUnderlineMode);
    if (!textAttrUnderlineMode) {
      break;
    }
    textAttrUnderlineMode->SetMode(IDrawingStyle::kUnderlineSingle);
    charAttributeBossList->ApplyAttribute(textAttrUnderlineMode);

    // Create a command to apply the attribute. We are applying character
    // attributes, so we indicate kCharAttrStrandBoss.
    InterfacePtr <ICommand> applyCharAttrCmd(textModel-
    >ApplyCmd(position,
    length,
    charAttributeBossList,
    kCharAttrStrandBoss));
    ASSERT(applyCharAttrCmd);
    if(applyCharAttrCmd == nil) {
      break;
    }

    // Apply the character attributes.
    status = CmdUtils::ProcessCommand(applyCharAttrCmd);
    if (status != kSuccess) {
      ASSERT_FAIL("ITextModel::ApplyCmd failed to apply character
      attributes");
      break;
    }

  } while(false);
  return status;
}
```

Note that this command always assumes ownership of the `AttributeBossList` passed in the `list` parameter that contains the overrides to be applied, so you should always allocate your `AttributeBossList` on the heap. **It is important to apply attributes to the correct strand**: paragraph attributes should be applied to the paragraph attribute strand, and character attributes should be applied to the character attribute strand. For example, it would make no sense to attempt to set the justification of text on the character attribute strand as this is a paragraph attribute. Likewise, it would not be a good idea to set the point size of text on a paragraph strand, as this attribute is a character attribute. Note, although you cannot apply character attribute overrides directly to the paragraph attribute strand, you can do so indirectly be defining a paragraph style with the character attribute override defined, this style is itself applied to the paragraph attribute strand. Text attributes overrides can also be applied using `ITextModel::UserApplyCmd`. A difference between this command and

`ITextModel::ApplyCmd` is that it respects text locking. If the text content is locked (see `ITextLockData`), the method returns nil, if it is not locked the method returns a valid command.

13.5.28. How do I clear text attribute overrides?

To clear text attribute overrides on an arbitrary range of text use `ITextModel::ClearOverridesCmd`. Recall, overrides are local deviations from the style that is applied. See the ClearOverrides method in code snippet SnipTextModel for sample code.

13.5.29. How do I know if a text atribute is a paragraph or a character attribute?

All attributes support the `IAttrReport` interface which has the method `IsParagraphAttribute`. This method returns `kTrue` for paragraph attributes, `kFalse` for character attributes.

13.5.30. How do I create an inline graphic in a text frame?

Insert a `kTextChar_ObjectReplacementCharacter` character into the text model at the index you want the inline to be anchored in the text flow. Then process `kChangeILGCmdBoss` to make the page item into an inline graphic in the text flow. See code snippet SnipTextInsertInline for sample code.

13.5.31. How do I access owned items like inline graphics?

Owned items can be discovered by accessing the owned item strand (`IItemStrand`). See code snippet SnipCountStoryOwnedItems for sample code.

13.5.32. How do I directly manipulate the text model?

`ITextModel` also supplies low level mechanisms that allow you to directly update the text model. ***You should leave these methods alone unless you have a specific need to work at this level.*** The command generation API's provided by ITextModel (e.g. InsertCmd) should suffice for most situations.

Most operations directly support undo-ability by returning the information required to undo the modification. These methods, while not providing the transactional mechanisms to update the text model, maintain the integrity of the individual strands, i.e. all strands are kept in synchronisation with each other.

figure 13.5.32.a. ITextModel methods that manipulate the model directly

```
virtual UndoInfo* DoInsert(TextIndex start, const WideString* data,
const ILanguage *language = nil ) = Ø;
virtual UndeleteInfo* DoDelete( TextIndex start, int32 len) = Ø;
virtual UndeleteInfo* DoDelete( const RangeData& range) = Ø;
virtual UnreplaceInfo* DoReplace(TextIndex start,
 int32 len,
 const WideString *data,
 const ILanguage *language = nil,
 bool16 clearNonContinuingAttrs = kTrue) = Ø;
virtual void DoPaste(TextIndex start, VOSAllSavedData *data,
K2Vector<ICommand*>* cmdList = nil) = Ø;

virtual UndoInfo* DoApplyStyle(TextIndex start, int32 len, UID
styleref, ClassID which, bool16 destroyAll, bool16 getUndoInfo) = Ø;
virtual UndoInfo* DoApplyOverrides(TextIndex start, int32 len, const
AttributeBossList *these, ClassID which, bool16 getUndoInfo) = Ø;
virtual UndoInfo* DoClearOverrides(TextIndex start, int32 length,
const AttributeBossList *these, ClassID which, bool16 getUndoInfo) =
Ø;

virtual void UndoDelete(UndoInfo* undo, TextIndex start, int32 len) =
Ø;
virtual void UndoApply(UndoInfo* undo, TextIndex start, int32 len) =
Ø;
virtual void UndoReplace(UndoInfo* undelIn, TextIndex start, int32
oldLen, int32 newLen) = Ø;
```

13.5.33. How do I find the text foci that apply to a text model?

Figure 13.5.33.a shows how you would navigate from a story to the text foci that apply to the story. Figure 13.5.33.b details code that displays to trace all the text foci associated with a particular story.

figure 13.5.33.a. Navigating from the story to a text focus

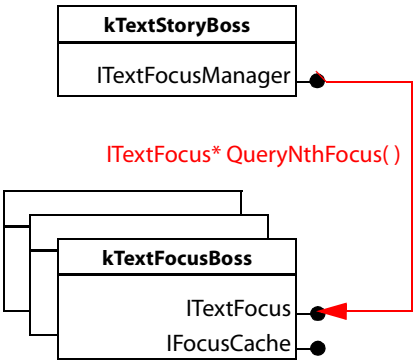


figure 13.5.33.b. Displaying text foci

```
void DumpFoci(ITextFocusManager* forThis)
{
  int32 foc = forThis->GetFocusCount();
  for (int loopCnt=0; loopCnt < numOfFoc; loopCnt++)
  {
    InterfacePtr<ITextFocus> nthFocus(forThis->QueryNthFocus(
      loopCnt));
    int32 start,end;
    nthFocus->GetRange(&start, &end);
    Trace("Text focus %d starts %d ends %d\n",loopCnt,start,end);
  }
}
```

13.5.34. How do I create a text focus?

A text focus can be created using the `ITextFocusManager::NewFocus` method. The lifetime of a text focus is managed by reference counting the ITextFocus interface. Once its reference count becomes 0 it is deleted (if it still exists in the list maintained by the `ITextFocusManager` interface, it is removed before it is deleted).

See the QueryTextFocus method in code snippet SnipTextModel for sample code that shows how to create a text focus that describes the range of characters displayed in a text frame(included below).

figure 13.5.34.a. SnipTextModel::QueryTextFocus

```
/**Return text focus describing the range of characters displayed in the given
frame.
@param textFrame
@return text focus describing the range of characters displayed in the frame.
 */
ITextFocus* SnipTextModel::QueryTextFocus(ITextFrame* textFrame)
{
  ITextFocus* result = nil;
  do {
    ASSERT(textFrame);
    if (!textFrame) {
      break;
    }
    InterfacePtr<ITextModel> textModel(textFrame->QueryTextModel());
    ASSERT(textModel);
    if (!textModel) {
      break;
    }

    // Check if the story contains any characters.
    // Note that when a story is created it has a terminating
    // character and length of 1 characters. We never
    // want to include the terminating character in our focus.
    int32 charactersInPrimaryStoryThread =
      textModel->GetPrimaryStoryThreadSpan();
    // Number of characters in the story including the terminating character
    if (charactersInPrimaryStoryThread <= 1) {
      break; // the story has no significant characters
    }

    // Check if this text frame displays any characters.
    int32 span = textFrame->TextSpan();
    if (span <= 0) {
      break; // the text frame is empty
    }

    // Get the range of characters displayed in the frame.
    TextIndex startIndex = textFrame->TextStart();
    // Index into the text model of the first character in the frame.
    TextIndex finishIndex = startIndex + span;
    // Index into the text model of the last character in the frame.

    // Check if this frame displays the story's terminating character.
```

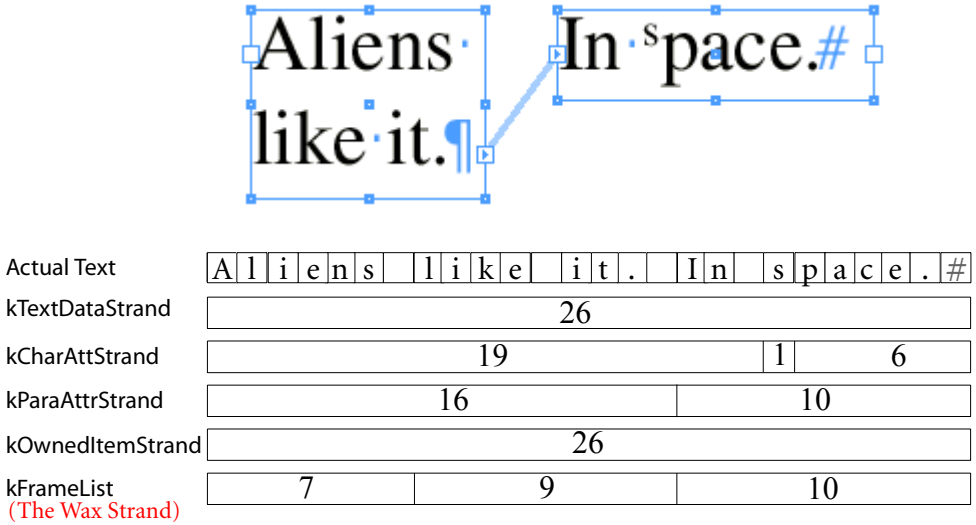
```
    if (finishIndex >= charactersInPrimaryStoryThread) {
      // This frame contains the story's terminating character.
      // Exclude the terminating character from the range of
      // characters described by the text focus being created.
      span--;
      finishIndex--;
    }

    // Don't make a text focus if the frame only displays
    // the story's terminating character.
    if (span <= 0) {
      break;
    }

    // Create a new text focus to describe the range
    // of characters displayed in the text frame...
    InterfacePtr<ITextFocusManager> textFocusManager(textModel,
    UseDefaultIID());
    ASSERT(textFocusManager);
    if (!textFocusManager) {
      break;
    }
    result = textFocusManager->NewFocus(RangeData(startIndex,
    finishIndex, RangeData::kLeanForward), kInvalidClass);
    ASSERT(result != nil);
  } while(false);
  return result;
}
```

13.5.35. How do I access the IStrand runs on each strand?

Consider the text shown in figure 13.5.35.a. Hidden characters and text frame threads are shown for clarity. With this text, what information is held on the individual strands? There are a total number of 26 characters held in this story (all stories have at least one character - a `kTextChar_CR`). There are two paragraphs, and the "s" of the second paragraph is defined to be superscript.

We can use the `IStrand` interface of each strand boss class to examine the constitution of the individual strands. Recall, the strands are broken up into a sequence of **runs**. Runs for each of the strands do not run in parallel, i.e. run lengths are different depending on the strand.

figure 13.5.35.a. IStrand runs in a text model




```
/* See method ReportStrands in code snippet SnipTextModel for sample code. For
figure 13.5.35.a this code yields the results below under the debug build:-
TextModel strands
IStrand runs on ITextModel of TotalLength=26
 strandBossClassID, run, textIndex, runLength
 kFrameListBoss, 0, 0, 7
 kFrameListBoss, 1, 7, 9
 kFrameListBoss, 2, 16, 10
 kParaAttrStrandBoss, 0, 0, 16
 kParaAttrStrandBoss, 1, 16, 10
 kCharAttrStrandBoss, 0, 0, 19
 kCharAttrStrandBoss, 1, 19, 1
 kCharAttrStrandBoss, 2, 20, 6
 kTextDataStrandBoss, 0, 0, 26
 kOwnedItemStrandBoss, 0, 0, 26
 kStoryThreadStrandBoss, 0, 0, 26
 kTextIndexIDListStrandBoss (no runs on IStrand)
 kXMLStrandBoss (no runs on IStrand)
 0x2025 (no runs on IStrand)
 ok
*/
```

As can be seen by the above results, the first thing the code reports is information from the `IStrand` interface on the `kFrameListBoss`. This is detailing the wax strand. The `IStrand` interface on `kFrameListBoss` reports the length of **wax lines**, i.e. the number of characters in each line of composed text.

The `IStrand` interface on `kParaAttrStrandBoss` has a run per paragraph. The length of the run represents the number of characters in the paragraph. Note that the run lengths on the `IAttributeStrand` interface on `kParaAttrStrandBoss` do not run in parallel with its `IStrand` runs. `IAttributeStrand` represents formatting changes and groups paragraphs with the same style and overrides into runs. Overall the strand contains objects that hold a collection a paragraph lengths (`IStrand`) along with a collection of paragraph formatting runs (`IAttributeStrand`). The IAttributeStrand runs are not shown in the diagram above.

The `kCharAttrStrandBoss` holds the run information for sequences of characters. If there are no local character overrides the character attribute strand will contain one run, the length of the story. As we have a character override (the 20th character is set to be superscript), the character attribute strand is split into three runs, the first has no overrides applied, the second has the superscript override, and the third has no overrides.

The `kTextDataStrandBoss` reports that it has all the text in one 26 character block. Larger stories would be split into different runs.

As we have no owned items there is only one run identified by the `kOwnedItemStrandBoss`.

13.5.36. Can I add a custom data interface to kTextStoryBoss?

There are some caveats to be aware of when considering adding custom data interfaces to stories. Although you can directly control the lifespan of a `kTextStoryBoss` object, it is affected by other commands (either directly, or through other user interaction). For example, if two stories are merged (the outport box of a text frame is connected to an inport box of an as-yet unconnected text frame), one of the stories are deleted. This behaviour has serious implications if a custom interface is added to the `kTextStoryBoss` and it is desirable to maintain the information this interface represents. You need to copy your data from the story being deleted to the other story.

13.5.37. Can I get called when stories are created and deleted?

Yes. To be called when a story is created implement a new story signal responder (`IResponder`) boss class. The `ServiceID` is `kNewStorySignalResponderService` and the API provides a default implemention for the required `IK2ServiceProvider(kNewStorySignalRespServiceImpl)`. To be called when a story is deleted implement a delete story responder. The `ServiceID` is `kDeleteStoryRespService` and the API provides a default implemention for the required `IK2ServiceProvider(kDeleteStoryRespServiceImpl)`.

13.5.38. Can I lock a story?

The short answer is "no". The long answer is "kind of" and depends on the application, InCopy or InDesign. Simply stated support for story locking is currently inadequate. Under InCopy most changes (but not all) to a story can be locked out. Under InDesign alone story locking is not really supported.

Interface `ITextLockData` was originally added to `kTextStoryBoss` for InCopy. The methods the interface supports are listed in figure 13.5.38.a.

figure 13.5.38.a. ITextLockData methods

```
virtual void SetInsertLock(bool8 lock) = 0;
virtual bool8 GetInsertLock() = 0;
virtual void SetAttributeLock(bool8 lock) = 0;
virtual bool8 GetAttributeLock() = 0;
```

The InCopyShared plug-in provides a command (`kSetStoryLockStateCmdBoss`) to set the lock state of a list of stories. If InCopyShared is not present you could write your own command. *However we advise you to do this with caution because ITextLockData doesn't lock out as much as you would like. There are gaps in the support for story lock state.* Known gaps include, but are not limited to:

- Changing the text model through `ITextModel` methods other than `ReplaceCmd`, `DeleteCmd`, `UserApplyCmd`, `UserApplyCmdRegularUndo`, `PasteCmd`, `TypeTextCmd`. The methods named will return nil for the command if the story is locked.
- Changing the text model through commands such as `kReplaceTextCmdBoss`, `kDeleteTextCmdBoss`, `kInsertTextCmdBoss`.
- Other plug-ins or scripts that make direct changes to the text model.

For InCopy the gaps have been plugged by adding user interface code to check the story lock state and disable/enable the UI control accordingly. However, this approach is problematic in that some of the controls, like the swatch list, can still apply/change colors in locked stories because no funnel could be found at which the story's lock state could be checked.

Note that the text lock adornment that is added to text frames for locked stories is implemented in the InCopyShared plug-in so you would have to implement your own if you don't have InCopy plug-ins.

13.6. Summary

This chapter described stories (`kTextStoryBoss`), the fundamental abstraction through which text content is accessed and managed. We examined its text model (interface `ITextModel`) that provides services for manipulating the textual content. We discussed the strands used to hold separate components of the text. We discussed the mechanisms used to provide formatting of text through text attributes, `AttributeBossLists` and styles.

After an examination of these key concepts we presented information on the APIs and gave answers to some frequently asked questions.

13.7. Review

You should be able to answer the following questions:

1. Which boss object represents the textual content abstraction? (13.3.2., page 396)
1. What is a story thread? (13.3.8., page 399)
2. What basic element is used to hold a single item of formatting information for text? (13.3.10., page 406)
3. What boss object deals with formatting at a paragraph level? (13.3.8., page 399)
4. What boss object deals with formatting at a character level? (13.3.8., page 399)
5. What is the maximum size of a run on the text strand? (13.3.9., page 403)
6. What attributes are maintained by the root character style? (13.3.13., page 411)
7. Why does an attribute boss not support `IPMPersist`? (13.3.12., page 411)
8. What is the difference between a style and an `AttributeBossList`? (13.3.13., page 411)
9. What is recorded in non-root styles? (13.3.13., page 411)
10. What interface on what boss manages text foci? (13.4.12., page 428)
11. How should you perform updates on the data held on a particular strand? (13.4.3., page 425)

12. When adding an attribute to an AttributeBossList, there is an opportunity to take a copy of the attribute, why? (13.5.26., page 440)
13. Why not directly update the text model through the VOS abstractions? (13.3.19., page 422)

13.8. Exercises

13.8.1. Manipulate the text of a story

Write the code required to reverse the ordering of a story (so "Aliens and Earth" would become "htraE dna sneilA"). Grab the characters in the story by iterating the text using TextIterator. Use ITextModel::ReplaceCmd to change the text in the story.

13.8.2. Manipulate character attributes

Using the `ApplyCmd` method from the `ITextModel` interface to create the command, change all the text in a story to have 8 point text.

14.

Text Layout

14.0. Overview

This chapter describes the visual containers in which text is laid out and displayed in its composed form. It explains how plug-ins can layout text.

14.1. Goals

The questions this section answers are:

1. What is text layout?
2. What is a parcel?
3. What is a text frame?
4. What is a text inset?
5. What is a standoff?
6. What is text on a path?
7. What are the interfaces and commands related to text layout?
8. How can I create and manipulate text frames?

14.2. Section-at-a-glance

"Key concepts" on page 456 explains the architecture involved in the layout and display of text.

"Interfaces" on page 471 describes the bosses and interfaces provided by text layout.

"Frequently asked questions (FAQ)" on page 479 answers often asked questions concerning the layout of text.

table 14.0.a. version history

Rev	Date	Author	Notes
2.0	18-Dec-2002	Seoras Ashby	Update content for InDesign 2.x API
0.3	14-Jul-00	Adrian O'Lenskie Seoras Ashby	Third Draft

"Summary" on page 483 provides a summary of the material covered in this chapter.

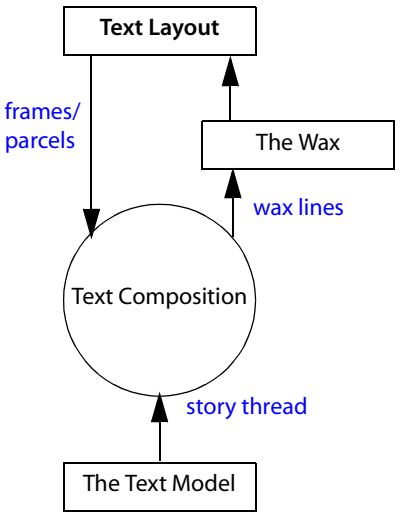
"Review" on page 483 provides questions to test your understanding of the material covered in this chapter.

"Exercises" on page 484 provides suggestions for other tasks you might want to attempt.

14.3. Key concepts

14.3.1. Text layout

figure 14.3.1.a. Text layout



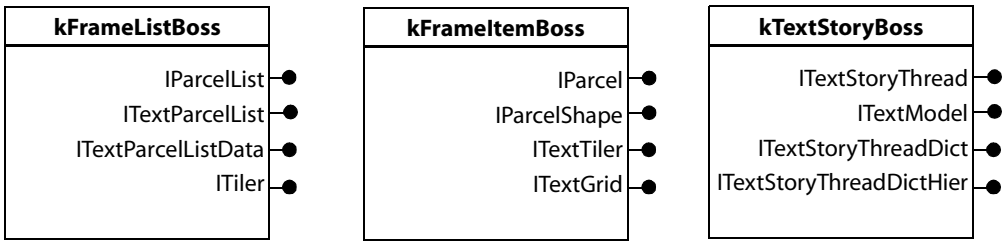
Text layout defines the shape and form of the visual containers in which text is composed and displayed. The text model maintains the character and formatting information for a story. This information is split into one or more story threads that each repesent an independent flow of text content (see "The Text Model" chapter and interface `ITextStoryThread`). Text composition flows text content from the story thread into its visual containers creating wax that fits their layout. Text layout in turn displays the wax. When the layout is updated text must be recomposed to reflect the change. This is depicted in figure 14.3.1.a.

14.3.2. Parcels

The abstraction that represents the visual container for text is the **parcel**(see interface `IParcel`). The text of a story thread (`ITextStoryThread`) is flowed into a list of parcels (`IParcel`) in a parcel list (`IParcelList`) for layout and display. For example a text frame is one kind of parcel and a table cell is another and other new kinds of parcel may be introduced in the future.

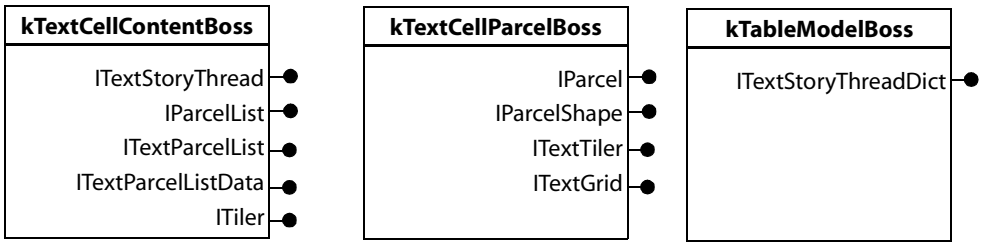
The text for the primary story thread (see "The Text Model" chapter) is displayed through the parcels given by the parcel list (`IParcelList`) on the frame list (`kFrameListBoss`). These parcels are the text frames (`kFrameItemBoss`). The arrangement is illustrated in figure 14.3.2.a:

figure 14.3.2.a. Text layout parcel APIs



The text for the story thread of a table cell (`kTextCellContentBoss`) is displayed through the parcels given by its parcel list. These parcels are table cell parcels (`kTextCellParcelBoss`). The arrangement is illustrated in figure 14.3.2.b. Please read Technical Note #10005 "Essentials for the Table API" for more information on tables:

figure 14.3.2.b. Tables parcel APIs



14.3.3. Text frames

The fundamental abstraction used to layout and display text is the **text frame**. It is a represented by a number of associated page items and to gain an understanding of the items involved we will look at an example.

Figure 14.3.3.b shows an example of a text frame with two columns, an inset and a gutter. Text frames have properties, such as the number of columns, column width and text inset, that control where text flows.

figure 14.3.3.a. Sample text frame

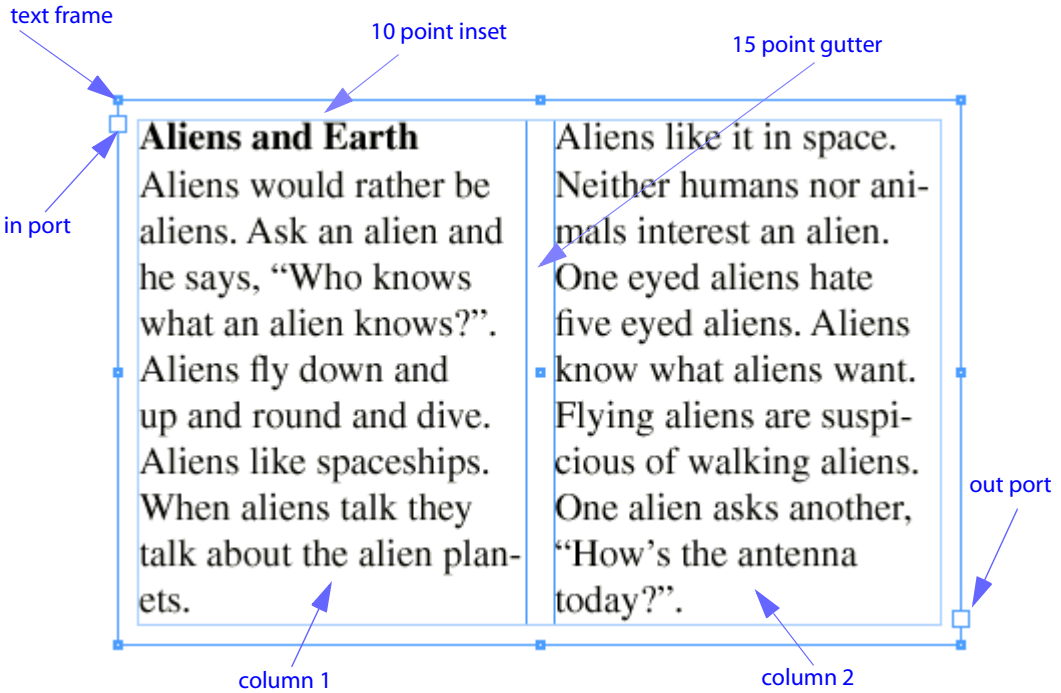
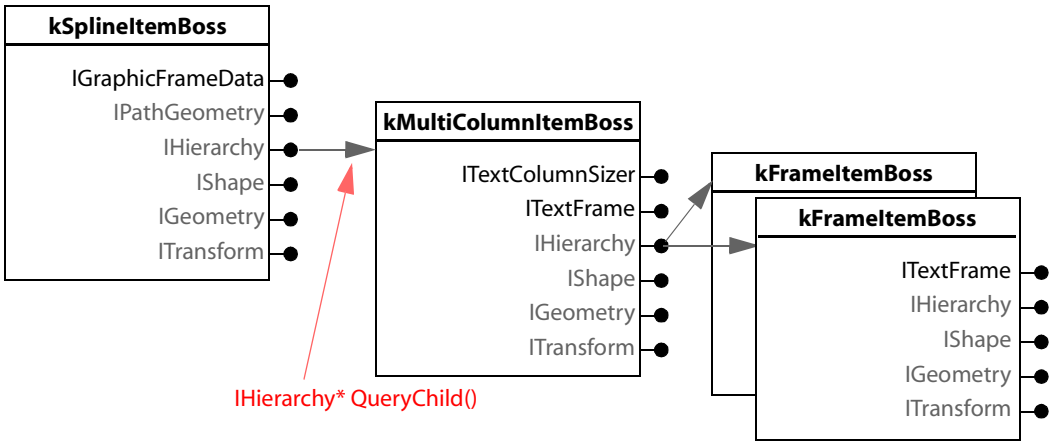


Figure 14.3.3.b annotates the text frame shown in figure 14.3.3.a with the boss classes that represent it internally. The text frame is represented by a hierarchy of page items. The overall frame is a spline item (`kSplineItemBoss`) and the columns within it are controlled by a multicolumn item (`kMultiColumnItemBoss`). Each column is represented by a frame item (`kFrameItemBoss`), the object that displays the text.

figure 14.3.3.b. Sample text frame page item representation

Figure 14.3.3.c shows the interfaces used to navigate from between objects. Interfaces `IHierarchy`, `IShape`, `IGeometry`, `ITransform` , `IPathGeometry` are not specific to the text architecture so they are shown is a different colour.

figure 14.3.3.c. Sample text frame page item relationships



Interface `IGraphicFrameData` is the signature interface that identifies a frame. It provides a helper method, `GetTextContentUID`, that will return the UID of the underlying multicolumn item or `kInvalidUID` if the frame does not have textual content.

The relationship between the frame(`kSplineItemBoss`) and its contents is maintained by the `IHierarchy` interface. You can navigate down from the spline to its associated multicolumn item and then onto individual columns, the frame items, using the `QueryChild()` method on the `IHierarchy` interface. Conversely you can navigate up from a single column (`kFrameItemBoss`) to the multicolumn item and on up to the spline item using the `QueryParent()` method on the `IHierarchy` interface.

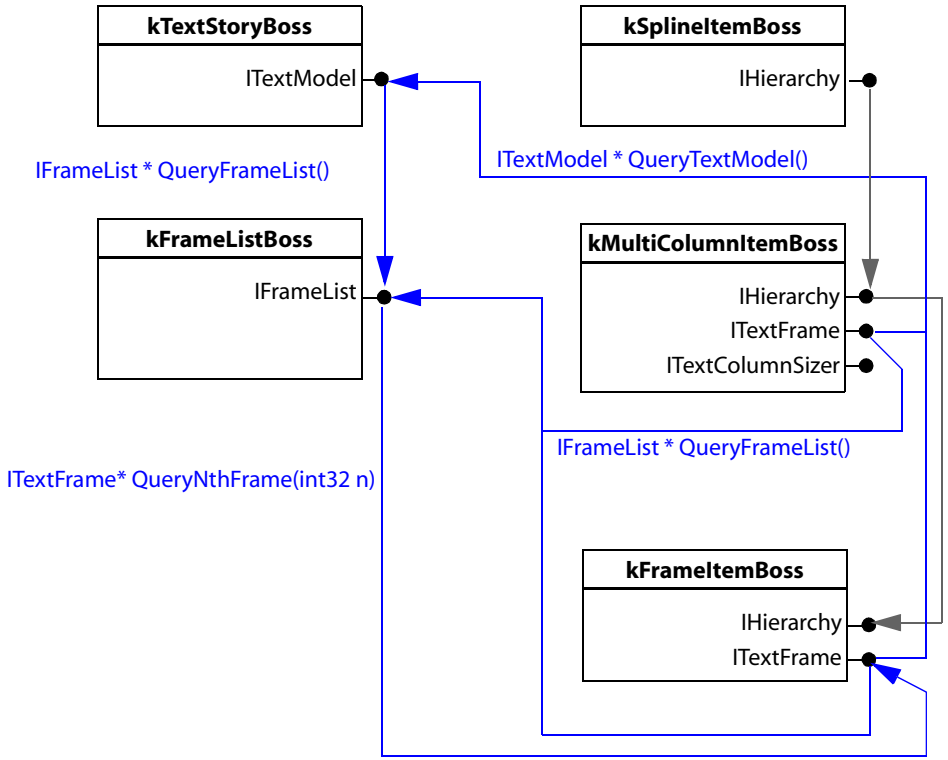
The multicolumn item (`kMultiColumnItemBoss`) is the controller for a text frame. The interface that controls its properties is `ITextColumnSizer`.

The frame item (`kFrameItemBoss`) represents a single column.

Interface `ITextFrame` provides access to the story and the range of text displayed by the item (either the spline in the case of the multicolumn item, or the column in the case of the frame item).

Figure 14.3.3.d shows how you can navigate between the layout and its asociated story. For simplicity many of the navigational paths have been omitted. From the story (`kTextStoryBoss`) you can navigate to the frame list (`kFrameListBoss`). From the frame list you can navigate to each of the associated columns (`kFrameItemBoss`). From either the multicolumn item (`kMultiColumnItemBoss`), or the individual columns (both support different implementations of the `ITextFrame` interface) you can navigate to the framelist or the story.

figure 14.3.3.d. Navigating between the story and its layout



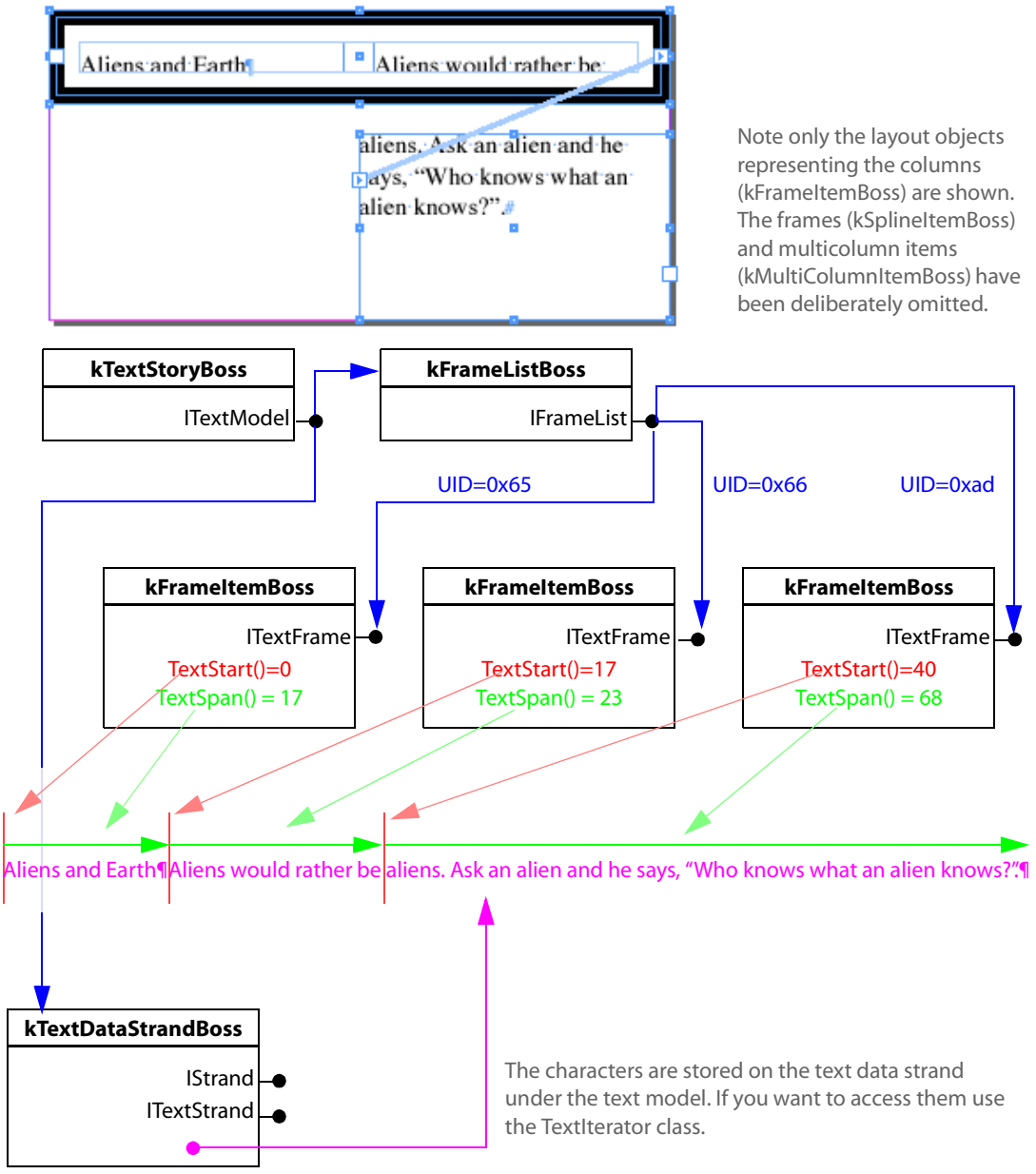
14.3.4. Span

The range of text displayed by a frame or parcel is known as the **span** (sometimes it is called the frame span or text span or thread span). Each object that displays text is associated with a story thread and following composition knows the index into the text model of the first character it displays and the total number of characters it shows. The range of text displayed is available on several different interfaces (`ITextFrame`, `IFrameList`, `ITextParcelList`,

`ITextParcelListData`). Note that these ranges will only be accurate if the text in the object is fully composed. You should check for damage before relying on these methods. If necessary you can force the object to recompose. The "Text Composition" chapter describes how this is done.

For example, say you have a story displayed across two linked frames as shown in figure 14.3.4.a. The first frame contains two columns and the second a single column giving three columns in total. The range of text displayed in each column is illustrated in figure 14.3.4.a.

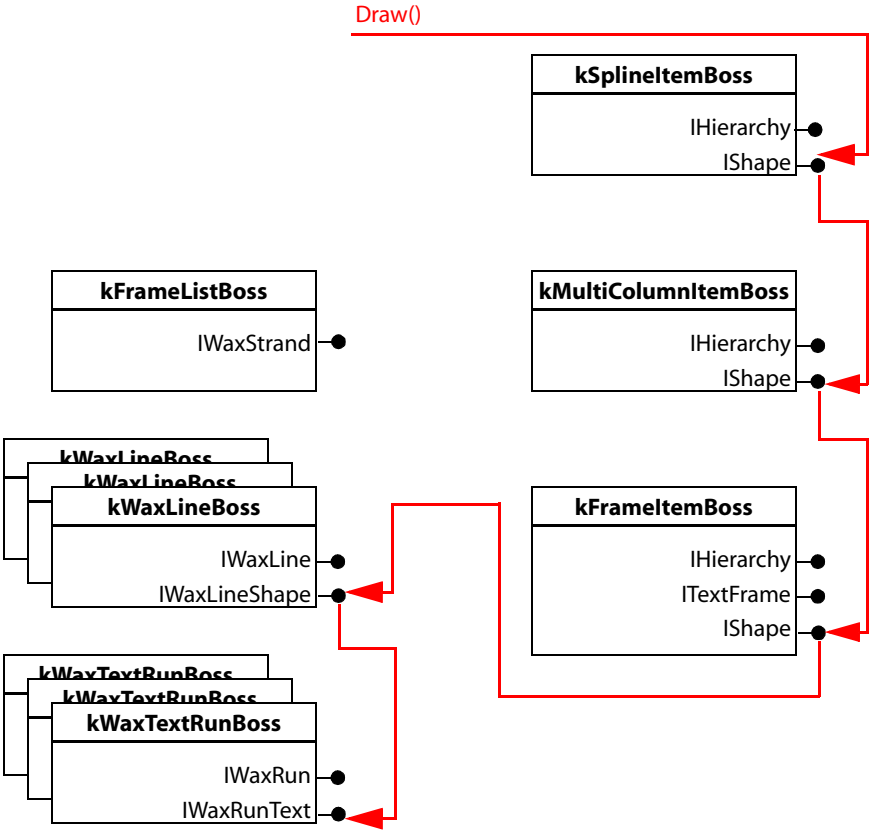
figure 14.3.4.a. Accessing the range of text displayed in a frame via ITextFrame



14.3.5. Text frame drawing

When the spline is asked to draw the interfaces shown in figure 14.3.5.a come into play. The request to draw propogates down the hierarchy to the `kFrameItemBoss` which locates the wax lines it displays using `ITextFrame` and `IWaxStrand` and then requests them to draw. Each wax line requests its wax run to draw (in the general case a wax line could have more than one wax run).

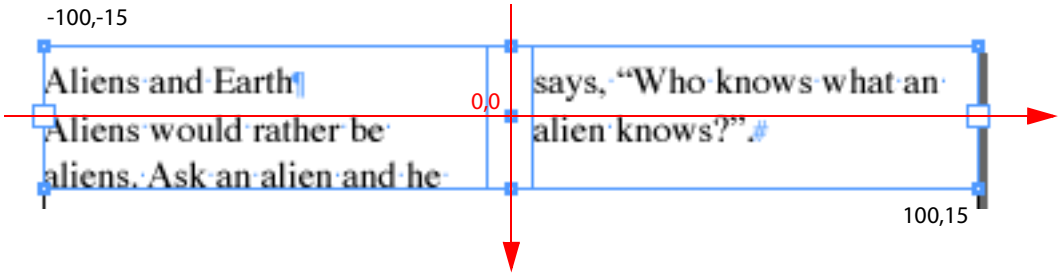
figure 14.3.5.a. Text frame drawing



14.3.6. Text frame geometry

The geometries the page items that make up the text frame shown in figure 14.3.6.a are tabulated in inner co-ordinates of the spline.

figure 14.3.6.a. Text frame geometry



Item	Left	Top	Right	Bottom
`kSplineItemBoss`	-100.00	-15.00	100.00	15.00
`kMultiColumnItemBoss`	-100.00	-15.00	100.00	15.00
`kFrameItemBoss` (left column)	-100.00	-15.00	-5.00	15.00
`kFrameItemBoss` (right column)	5.00	-15.00	100.00	15.00

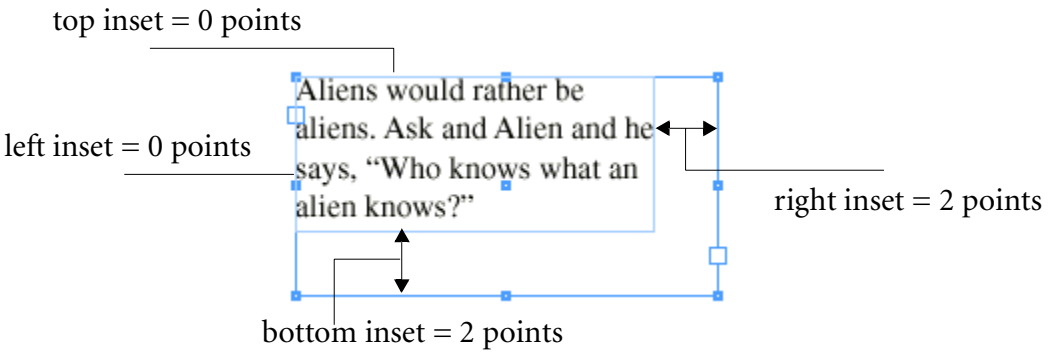
From this table you can see that the geometries of the multi-column and column items are expressed in the co-ordinate space of their parent, the spline. Effectively they share a common co-ordinate space as shown.

14.3.7. Text inset

A **text inset** can be associated with a page item, this is an internal area between the area text flows in and the containing spline. Text inset is represented by the `kTextInsetPageItemBoss` abstraction. Please refer to "Text layout class diagram" on page 471 for a description of the relationships involved.

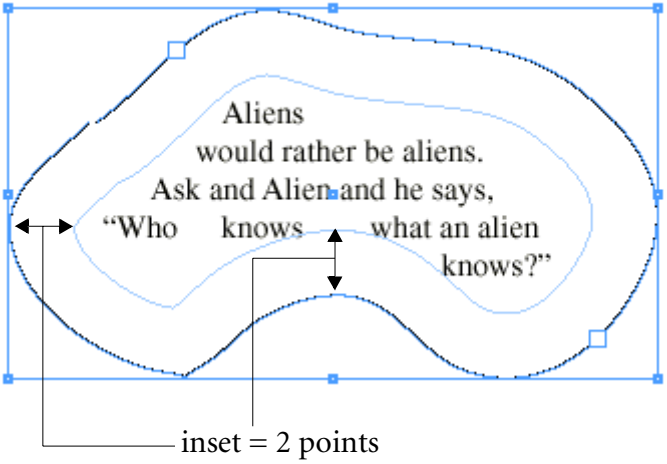
Figure 14.3.7.a shows text frame with a text inset of 2 points set on both the right and bottom sides.

figure 14.3.7.a. A text frame with text inset



If the containing spline is regular in shape you can specify the inset independently for each side of the text frame, however with irregular shapes the inset follows the contour of the spline, i.e. there is only one inset value for the object. This is shown in figure 14.3.7.b.

figure 14.3.7.b. Irregular text frame with inset

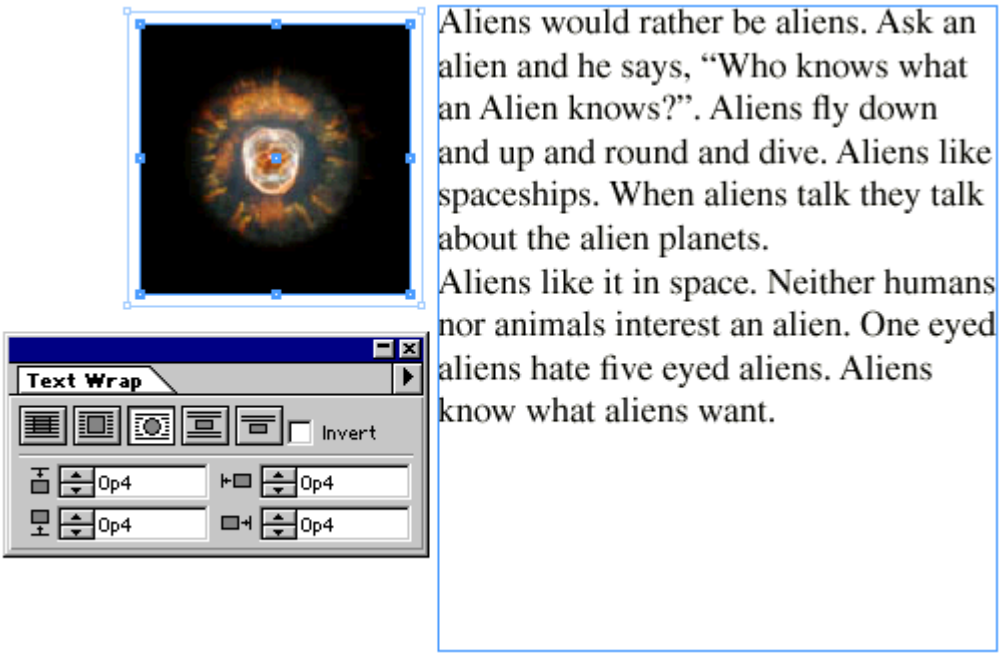


14.3.8. Text wrap

The flow of text in a text frame can be affected by other page items that have text wrap set. Text wrap is represented by the **stand off** abstraction(`kStandOffPageItemBoss`). A stand off describes whether there should be text wrap, and if so, to what degree (i.e. the boundary of the page item that is to repel text). Please refer to "Text layout class diagram" on page 471 for a description of the internal representation.

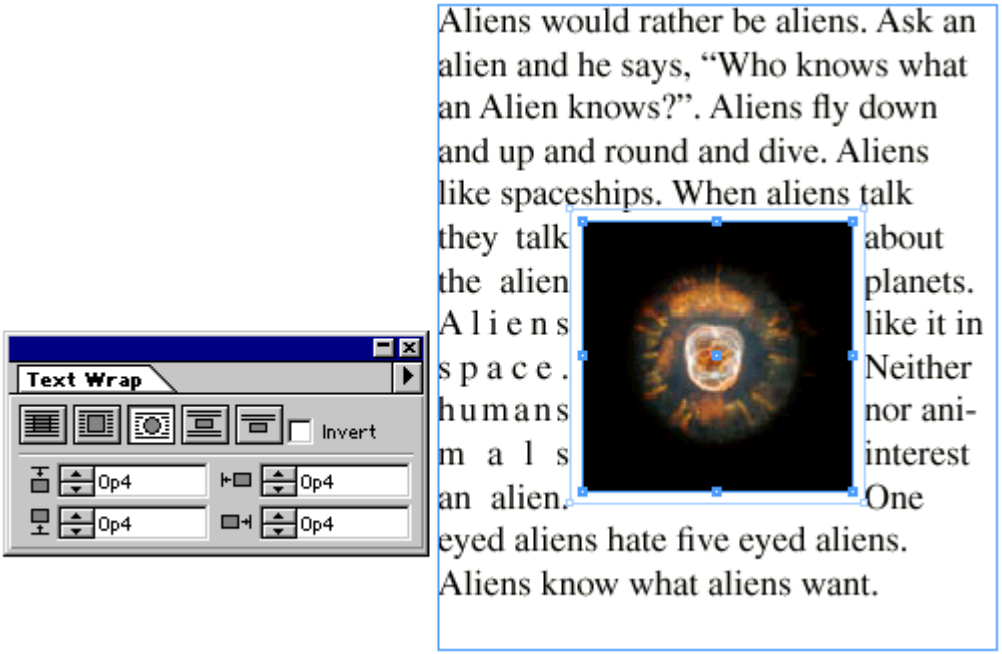
Figure 14.3.8.a shows a spline object with text wrap set to flow outside a 0p4 border around the object. The figure also includes a text frame with some content, however, the image is totally independent from it.

figure 14.3.8.a. A text frame next to a spline with text wrap set



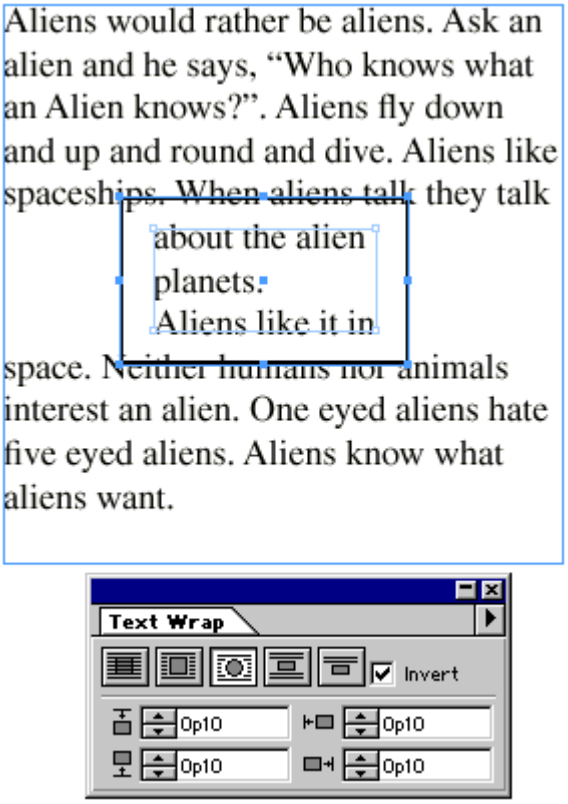
If this spline object overlaps a text frame, the text within that frame is forced to wrap around the object. The spline object is said to *repel* the text. Figure 14.3.8.b shows the same object overlapping a text frame.

figure 14.3.8.b. Text wrap affecting a text frame



By inverting the text wrap, a page item can indicate it is to be used to totally enclose text on the horizontal plane. This is shown in figure 14.3.8.c. We have a simple spline that has inverted text wrap set. Now text flows within the set boundaries.

figure 14.3.8.c. Inverted text wrap

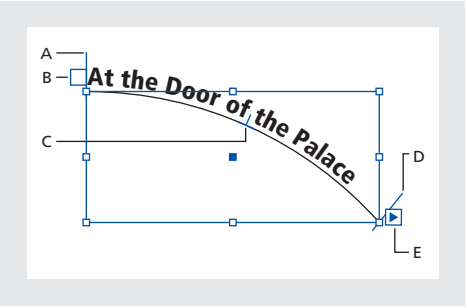


14.3.9. Text on a path

The abstraction that allows text to flow along the edge of any spline (`kSplineItemBoss`) is **text on a path**. The internal representation of this abstraction is described in the "Text layout class diagram" on page 471.

Text on a path has an in port and an out port just like other text frames, so you can link text in other frames to and from it as illustrated in figure 14.4.10.a. .

figure 14.3.9.a. Sample text on a path



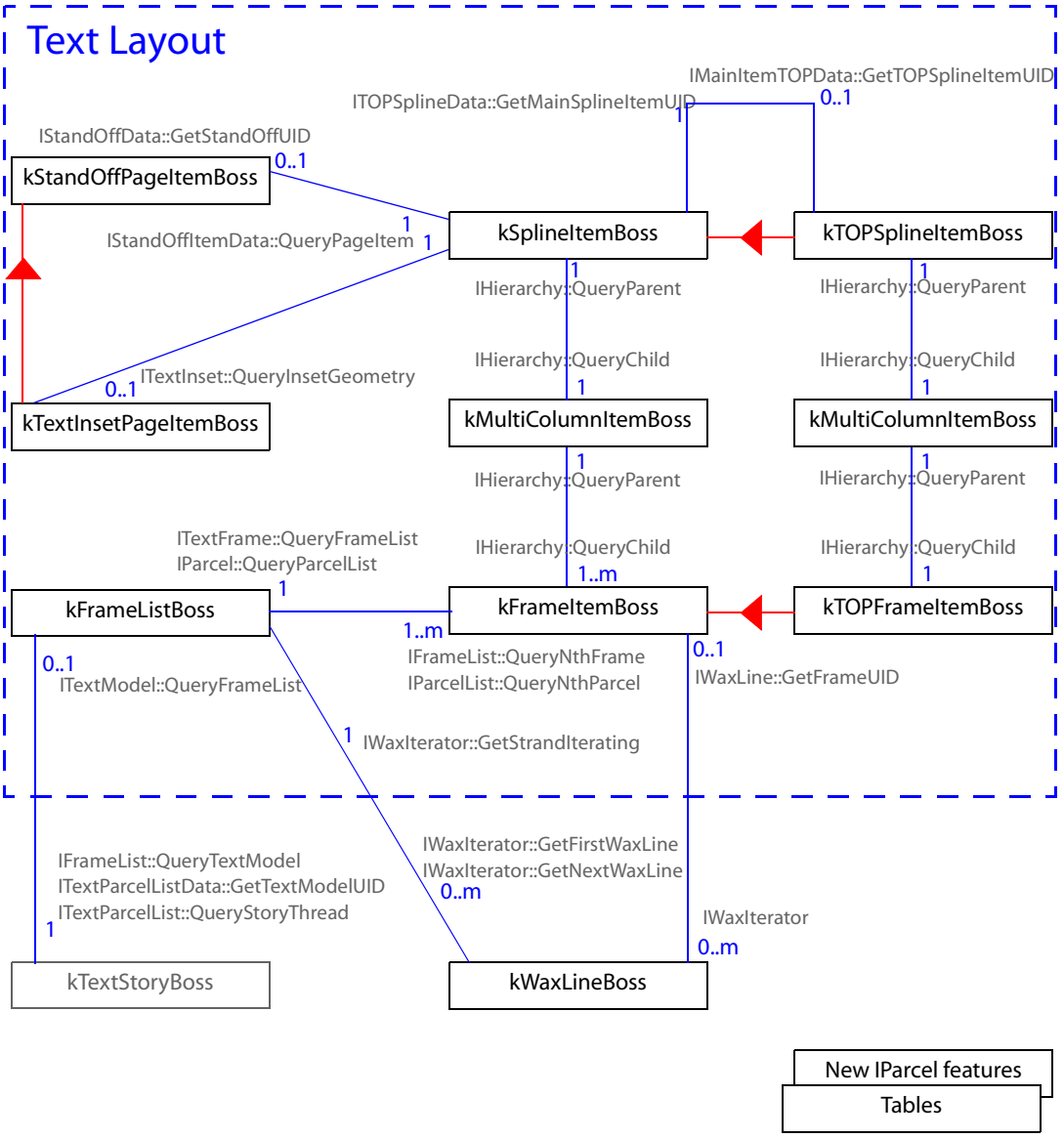
A. Start bracket **B.** In port **C.** Center bracket **D.** End bracket **E.** Out port indicating threaded text

14.4. Interfaces

14.4.1. Class Diagram

Figure 14.4.1.a shows the associations between major objects involved in text layout.

figure 14.4.1.a. Text layout class diagram



A text frame is represented by the hierarchy of page items shown in the centre of figure 14.3.1.a. A spline (`kSplineItemBoss`) can display text if it has an associated multicolumn item. Multicolumn items (`kMultiColumnItemBoss`) are column controllers for text frames, as such they can hold one or more frame items (`kFrameItemBoss`), one frame item for each column. A frame item (`kFrameItemBoss`) is the fundamental visual container for text. The boss class supports the `ITextFrame` interface (as does `kMultiColumnItemBoss`) that describes the range of text displayed. The frame list (`kFrameListBoss`) maps a story onto the set of parcels through which the primary story thread flows.

A spline (`kSplineItemBoss`) can optionally have text on a path associated with it. A spline that has text on a path has a similar hierarchy of page items to that of a normal text frame described above. However these page items lie off to one side of the main hierarchy so you won't find these objects if you navigate the `kSplineItemBoss`'s `IHierarchy` interface. You navigate from the spline to the text on a path spline (`kTOPSplineItemBoss`) using interface `IMainItemTOPData`. You navigate back using interface `ITOPSplineData`. Once you have an interface on the `kTOPSplineItemBoss` you can navigate to the text on a path frame item (`kTOPFrameItemBoss`) that display the text using `IHierarchy`.

A spline (`kSplineItemBoss`) can optionally have a text inset item (`kTextInsetPageItemBoss`), if an inset is applied. A page item (a containing frame or its image content) can optionally have a stand off item(`kStandOffPageItemBoss`) if text wrap is applied. The text inset item and stand off item represent the contour of the inset or stand-off.

The layout of text in tables has not been shown explicitly in figure 14.4.1.a. For more information take a look at figure 14.3.2.b and read Technical Note #10005 "Essentials for the Table API". Note also that in the future new features that support the architecture described in "Parcels" on page 457 may be introduced and used to layout and display text.

14.4.2. IFrameList

`kFrameListBoss` . . . . . `IFrameList`

`IFrameList` lists the frames that display the primary story thread. It provides accessors to determine the associated story, the frames that display its text and the range of characters displayed in each frame. The major methods are shown

in figure 14.4.3.a. To navigate from a story to its frame list use `ITextModel::GetFrameListUID` or `ITextModel::QueryFrameList`.

figure 14.4.2.a. Major IFrameList methods

```
// Access to the story associated with frame list.
virtual UID GetTextModelUID() = 0;
virtual ITextModel * QueryTextModel() = 0;

// Access to the frames in the frame list.
virtual int32 GetFrameIndex(UID frameUID) = 0;
virtual int32 GetFrameCount() = 0;
virtual UID GetNthFrameUID(int32 n) = 0;
virtual ITextFrame * QueryNthFrame(int32 n) = 0;

// Access to the multi-column item associated with the frame list.
virtual UID FindMultColParentFrameUID(const UIDRef& frameRef) = 0;

// Determine whether all frames in the list are fully composed.
// Returns -1 if the entire frame list is fully composed.
virtual int32 GetFirstDamagedFrameIndex() = 0;

// Provide information about the ranges of text shown in a frame.
// Returns the first text index shown in the given frame.
virtual TextIndex GetFrameStart(UID frameUID) = 0;

// Returns the number of characters shown in the given this frame.
// Note this value can be zero (if the frame is too small for any glyphs)
// and for damaged text this value can be negative.
virtual int32 GetFrameSpan(UID frameUID) = 0;

// Returns the frame showing the given text index if leanLeftSide is kFalse.
// Returns the first frame that touches the given text index if leanLeftSide is kTrue.
// If in doubt use leanLeftSide = kFalse, that way you are guaranteed the frame
// returned displays the TextIndex of interest.
// Returns the frame's index in the frame list if frameIndex is not nil.
// Return's nil and a frameIndex of -1 if the textIndex is not displayed in any
// frame.
// NOTE:  This call will cause the text to compose up to the textIndex,
// if it wasn't already composed.
virtual ITextFrame* QueryFrameContaining
(
TextIndex textIndex, int32 *frameIndex,
```

```
bool16 leanLeftSide
) = 0;
```

14.4.3. ITextFrame

```
kMultiColumnItemBoss . . . . . .ITextFrame
kFrameItemBoss . . . . . .ITextFrame
kTOPFrameItemBoss . . . . . .ITextFrame
```

`ITextFrame` provides accessors to determine the text model for the associated story, the frame list for the associated story and the range of characters displayed. Some major methods are shown in figure 14.4.3.a.

figure 14.4.3.a. Major ITextFrame methods

```
// Access to the story the frame is associated with.
virtual UID GetTextModelUID() = 0;
virtual ITextModel * QueryTextModel() = 0;

// Access the frame list the frame is contained in.
virtual UID GetFrameListUID() = 0;
virtual IFrameList * QueryFrameList() = 0;

// Returns the text index of the first character in this frame.
virtual TextIndex TextStart() = 0;

// Returns the number of characters shown in the frame.
// When the frame is fully composed this number may be zero.
// (this could happen when no glyphs would fit in the frame
// perhaps because of large point size text or large indents)
// If the frame is not fully recomposed, in some cases this number
// may be negative.
virtual int32 TextSpan() = 0;
```

14.4.4. IParcelList

```
kFrameListBoss . . . . . IParcelList
kTextCellContentBoss . . . . . IParcelList
```

`IParcelList` manages the parcels associated with a story thread(`ITextStoryThread`). A story thread has a list of parcels associated with it in which the text is composed.

The parcel list on the frame list boss class (kFrameListBoss) manages the parcels that display the primary story thread. The parcels listed by it are those for the text frames (kFrameItemBoss).

The parcel list on a table cell (kTextCellContentBoss) manages the parcels that display the cells story thread.The parcels listed by it are those for the table cell parcels (kTextCellParcelBoss).

14.4.5. IParcel

```
kFrameItemBoss . . . . . . . . . . . . . . . . . . . . . . . . . . . IParcel
kTOPFrameItemBoss . . . . . . . . . . . . . . . . . . . . . . . . . IParcel
kTextCellParcelBoss . . . . . . . . . . . . . . . . . . . . . . . . IParcel
```

A parcel is a container into which the text of a story thread (ITextStoryThread) is flowed for composition and display.

A parcel is associated with zero or one text frame (kFrameItemBoss) as indicated by IParcel::GetFrameUID. If there is no associated text frame then the parcel is overset and is not displayed. For example the parcel on a text frame (kFrameItemBoss) will *always* have an associated text frame, i.e. itself. Parcels for table cells on the other hand may sometimes not be displayed if there is not sufficient room in the text frame. In this case their parcel may not have an associated text frame.

IParcel provides rectangular geometric bounds. For example the bounds for a parcel on a text frame(kFrameItemBoss) give the bounds of the frame (this is the same as the bounds given by its IGeometry interface). The bounds for a table cell parcel give the bounds of the cell.

The boss classes IParcelList and IParcel are aggregated on are not assumed to be UID based.

14.4.6. IParcelShape

```
kFrameItemBoss . . . . . . . . . . . . . . . . . . . . . . . . . IParcelShape
kTOPFrameItemBoss . . . . . . . . . . . . . . . . . . . . . . . . IParcelShape
kTextCellParcelBoss . . . . . . . . . . . . . . . . . . . . . . . IParcelShape
```

Draws and hit tests a parcel.

14.4.7. ITextParcelList

```
kFrameListBoss . . . . . IParcelList
kTextCellContentBoss . . . . . IParcelList
```

Maintains the range of text displayed by parcels in the parcel list once the text has been composed. It gives the text index(`TextIndex`) in the text model of the first character and the number of characters (span) displayed.

14.4.8. ITextParcelListData

```
kFrameListBoss . . . . . IParcelList
kTextCellContentBoss . . . . . IParcelList
```

Maintains various properties associated with parcels in a parcel list.

14.4.9. ITiler

```
kFrameListBoss . . . . . ITiler
kTextCellContentBoss . . . . . ITiler
```

`ITiler` manages the tiles for a parcel list and is used by paragraph composers to determine the areas on a line into which text can flow.

An IParcelList and ITextParcelList must be aggregated on the boss class that aggregates ITiler.

14.4.10. ITextColumnSizer

```
kMultiColumnItemBoss . . . . . ITextColumnSizer
```

`ITextColumnSizer` is the key interface that controls the properties of a multicolumn item (`kMultiColumnItemBoss`). Figure 14.4.10.a shows some of its methods.

figure 14.4.10.a. Major ITextColumnSizer methods

```
// Use command kChangeNumberOfColumnsCmdBoss to mutate.

// Methods for columns and gutters.
virtual void SetNumberOfColumns(int32 columns = 1) = 0;
virtual int32 GetNumberOfColumns() = 0;
virtual PMReal GetGutterWidth() = 0;
virtual void SetGutterWidth(PMReal width) = 0;

// Methods to use if column size is fixed.
virtual void UseFixedColumnSizing(int16 fixedSize = kTrue) = 0;
```

```
virtual int16 IsFixedColumnSizing() = 0;
virtual void SetFixedWidth(const PMReal &width) = 0;
virtual PMReal GetFixedWidth() = 0;

// Information about frame UIDs of column frames.
virtual ITextFrame *QueryTextFrame(const PBPMPoint& pPt) = 0;
virtual void SetFirstTextFrameUID(UID firstUID) = 0;
virtual UID GetFirstTextFrameUID() = 0;
virtual void SetLastTextFrameUID(UID lastUID) = 0;
virtual UID GetLastTextFrameUID() = 0;
virtual int32 GetFirstFrameIndex() = 0;
virtual int32 GetLastFrameIndex() = 0;

// Information about text inset.
virtual PMReal GetInset(WhichInset which) = 0;
```

14.4.11. IGraphicFrameData

`IGraphicFrameData . . . . . kSplineItemBoss`

`IGraphicFrameData` is the signature interface for a frame(`kSplineItemBoss`) in which content can be laid out. It provides a helper method, `GetTextContentUID`, that wraps up the `IHierarchy` calls you need to use to navigate from the spline to its underlying multicolumn item. If this method returns a valid UID then the `kSplineItemBoss` has text content.

14.4.12. ITextInset

`ITextInset . . . . . kSplineItemBoss`

The `ITextInset` interface provides methods for manipulating text inset. Use `kSetTextInsetCmdBoss` to change it. Note that the `ITextInset` interface is aggregated onto all page items so it is important you access the right one, the interface on the containing frame, `kSplineItemBoss`. The interface on the containing frame gets populated with data that describes the text inset. When a text inset exists a text inset page item, `kTextInsetPageItemBoss`, will be associated with the containing frame. The boss classes and interfaces are shown in figure 14.4.12.a and major `ITextInset` major methods are show in figure 14.4.12.b.

figure 14.4.12.a. Boss classes and interfaces that represent text inset

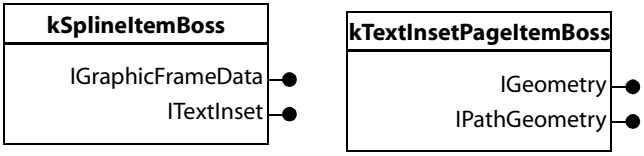


figure 14.4.12.b. Major ITextInset methods

```
// Use kSetTextInsetCmdBoss to mutate.

// Methods that get/set the associated kTextInsetPageItemBoss.
// The inset can be a rect or it can be a path.
virtual void SetInsetGeometry( UID nInsetGeo ) = 0;
virtual IGeometry* QueryInsetGeometry() = 0;
virtual UID GetInsetGeometry() const = 0;

// Methods that get/set the inset.
virtual void SetInset(  PMReal nInset  ) = 0;
virtual PMReal GetInset() const = 0;
virtual bool16 SetRectInset(  const PMRect &insetRect  ) = 0;
virtual const PMRect&GetRectInset() const = 0;
```

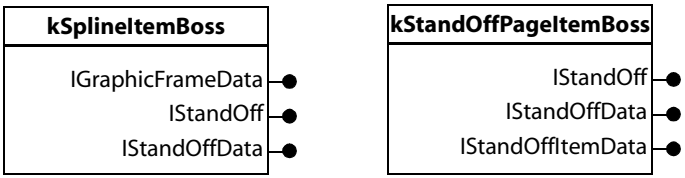
14.4.13. IStandOffData and IStandOff

```
IStandOffData . . . . . kSplineItemBoss
IStandOffData . . . . . other page items
```

The `IStandOffData` interface provides methods for manipulating text wrap. The type of text wrap applied can be obtained from `IStandOffData::GetMode`. The offsets can be obtained from `IStandOffData::GetMargin`.

When a text wrap is applied to a page item a standoff page item, `kStandOffPageItemBoss`, will be associated with it. Frames (`kSplineItemBoss`) and their content (e.g. `kImageItem`) can have their own standoff. *The standoff is not part of the page item hierarchy* (you don't navigate to it via `IHierarchy`). The `kStandOffPageItemBoss` object will be returned if you call `IStandOffData::QueryStandOffGeometry`. It is similar in nature to a spline, it has a path geometry (`IPathGeometry`) that represents the standoff path.

figure 14.4.13.a. Boss classes and interfaces that represent text wrap.



14.5. Frequently asked questions (FAQ)

14.5.1. What is text layout?

See “Text layout” on page 456.

14.5.2. What is a parcel?

See “Parcels” on page 457.

14.5.3. What is a parcel list?

See “Parcels” on page 457.

14.5.4. What is a text frame?

See “Text frames” on page 458.

14.5.5. What is a frame list?

See “IFrameList” on page 472.

14.5.6. What is text inset?

See “Text inset” on page 465.

14.5.7. What is text wrap, what is a stand off?

See “Text wrap” on page 467.

14.5.8. What is text on a path?

See “Text on a path” on page 469.

14.5.9. How do I detect if a page item is a text frame?

Call IPageItemTypeUtils as shown in figure 14.5.9.a.

figure 14.5.9.a. Testing a page item for text content

```
// Returns kTrue if the page item is frame with text content, kFalse otherwise.
```

```
bool16 IsTextFrame(const UIDRef& pageItemUIDRef)
{
  return Utils<IPageItemTypeUtils>()->IsTextFrame(pageItemUIDRef);
}
```

Under the hood the IPageItemTypeUtils::IsTextFrame method navigates the hierarchy (IHierarchy) to determine if the content of the page item is textual. Figure 14.5.9.b shows the code you might write if you wanted to examine the content of the page item yourself.

figure 14.5.9.b. Testing a page item for text content (under the hood)

```
// Returns kTrue if the page item is frame with text content, kFalse otherwise.
bool16 IsTextFrame(const UIDRef& pageItemUIDRef)
{
  // Make sure the page item has associated children (i.e. kMultiColumnItemBoss)
  InterfacePtr<IHierarchy> theItem(pageItemUIDRef, IID_IHIERARCHY);
  int32 numberOfChildren = theItem->GetChildCount();
  if (numberOfChildren < 1) {
    // Page item is not a frame with text content.
    return kFalse;
  }
  // Navigate down the hierarchy to the child object.
  InterfacePtr<IHierarchy> multicolumnitem(theItem->QueryChild(0));
  // The signature interface that identifies a kMultiColumItemBoss is
  // ITextColumnSizer. If the child aggregates this interface the frames
  // content is textual.
  InterfacePtr<ITextColumnSizer> myTextColumnSizer(multicolumnitem,
    UseDefaultIID());
  if (myTextColumnSizer == nil) {
    // Page item is not a frame with text content.
    return kFalse;
  }
  //  If we reach here the page item is a frame with text content.
  return kTrue;
}
```

14.5.10. How do I create a text frame?

Process the `kCreateMultiColumnItemCmdBoss` command. You can control columns and gutters for the frame by populating the command's `IMultiColumnItemData` interface. You can control orientation of the frame by populating `ICreateFrameData`. If you don't populate these data interfaces the text frame options will be picked up from defaults in the workspace. You have

to process other commands after creating the text frame if the option you want to set is not available on `kCreateMultiColumnItemCmdBoss`.

The BasicTextFrame plug-in and the SnipCreateTextFrame code snippet show how create frames for horizontal text. The VerticalTextFrameJ plug-in shows how create a text frame for vertical text.

14.5.11. How do I change the default text frame options?

Text frame options not expicitly stated by your commands will be set to default values picked up from workspace interfaces `IColumnPrefs` and `ITextOptions`. The defaults can be changed by processing `kSetColumnPrefsCmdBoss` and `kSetFramePrefsCmdBoss`.

14.5.12. How do I add and remove columns in a text frame?

Process the `kChangeNumberOfColumnsCmdBoss` command. The code snippets SnipNudgeNumTextCols and SnipCmdChangeNumberOfCols show how it can be used.

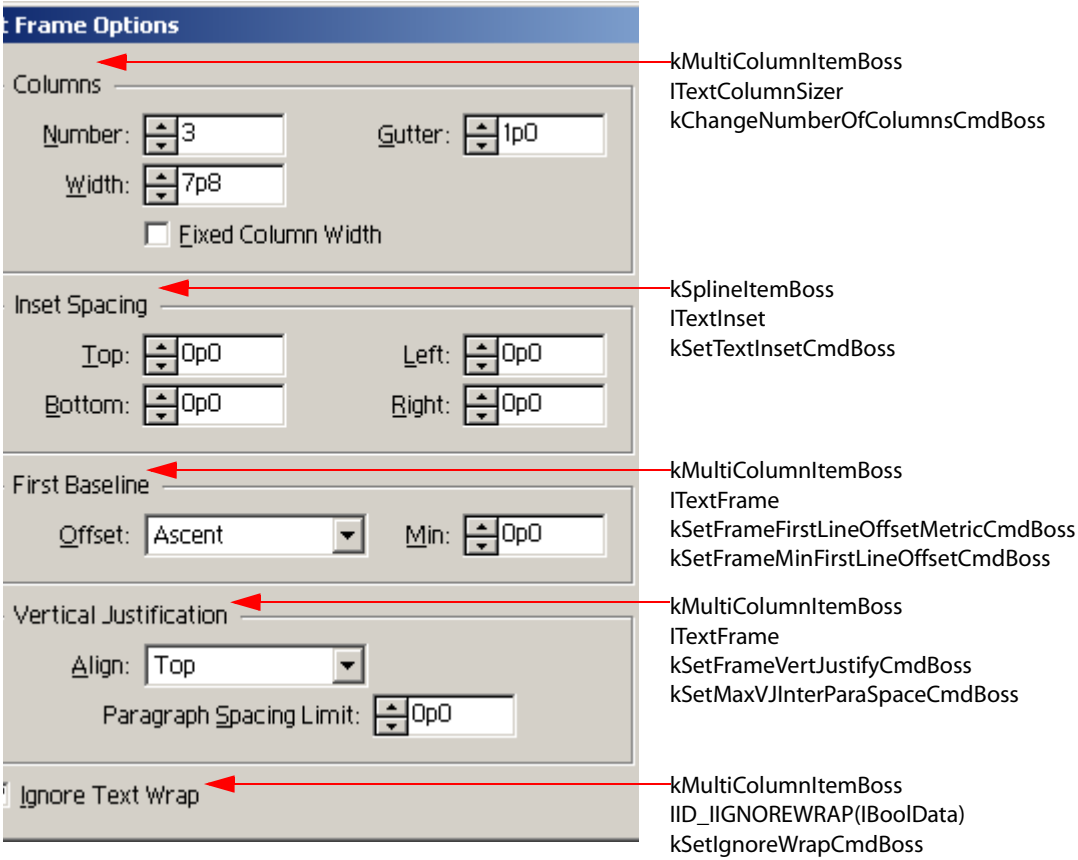
There is no need to specify every option when using this command, for example, it can be used to change the number of columns without referering to the gutter width or fixed column value. Dependencies exist between the properties, for example, if youask for two columns and specify fixed column widths (without setting the value of the column width), the frame width will change to twice its original (plus the gutter width).

Any option not expicitly stated by your command will pick up a default value for the workspace.

14.5.13. How do I modify text frame options?

Figure 14.5.13.a shows the text frame options dialogue and indicates the interfaces that store these options and the commands used to change them.

figure 14.5.13.a. Interfaces that store text frame options and commands that mutate them



14.5.14. How do I link text frames?

Process the `kTextLinkCmdBoss` command. See code snippet SnipTextLinkCmd for sample code.

Note you can link a text on a path frame(`kTOPSplineItemBoss`) by navigating to its `kMultiColumnItemBoss` and passing this item into `kTextLinkCmdBoss`.

14.5.15. How do I find the range of characters displayed by a text frame?

Use the span stored in ITextFrame to figure this out. For the theory on this read “Span” on page 461. See the QueryTextFocus method in code snippet SnipTextModel for sample code that shows how to create a text focus that describes the range of characters displayed in a text frame.

14.5.16. How do I detect when a story is overset?

When the frames that display a story are not large enough to show all of its text, a story is said to be overset. To detect this condition call `ITextUtils::IsOverset`. See code snippet SnipIsStoryOverset for sample code.

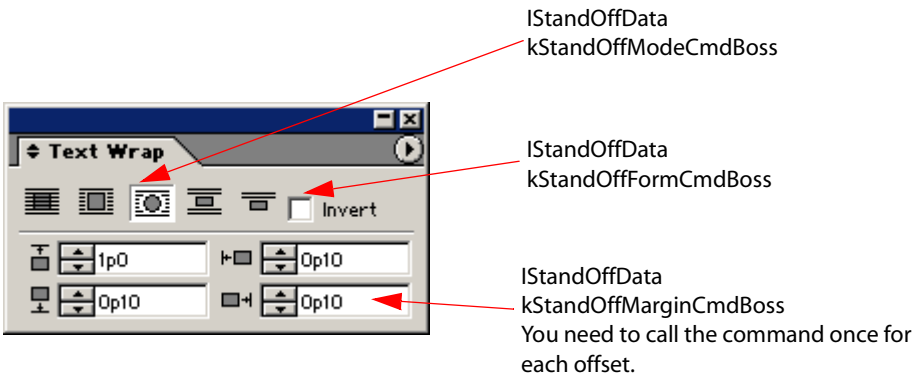
14.5.17. How do I detect when a text frame is overset?

When a text frame is not large enough to display the remaining text of a story it is said to be overset. Under this condition the characters overflow into the next text frame. You can detect if a text frame is overset by checking if the frame displays the final character in the story's primary story thread. See code snippet SnipIsTextFrameOverset for sample code.

14.5.18. How do I manipulate text wrap?

Figure 14.5.18.a shows the text wrap panel and indicates the page item interface that store these options and the commands used to change the text wrap properties. Text wrap can be set for the containing frame (`kSplineItemBoss`) or its content (e.g. `kImageItem`).

figure 14.5.18.a. Interfaces that store text wrap properties and commands that change them



14.6. Summary

This chapter described text layout. The parcel abstraction that represents the core visual container for text was described. The anatomy of a text frame was examined and the boss classes and interfaces involved were described. Finally some practical examples of the use of the text layout API were presented.

14.7. Review

You should be able to answer the following questions:

1. What is text layout? (14.3.1., page 456)
2. What is a text frame? (14.3.3., page 458)
3. Name the three major objects that implement a text frame? (14.3.3., page 458)
4. Which interface stores the properties of a text frame such as the number of columns and the gutter width? (14.4.10., page 476)

14.8. Exercises

14.8.1. Test for a text frame

Test the current selection to see if it contains a valid text frame.

14.8.1. Manipulate Text Frame Options

Extend your solution to the exercise above to set the selected text frame to a single column, variable width frame.

15.

The Wax

15.0. Overview

This chapter describes **the wax** and how your plug-ins can access the information it stores.

15.1. Goals

The questions this chapter answers are:

1. What is the wax?
2. What is the wax strand (`IWaxStrand`)?
3. What is a wax line (`kWaxLineBoss`)?
4. What is a wax run (`kWaxRunBoss`)?
5. How can a plug-in access the wax?

The wax is created by text composition and you may want to know more about how this is done. If so you should read this chapter first and then read the "Text Composition" chapter. You should have a working knowledge of the role and organisation of the wax before you proceed onto text composition.

15.2. Chapter-at-a-glance

"The Wax" on page 486 describes the wax and how it is organised.

"Examples of The Wax" on page 487 illustrates the wax generated by text composition for different scenarios.

table 15.1.a. version history

Rev	Date	Author	Notes
1.1	5-Nov-02	Paul Norton	Adobe InDesign 2.x updates
0.3	14-Jul-00	Seoras Ashby Adrian O'Lenskie	Third Draft
0.2	15-May-00	Seoras Ashby Adrian O'Lenskie	Second Draft
0.1	01-May-00	Seoras Ashby Adrian O'Lenskie	First Draft

"The Wax Interfaces" on page 500 describes the bosses and interfaces provided by the wax.

"Working With The Wax" on page 507 provides some practical examples of code that accesses the wax.

"Summary" on page 510 provides a summary of the material covered in this chapter.

"Review" on page 510 provides questions to test your understanding of the material covered in this chapter.

"Exercises" on page 511 provides suggestions for other tasks you might want to attempt.

15.3. The Wax

The output of text composition is called **the wax**. The wax is responsible for drawing, hit testing, and selecting the text of a story.

The wax metaphor comes from the manual pasteup process that was traditionally used to create magazine and newspaper pages in the days before the advent of interactive pagination software. In the traditional process typeset columns of text, known as galleys, were received from the typesetter, run through a waxer, then cut into sections and positioned on an art board. Wax was used as an adhesive to stick the sections on the art board.

The art board in InDesign is a spread and the galleys can be thought of as text frames. The typeset columns of text can be seen as the wax that is generated by text composition. The wax adheres, or fixes, the position of a line of text within a frame.

The wax is organised as a tree of lines and runs. A **wax line** is created for each line of text in a frame. A **wax run** is created each time the appearance of the text changes within the line. Examples of this are when the point size or font changes or when the flow of text in a line is interrupted because text wrap makes text flow around another frame. (NOTE: The text layout inner coordinate system rotates clockwise by 90 degrees when the text frame is vertical.)

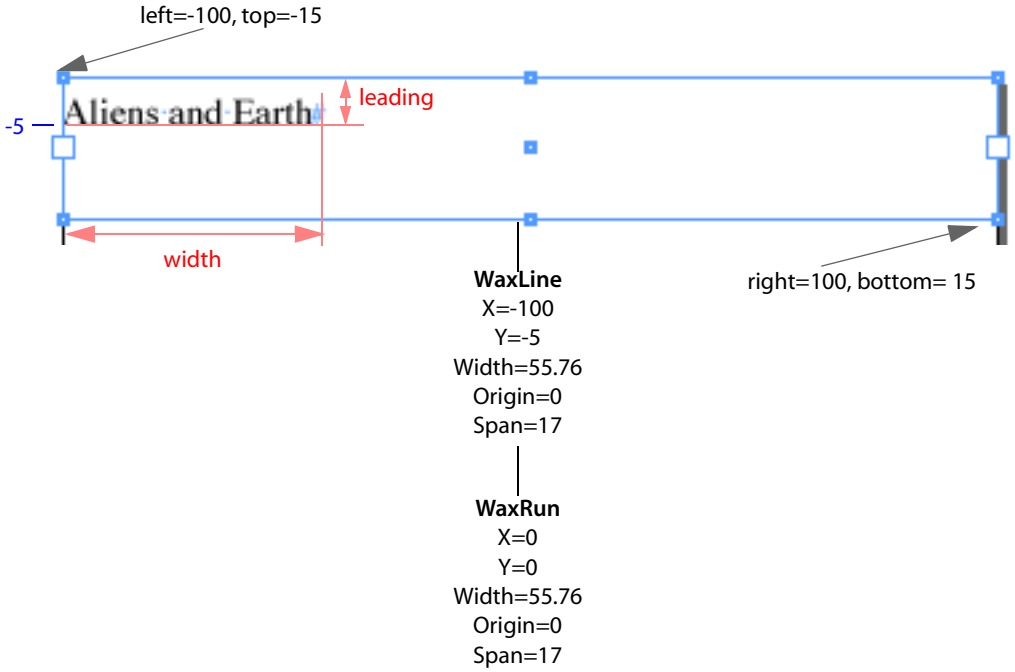
15.4. Examples of The Wax

This section describes the wax that is generated for some example text frames. If you want to re-create these examples you should use the Text Tool to create the frames. If you use another tool, such as the Place Gun or a graphic frame tool, the inner co-ordinate spaces for the frames will be different from those illustrated.To keep things simple, a sample page size 200 points wide and100 points deep is used and the text is formatted using 8 point type, the Times Regular font, and 10 point leading. All text is composed by the Adobe Roman Multi-line composer in a horizontal text frame.

15.4.1. Single Line with no Formatting Changes

The wax generated for a single line text with no formatting changes is shown in figure 15.4.1.a. This example has a frame 200 points wide and 30 points deep, containing one line of 8 point Times Regular text with 10 point leading. The **first baseline offset** setting for the frame has been set to **Leading**. This forces the baseline of the first line of text in the frame to be offset from the top of the frame by a distance equal to the leading value for the text (i.e. 10 points).

figure 15.4.1.a. Wax for a Single Line with No Formatting Changes



Each node in the wax tree records its position, width and a reference to the characters in the text model it describes. The **origin** records the index into the text model to the first character in the node. The **span** records the number of characters in the node.

Wax lines record their position in the inner coordinate space of the frame in which they are displayed (the exact meaning of this will become obvious as we progress through the examples below). Wax runs record their position as an offset relative to the position of the wax line. Additional information is stored specific to the type of node - wax line or wax run.

figure 15.4.1.b. Information Stored in The Wax

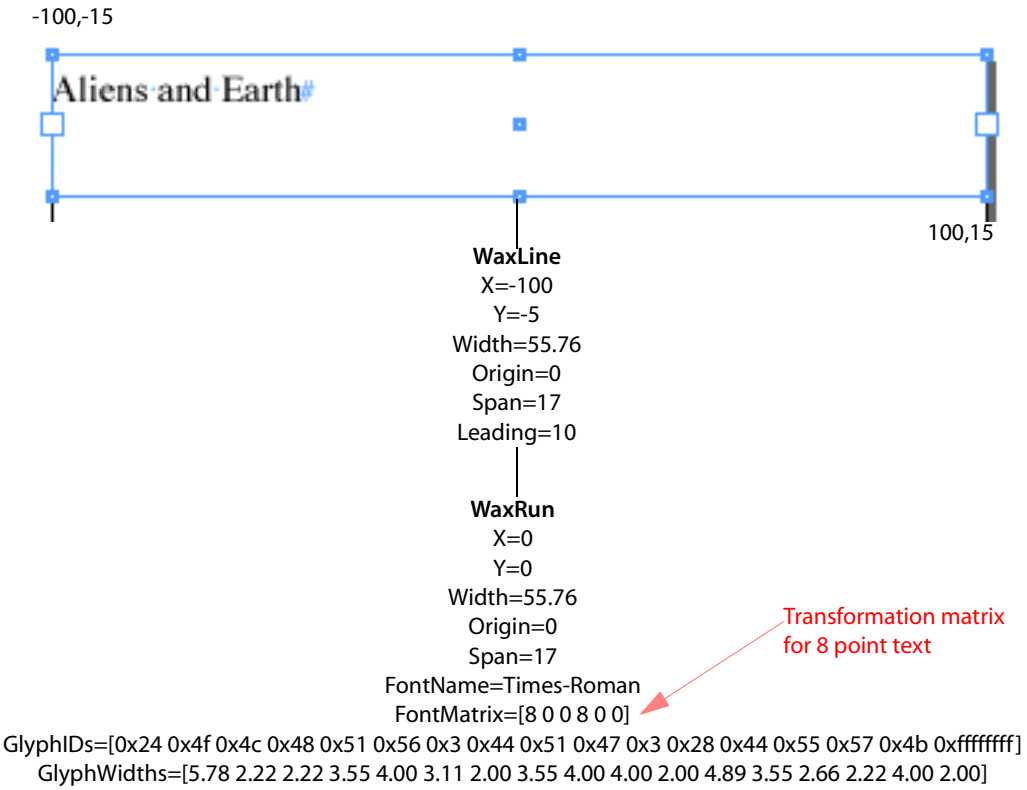


Figure 15.4.1.b exposes *some* of the additional data in the wax. A wax line stores the leading for the line. A wax run stores font name, a font transformation matrix, glyph[1] information and other data necessary to describe how the text should be drawn.

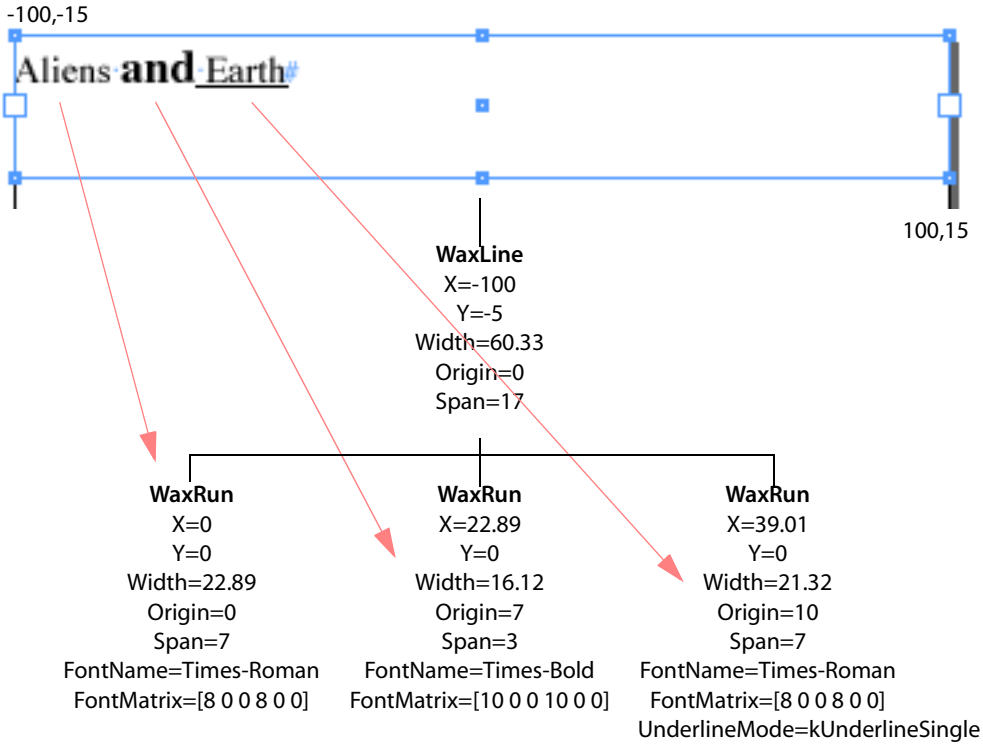
When a character[2] is composed, its character code is mapped to its corresponding `GlyphID` from the font being used to display the character. The font gives the initial width of a glyph at a particular point size. This width may be adjusted by composition to account for letter spacing, word spacing and kerning. The `GlyphIDs` and their widths *after* composition are stored in the wax run as shown in figure 15.4.1.b.

15.4.2. Single Line With Formatting Changes

This example looks at the effect of applying text attributes that change the formatting of the text.

1. The term **glyph** is used to refer to an element of a font.
2. The term **character** denotes a member of an alphabet or a character code (Unicode, ASCII)

figure 15.4.2.a. Wax for Single Line With Formatting Changes

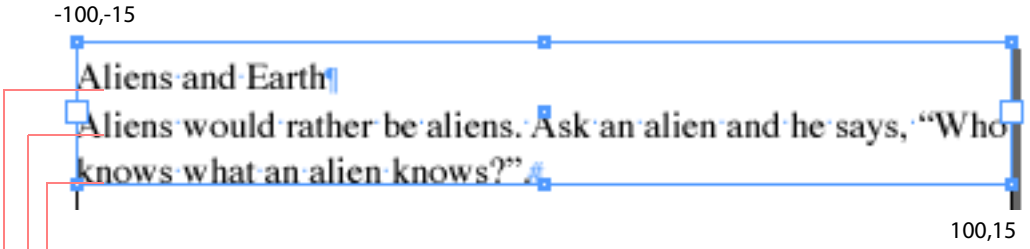


A wax run is created each time the text attributes specify that the appearance of the text should change as illustrated in figure 15.4.2.a. The arrows show the correspondence between the text drawn in the frame and the wax run that describes its appearance and location.

15.4.3. Multiple Lines in a Single Frame

This example looks at how wax lines are organised within a single frame.

figure 15.4.3.a. Wax for Multiple Lines in a Single Frame.



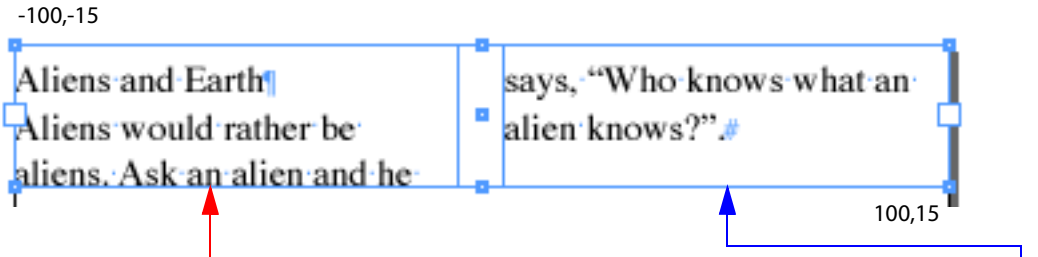
Wax	#	X	Y	Width	Origin	Span	Leading
Line	1	-100.00	-5.00	55.76	0	17	10.00
Run	1	0.00	0.00	55.76	0	17	
Line	2	-100.00	5.00	199.28	17	62	10.00
Run	1	0.00	0.00	199.28	17	62	
Line	3	-100.00	15.00	99.53	79	29	10.00
Run	1	0.00	0.00	99.53	79	29	

Rather than show the wax as a tree the wax information has been flattened into the table shown in figure 15.4.3.a. A wax line is created for each line of text in the frame and each wax line has at least one corresponding wax run. In this case there are no formatting changes so there is one wax run per line. The arrows indicate the wax line that corresponds to each line of text drawn in the frame.

15.4.4. Single Frame with Two Columns

This example shows how wax is organised in a frame with two columns of text. The text frame shown in figure 15.4.4.a is 200 points wide and 30 points deep overall. It has two columns of width 95 points and a 10 point gutter.

figure 15.4.4.a. Wax for a Single Frame With Two Columns



Wax	#	X	Y	Width	Origin	Span	Leading	FrameUID
Line	1	-100.00	-5.00	55.76	0	17	10.00	0x65
Line	2	-100.00	5.00	75.09	17	23	10.00	0x65
Line	3	-100.00	15.00	87.31	40	28	10.00	0x65
Line	1	5.00	-5.00	88.87	68	25	10.00	0x66
Line	2	5.00	5.00	49.54	93	15	10.00	0x66

The wax for a story is managed as a single tree. A flattened representation of some of the wax information is shown as a table in figure 15.4.4.a. The wax lines are associated with the column[1] of text in which they are displayed. Each wax line stores a reference to its column.

1. A column is sometimes described as a frame which can be confusing - the word frame is heavily overloaded.

15.4.5. Text Frame Geometry

Content is laid out on a spread within a frame which is implemented as a `kSplineItemBoss`. A `kSplineItemBoss` that contains text always has a `kMultiColumnItemBoss` and one `kFrameItemBoss` per column of text as children on its hierarchy. This is described in detail in the "Text Layout" chapter.

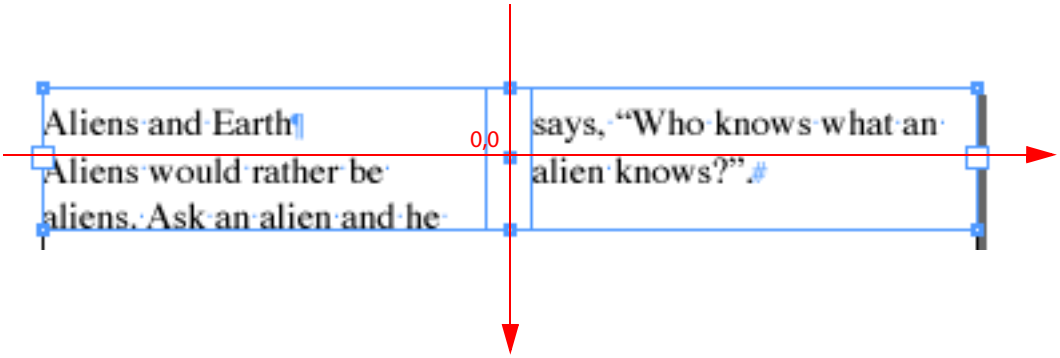
The geometries the page items that make up the text frame shown in figure 15.4.4.a are shown below in inner co-ordinates.

figure 15.4.5.a. Stroke Bounds for Sample Text Frame

Item	Left	Top	Right	Bottom
kSplineItemBoss	-100.00	-15.00	100.00	15.00
kMultiColumnItemBoss	-100.00	-15.00	100.00	15.00
kFrameItemBoss (left column)	-100.00	-15.00	-5.00	15.00
kFrameItemBoss (right column)	5.00	-15.00	100.00	15.00

From figure 15.4.5.a you can see that the geometries of the multi-column and column items are expressed in the co-ordinate space of their parent - the spline. Effectively they share a common co-ordinate space as shown below.

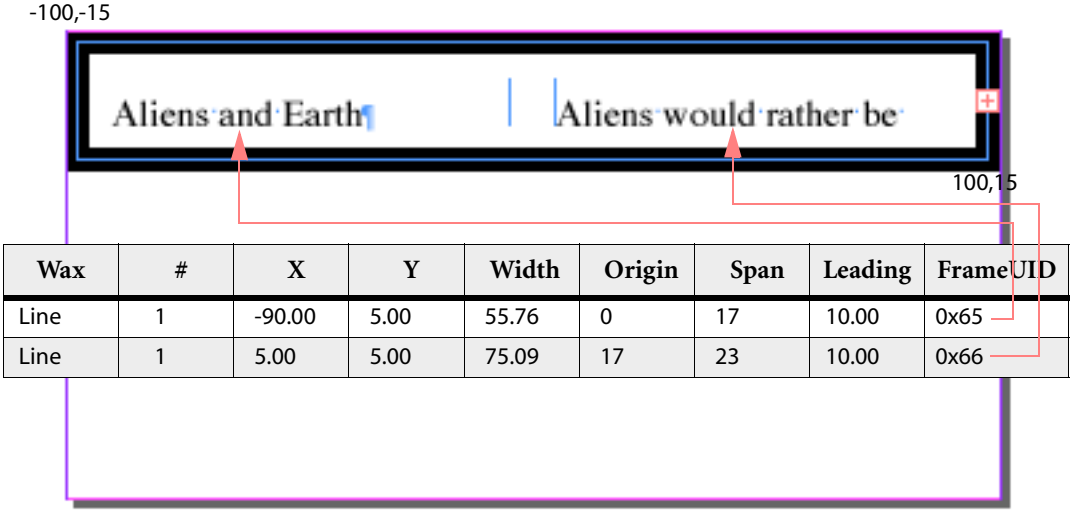
figure 15.4.5.b. Text Frame Geometry



15.4.6. Overset Text

This example examines what happens when the area within a frame is not large enough to display all of the story's text.

figure 15.4.6.a. Overset Story



Wax	#	X	Y	Width	Origin	Span	Leading	FrameUID
Line	1	-90.00	5.00	55.76	0	17	10.00	0x65
Line	1	5.00	5.00	75.09	17	23	10.00	0x66

In the example shown in figure 15.4.6.a the area within the frame where text can flow is reduced by setting the stroke weight of the frame to 5 points and applying a 5 point text inset on all sides. There is now more text in the story than can fit in the frame. Conceptually the story overflows the frames through which it is displayed and the story is said to be **overset**. In the case illustrated the story has an overall length of 108 characters. 40 characters fit in the frame and 68 characters are not displayed.

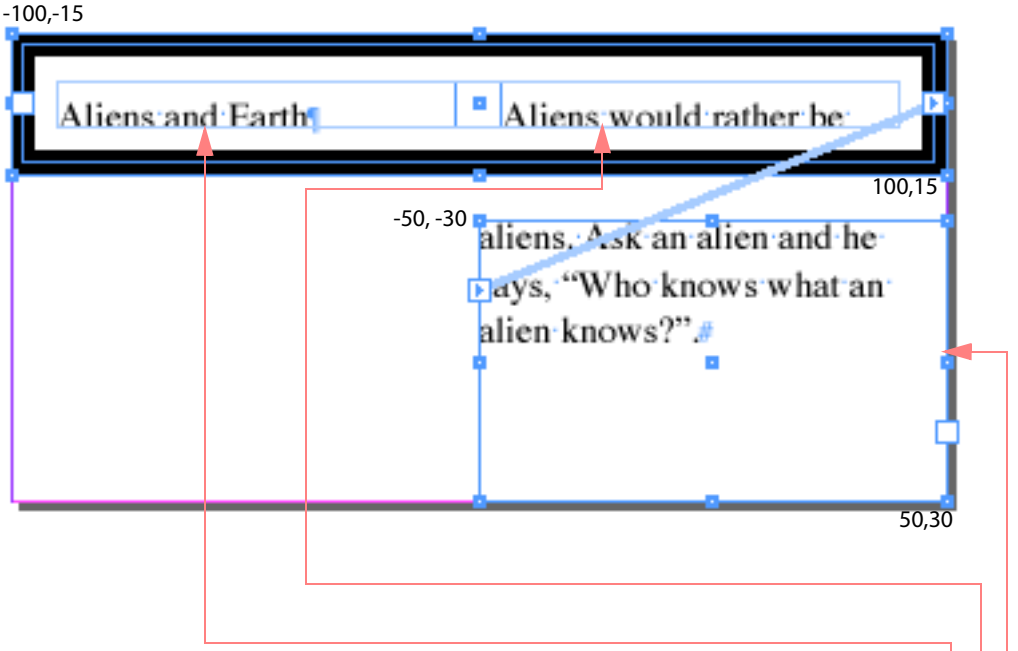
figure 15.4.6.b. The Overset Text

aliens. Ask an alien and he says, "Who knows what an alien knows?".#

15.4.7. A Story Displayed over Two Text Frames

This example describes how wax is organised when a story flows through two text frames. In figure 15.4.7.a a new 100 point wide by 60 point deep frame has been created and linked to the outport of the story shown in figure 15.4.6.a.

figure 15.4.7.a. Wax For A Story Displayed over Two Text Frames



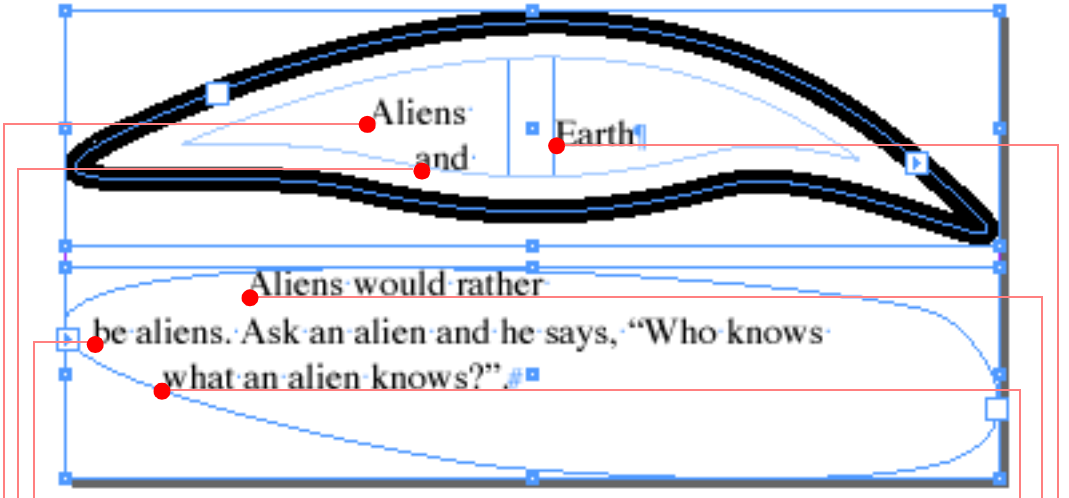
Wax	#	X	Y	Width	Origin	Span	Leading	FrameUID
Line	1	-90.00	5.00	55.76	0	17	10.00	0x65
Line	1	5.00	5.00	75.09	17	23	10.00	0x66
Line	1	-50.00	-24.00	87.31	40	28	10.00	0xad
Line	2	-50.00	-14.00	88.87	68	25	10.00	0xad
Line	3	-50.00	-4.00	49.54	93	15	10.00	0xad

The previously overset text now flows into the new frame and composition creates the new wax. Each wax line refers to its column as shown in figure 15.4.7.a.

15.4.8. Irregular Frame Shape

The shape of the frame also effects where text can flow. Figure 15.4.8.a shows how wax is organised in non-rectangular frames.

figure 15.4.8.a. Wax for an Irregular Frame Shape



Wax	#	X	Y	Width	Origin	Span	Leading	FrameUID
Line	1	-32.00	0.00	22.89	0	7	10.00	0x65
Line	2	-22.00	10.00	13.55	7	4	10.00	0x65
Line	1	7.84	5.00	19.32	11	6	10.00	0x66
Line	1	-111.00	-10.88	65.54	17	20	10.00	0xad
Line	2	-144.00	-0.88	158.63	37	48	10.00	0xad
Line	3	-129.00	9.12	76.64	85	23	10.00	0xad

The text is flowed within the contour of each frame's shape and new wax is generated as shown in figure 15.4.8.a.. The arrows indicate the x, y position of each wax line within its frame.

The inner bounds of the upper and lower text frames are shown in figure 15.4.8.b. The upper frame is 200 points wide and 50 points deep and the lower frame is 200 points wide and 45 points deep. The bounds shown include the object's stroke.

figure 15.4.8.b. Stroke Bounds of Each Frame Shown in Figure 15.4.8.a

Item	Left	Top	Right	Bottom
upper frame	-97.16	-24.00	102.84	26.00
lower frame	-149.94	-16.88	50.06	28.12

15.4.9. Text Wrap

This example looks at the affect of text wrap settings. If a graphic is added to the arrangement shown in “figure 15.4.8.a.” on page 496 the text flows over it as illustrated in figure 15.4.9.a.

figure 15.4.9.a. Text Wrap Off

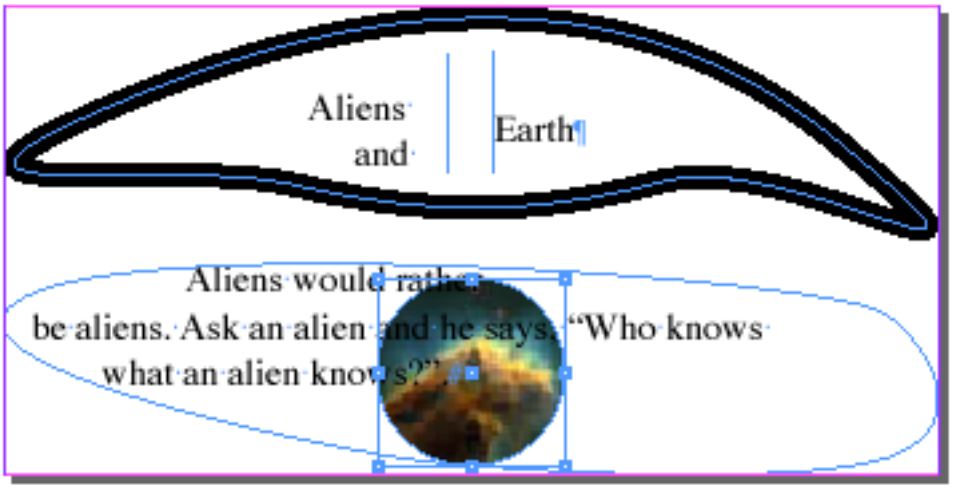
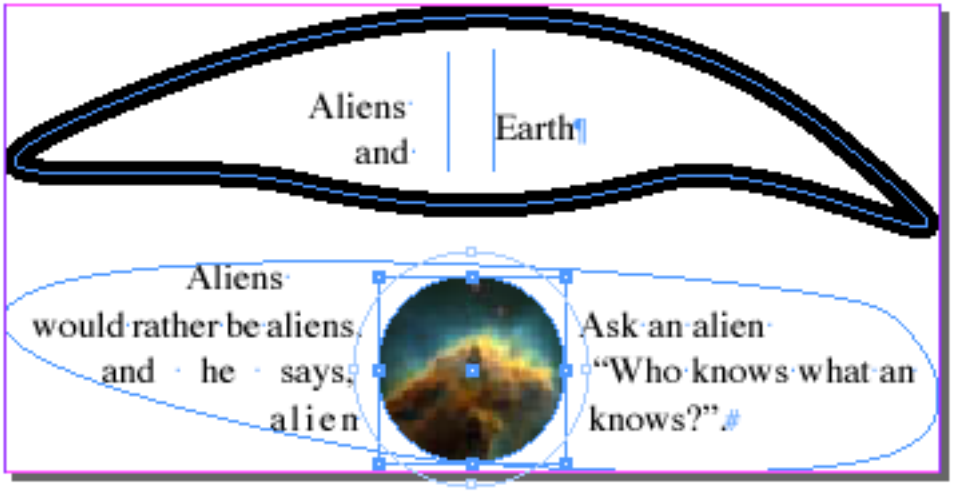
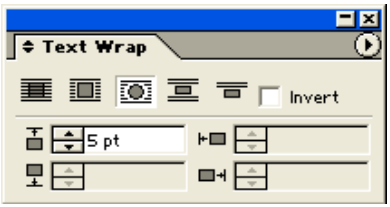


Figure 15.4.9.b shows the effect of turning text wrap on for the graphic frame.. When you apply a text wrap to the graphic frame, the application creates a boundary around the object that repels text and causes the text to flow around it. This boundary is known as a **stand-off** and is discussed in the “Text Layout” chapter.

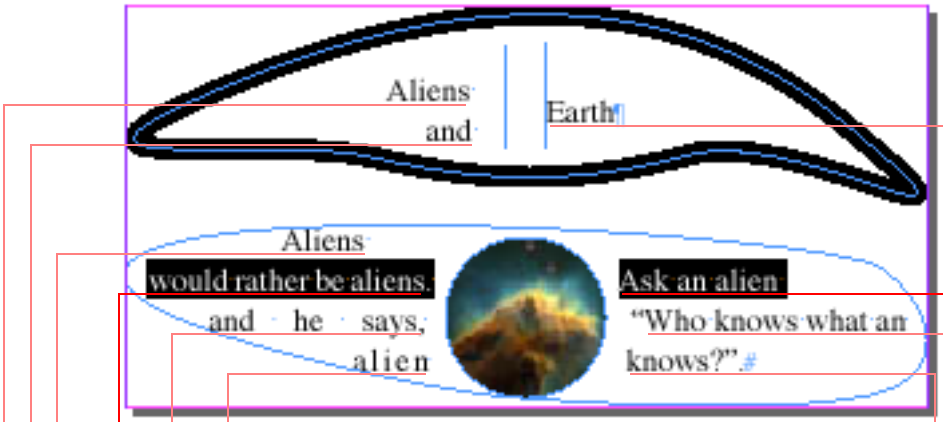
figure 15.4.9.b. Text Wrap On





The wax runs from which the text shown in figure 15.4.9.b was rendered is illustrated in figure 15.4.9.c. The wax line that corresponds to the text selection shown in figure 15.4.9.c is highlighted in the tabulated wax. Notice that the wax line has two wax runs to describe the part of the line that lies to the left and to the right of the text wrap. Wax runs are created when text wrap interrupts the flow of glyphs in a line.

figure 15.4.9.c. Wax for Text Wrap On



Wax	#	X	Y	Width	Origin	Span	Leading	FrameUID
Line	1	-32.00	0.00	22.89	0	7	10.00	0x65
Run	1	0.00	0.00	22.89	0	7		
Line	2	-22.00	10.00	13.55	7	4	10.00	0x65
Run	1	0.00	0.00	13.55	7	4		
Line	1	7.84	5.00	19.32	11	6	10.00	0x66
Run	1	0.00	0.00	19.32	11	6		
Line	1	-111.00	-10.88	22.89	17	7	10.00	0xad
Run	1	0.00	0.00	22.89	17	7		
Line	2	-144.00	-0.88	158.99	24	37	10.00	0xad
Run	1	0.00	0.00	71.00	24	24		
Run	2	117.00	0.00	41.99	48	13		
Line	3	-129.00	9.12	174.00	61	32	10.00	0xad
Run	1	0.00	0.00	54.00	61	13		
Run	2	105.00	0.00	69.00	74	19		
Line	4	-93.00	19.12	99.99	93	15	10.00	0xad
Run	1	0.00	0.00	19.00	93	6		
Run	2	68.00	0.00	31.99	99	9		

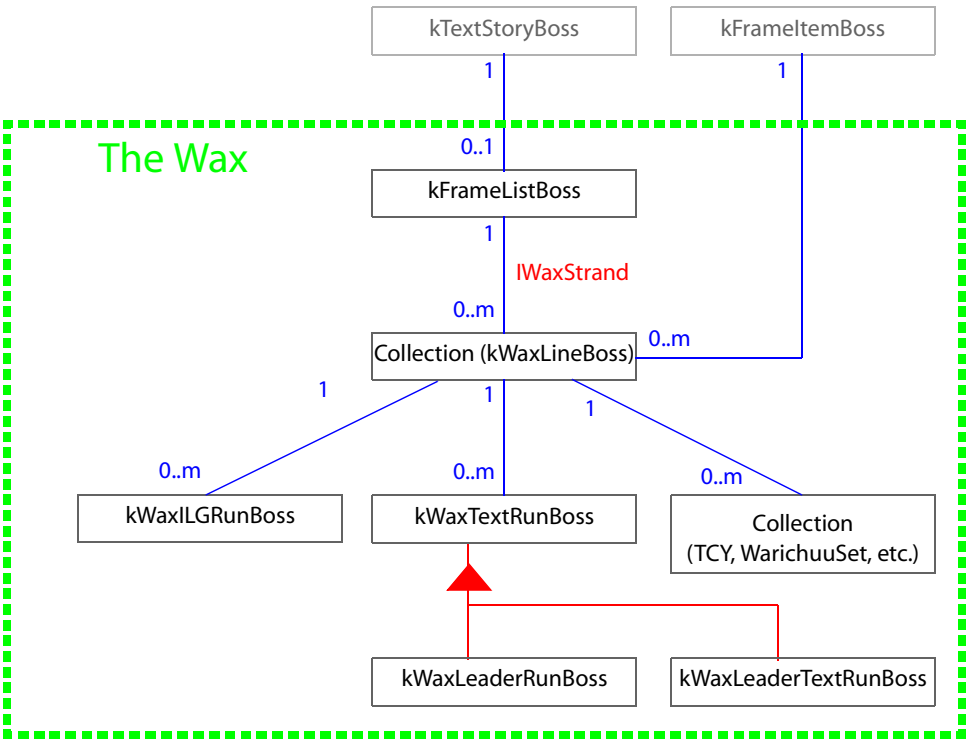
15.5. The Wax Interfaces

This section covers the bosses and interfaces that are used in both constructing (or building) and transversing (also called walking) the wax data. While all the bosses and interfaces in this section are used by the application in building the wax, it's important to note that most solutions will use `IWaxIterator` and `IWaxRunIterator` to do most of the work. `IWaxIterator` and `IWaxRunIterator` are not children of `IPMUnknown`, but helper classes that make walking through the wax easier.

15.5.1. Class Diagram

The bosses related to wax are shown in figure 15.5.1.a.

figure 15.5.1.a. The Wax Class Diagram



`kFrameListBoss` manages the wax for a story. The wax is organised as a hierarchy of collections and leaf runs. The most common case is a series of wax lines each with a collection of wax runs. A wax line is created for each line of text in a frame. A wax run is created each time the appearance of the text

changes within the line. Examples of this are when the point size or font changes or when the flow of text in a line is interrupted because text wrap makes text flow around another frame.

Interface `IWaxStrand` on `kFrameListBoss` owns all of the wax lines for a story and is the root of the wax tree.

`kWaxLineBoss` typically represents the wax for a single line of text. (**Warichuu** is an exception to this, where the Warichuu Set contains multiple lines. All of the lines within the Warichuu set relate to a single `kWaxLineBoss` object.) Each line owns its wax runs, collections of wax runs, or combination of runs and collections of runs. `kWaxLineBoss` provides access to is children through the `IWaxCollection` interface.

Any Boss that supports the `IWaxCollection` interface is a parent, in the wax hierarchy, to boss objects that support the `IWaxRun` interface. A boss can support both the `IWaxCollection` and `IWaxRun` interfaces, creating levels in the hierarchy.

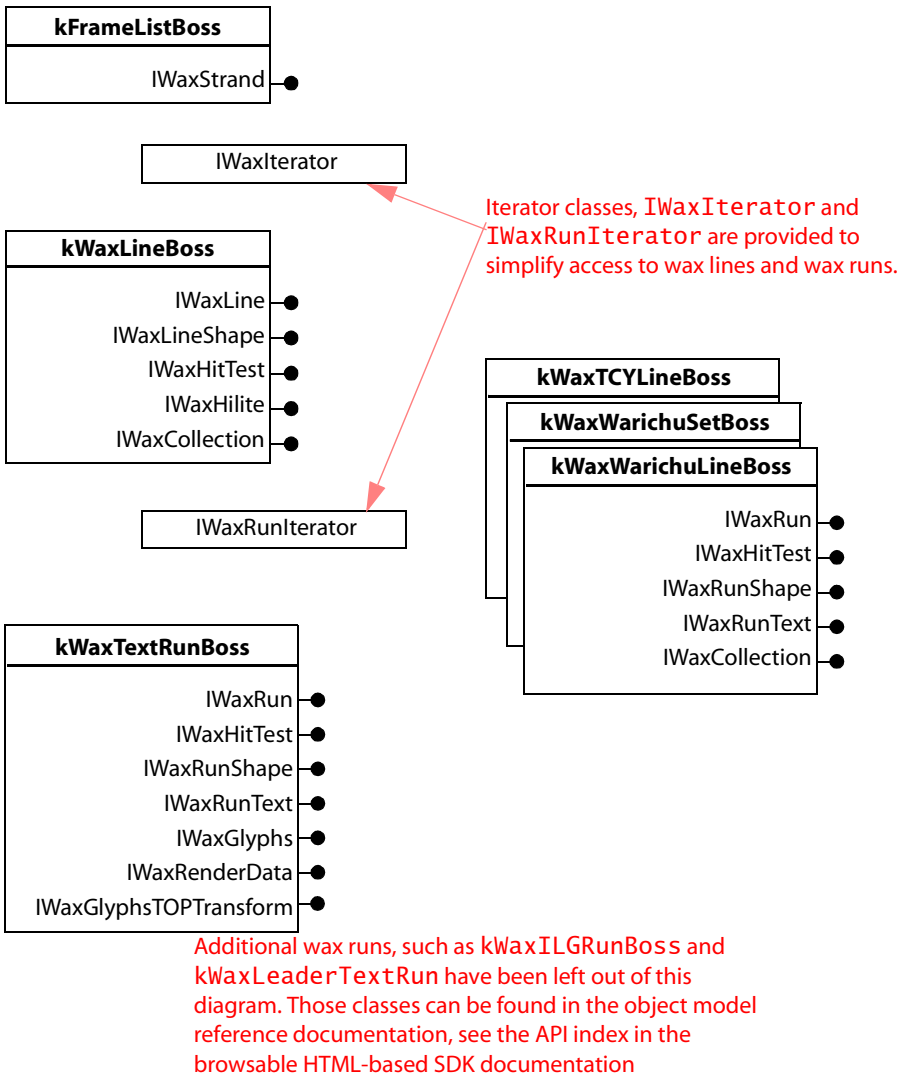
`kWaxTextRunBoss` is the object that represents the wax for ordinary text. It stores the information needed to render the glyphs and provides the interfaces that draw, hit-test and select the text.

`kWaxILGRunBoss` represents the wax for **in-line frames**. In-line frames allow frames to be embedded in the text flow. An in-line frame behaves as if it were a single character of text and moves along with the text flow when the text is recomposed. `kWaxILGRunBoss` provides the drawing, hit testing and selection behaviour for in-line frames.

15.5.2. Interface Diagram

The interfaces related to wax are shown in figure 15.5.1.a.

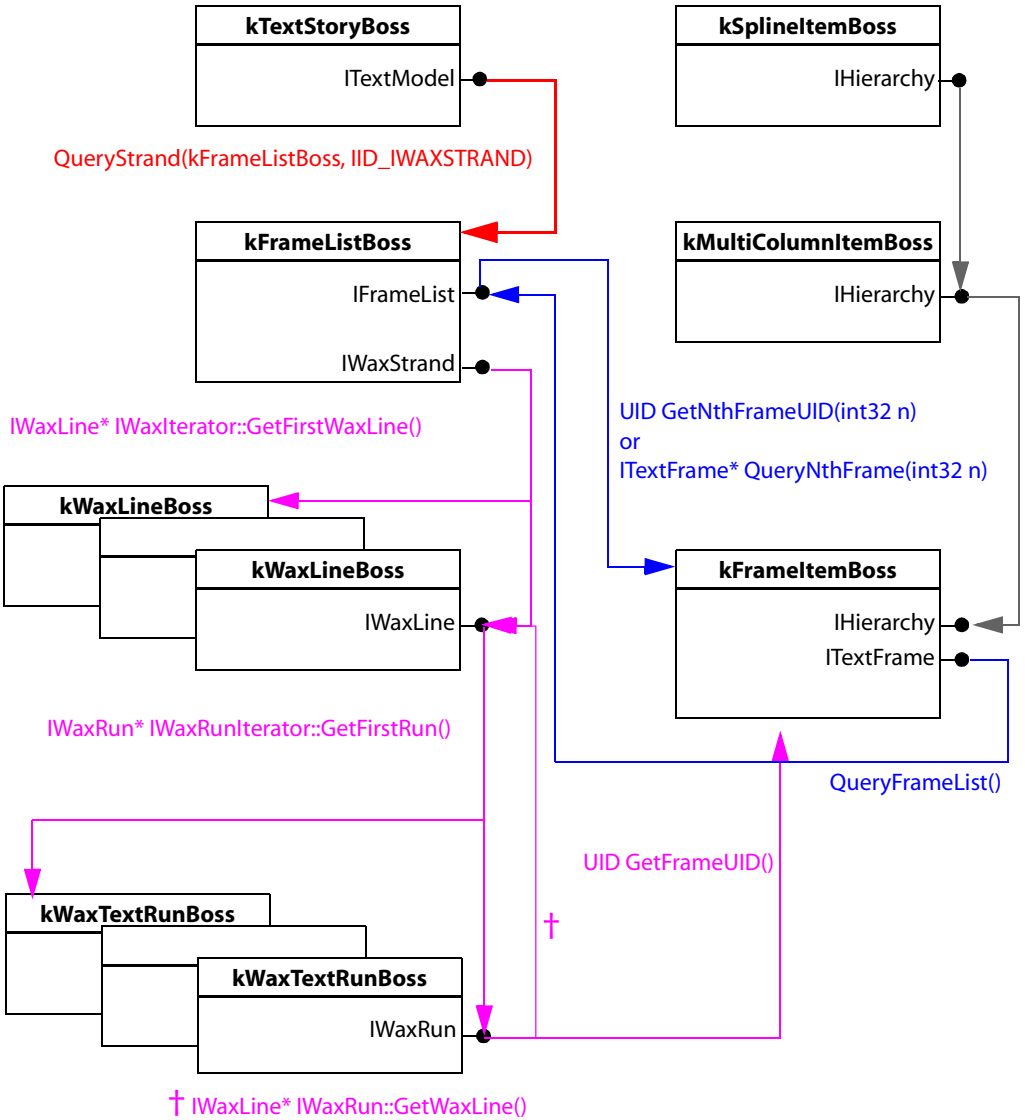
figure 15.5.2.a. The Wax Interface Diagram



15.5.3. Navigation Diagram

The methods used to navigate between a story or a frame and the wax are shown in figure 15.5.d.

figure 15.5.d. Navigating from a Story or a Text Frame to The Wax



IWaxGlyphIterator (from IWaxLine) is an alternative to IWaxRunIterator which walks the glyphs. IWaxGlyphIterator skips runs that don't have glyphs.

Interface IFrameList on kFrameListBoss provides the range of characters displayed in each frame (kFrameItemBoss). Accessor methods on this interface give the index into the text model of the first character displayed along with the total number of characters shown in each frame.Similar accessors are provided on interface ITextFrame. These accessors allow your plug-in to determine the wax lines being displayed by a frame. You can find sample code showing how this is done in "Working With The Wax" on page 507.

15.5.5. IWaxStrand

kFrameListBoss . . . . . IWaxStrand

IWaxStrand owns the wax for a story. A callback interface is provided to allow the wax for a story to be iterated over.

IWaxStrand also implements the core composition engine, known as the **frame composer**, that flows the story's text into frames.

Detailed interface reference for each of the interfaces can be found in the browsable API reference.

15.5.6. IWaxIterator

heap allocated C++ object . . . . . IWaxIterator

IWaxIterator wraps up the raw callback based iterator exposed by IWaxStrand giving a simple class that can be used to iterate wax lines. Note that IWaxIterator does not derive from IPMUnknown. It is allocated on the heap so the caller is responsible for deleting the object once it is no longer required.

Sample code showing how to use IWaxIterator can be found in "Iterating the Wax for a Story" on page 507. IWaxIterator method documentation can be found in the browsable API documentation (at *{SDK}\documentation\webdocs\iw\IWaxIterator.h*)

15.5.7. IWaxLine

kWaxLineBoss . . . . . IWaxLine

IWaxLine manages the hierarchy for the line. It references the frame that displays the line, the origin and span of the text model characters displayed and provides methods to add and remove wax runs. It also stores the position of the line and many other properties such as leading.

15.5.8. IWaxLineShape/IWaxRunText

```
kWaxLineBoss . . . . . . . . . . . . . . . . . . . . . . . . IWaxLineShape
kWaxTextRunBoss . . . . . . . . . . . . . . . . . . . . . . . IWaxRunText
kWaxILGRunBoss . . . . . . . . . . . . . . . . . . . . . . . . IWaxRunText
```

`IWaxLineShape and IWaxRunText` draw wax lines and runs respectively and store the **ink bounds** of the object. The ink bounds is a rectangle within which the object draws its contents.

The implementation of `IWaxLineShape` on a wax line requests each of its wax runs, its children if you like, to draw their wax. `IWaxLineShape` also provides methods for the accessing the text adornments that are attached to the wax (see the "Adding Text Attributes and Adornments" chapter).

15.5.9. IWaxHitTest

```
kWaxLineBoss . . . . . . . . . . . . . . . . . . . . . . . . IWaxHitTest
kWaxTextRunBoss . . . . . . . . . . . . . . . . . . . . . . . IWaxHitTest
kWaxILGRunBoss . . . . . . . . . . . . . . . . . . . . . . . . IWaxHitTest
```

`IWaxHitTest` provides methods for hit testing the wax. Each boss listed above provides an implementation to hit test data of its own particular kind i.e. a line, a run of normal text or an in-line frame.

Hit testing of the wax involves the translation of a point in the inner co-ordinate space of a frame into the index[1] of the closest glyph within a wax line or run. If the point cannot be found one of the constants shown in figure 15.5.9.a will be returned.

figure 15.5.9.a. IWaxHitTest::HitTest()Return Values

```
enum {kHitBefore=-1, kHitToTheRight=0x7FFFFFFE, kHitBelow=0x7FFFFFFF};
```

Hit testing text in general involves the translation of a point in user interface space to a unique `TextIndex` in the text model. A related interface, `ITextFrame::HitTest()`, wraps up the hit testing of wax within a frame and in most cases removes the need to call `IWaxHitTest` directly.

1. Note that this is not a `TextIndex` into the text model. It's the index of a glyph within the wax line or run.

15.5.10. IWaxLineHilite

```
kWaxLineBoss . . . . . . . . . . . . . . . . . . . . . . . . IWaxLineHilite
```

`IWaxLineHilite provides methods that hilite the wax.`

Hiliting in general involves drawing a text selection on a range of text indicated by the `TextIndex` of the first character wanted and the number of characters to be selected. A related interface, `ITextFrame::DrawHilite()`, wraps up highlighting of characters within a frame and in many cases removes the need to call `IWaxHilite` directly.

15.5.11. IWaxRun

```
{Leaf Runs}
kWaxTextRunBoss . . . . . . . . . . . . . . . . . . . . . . . . IWaxRun
kWaxILGRunBoss . . . . . . . . . . . . . . . . . . . . . . . . . IWaxRun
kWaxAnchorRunBoss . . . . . . . . . . . . . . . . . . . . . . . IWaxRun
{Collections}
kWaxWarichuSetBoss . . . . . . . . . . . . . . . . . . . . . . . IWaxRun
kWaxWarichuLineBoss . . . . . . . . . . . . . . . . . . . . . . IWaxRun
kWaxTCYLineBoss . . . . . . . . . . . . . . . . . . . . . . . . IWaxRun
```

`IWaxRun` represents a node in the wax heirarcy. The node will represent a run of similarly formatted text (a leaf run) or a group of such runs (a collection).

`IWaxRun` manages a reference to the collection that owns the run (a reference to its parent) and maintains the `TextIndex` of the first character in the wax run. The position of the run stored as an offset relative to the position of the parent wax line.

15.5.12. IWaxRenderData

```
kWaxRunBoss . . . . . . . . . . . . . . . . . . . . . . . . IWaxRenderData
```

`IWaxRenderData` stores properties that control the appearance of the glyphs in the run. Paragraph composers use the drawing style, `IDrawingStyle::FillOutRenderData(IWaxRenderData * data)`, to populate this interface with information. This is described in the "Text Composition" chapter.

15.5.13. IWaxGlyphs

```
kWaxRunBoss . . . . . . . . . . . . . . . . . . . . . . . . . IWaxGlyphs
kWaxILGRunBoss . . . . . . . . . . . . . . . . . . . . . . . . IWaxGlyphs
```

The following method is not implemented for character glyphs (only ILG glyphs have a reasonable response to this query) :

```
PMRect GetStrokeBoundingBox(const PMMatrix *pMatrix=nil) const=0;
```

`IWaxGlyphs` stores the identifier (`GlyphID`) and width of each glyph in the run and maintains the number of characters, or span, held by the run.

15.6. Working With The Wax

This section provides practical examples of how to program using the wax API.

15.6.1. Iterating the Wax for a Story

The sample code in figure 15.6.1.a iterates over each wax line and returns the sum total of the leading for all the lines of text in a story.

figure 15.6.1.a. Iterating the Wax for a Story

```
static PMReal GetTotalLeading(ITextModel* textModel)
{
  PMReal totalLeading = 0.0;
  do
  {
    InterfacePtr<IWaxStrand> waxStrand (((IWaxStrand*)
      textModel->QueryStrand(kFrameListBoss, IID_IWAXSTRAND)));
    if (waxStrand == nil)
      break;
    InterfacePtr<IFrameList> frameList(waxStrand, UseDefaultIID());
    if (frameList == nil)
      break;
    const int32 kNoDamage = -1;
    if (frameList->GetFirstDamagedFrameIndex() != kNoDamage)
      break;
    K2::scoped_ptr<IWaxIterator> waxIterator = waxStrand-
    >NewWaxIterator();
    if (waxIterator == nil)
      break;
    TextIndex start = 0;
    IWaxLine* waxLine = waxIterator->GetFirstWaxLine(start);
    while (waxLine != nil)
    {
        totalLeading += waxLine->GetTOFLineHeight();
        waxLine = waxIterator->GetNextWaxLine();
    }
  } while (false);
  return totalLeading;
}
```

Note how the code checks that the wax is not damaged before using the data. Since all the wax lines for the story are being scanned `IFrameList` is used to check that there are no damaged frames. You can find more information about damage in the "Text Composition" chapter.

`K2::scoped_ptr` is used to make sure the `IWaxIterator` is deleted automatically when it goes out of scope.

You must keep your `IWaxIterator` in scope to keep an `IWaxLine` interface pointer valid. The code sample shown in figure 15.6.1.b does *not* work.

figure 15.6.1.b. Common error caused when IWaxIterator is not kept in scope

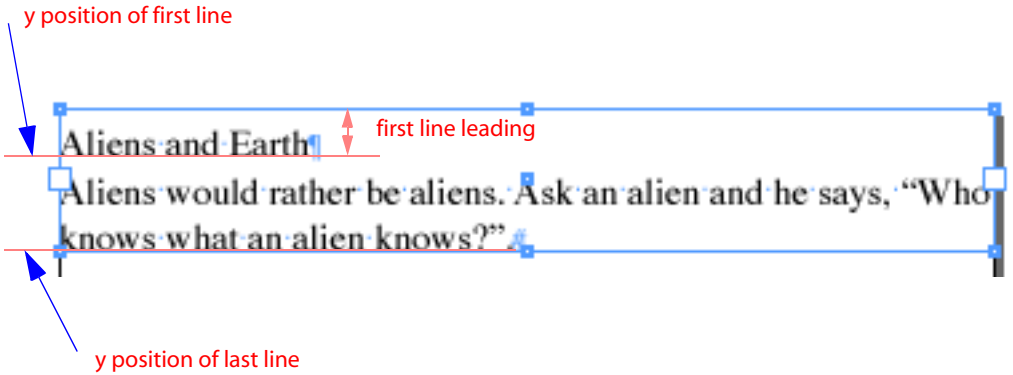
```
static IWaxLine* QueryWaxLineContaining
(
  IWaxStrand* waxStrand,
  const TextIndex& textIndex
)
{
  IWaxLine* line = nil;
  do
  {
    K2::scoped_ptr<IWaxIterator> waxIterator =
      waxStrand->NewWaxIterator();
    if (waxIterator == nil)
      break;
    IWaxLine* waxLine = waxIterator->GetFirstWaxLine(textIndex);
    if (waxLine == nil)
      break;
    line = waxLine;
    line->AddRef();
    //Associated IWaxLine is no longer valid when IWaxIterator
    // is destructed.
  } while(false);
  return line; // Not a valid IWaxLine
}
```

If you want to maintain references to several different wax lines simultaneously you should keep a wax iterator in scope for each wax line. The sample code discussed in "Estimating the Depth of Text in a Frame" on page 509 shows how to do this.

15.6.2. Estimating the Depth of Text in a Frame

The depth of the text in a frame, for horizontal text, can be roughly estimated as the y position of the last line of wax in the frame minus the y position of the first line plus the leading for the first line. The estimate is illustrated for a simple text frame in figure 15.6.2.a.

figure 15.6.2.a. Estimating the Depth of Text In A Frame



Note that this estimate does not account for other factors which affect the position of the baseline for the first line of text in the frame (for example first baseline offset setting for the frame or text wrap settings on overlapping frames). However this estimate works well for many situations and allows the depth to be calculated solely from information available from the wax.

The code sample in the `SnipTextEstimateDepth.cpp` showshow to scan the wax lines for a frame to calculate the estimate.

The method `IParcelList::RecomposeThruNthParcel()` is used to ensure that the text is fully composed. If it is not the wax may be inaccurate and should not be relied upon.

`ITextFrame` and `IFrameList` are described in the "Text Composition" chapter.

15.6.3. Creating Wax Lines and Wax Runs

Wax lines and wax runs are created by the paragraph composer. Each object is created using `CreateObject()` and then filled out with the appropriate information and tied into the wax hierarchy by the composer. The samples found in {SDK}\samplecode\text\singlelinecomposer\ and

{SDK}\samplecode\text\composerj\ are paragraph composers that work on a single line at a time. The samples demonstrate the construction of wax lines and wax runs.

15.7. Summary

This chapter described the output of text composition - the wax. It showed how the wax represents fully formatted text. It illustrated how wax is organised and showed how plug-ins can access the data it holds. It described the bosses involved and the interfaces used to draw, hit test and select text. Finally it presented some practical samples of code that uses the wax.

You may want to know more about how the wax gets created. If so you need to read the "Text Composition" chapter.

15.8. Review

You should be able to answer the following questions:

1. What is wax? (15.3., page 486)
2. What is a wax line and what type of information does it store? (15.4.1., page 487)
3. What is a wax run and what type of information does it store? (15.4.2., page 489)
4. What is a character? (15.4.1., page 487)
5. What is a glyph? (15.4.1., page 487)
6. Each time the appearance of text changes in a line a wax run is created to describe the location, metrics and appearance of the glyphs. Give another reason why new wax runs are created. (15.4.9., page 497)
7. What is a wax iterator? (15.5.6., page 504)
8. Which interface would you use to find the composed width of a line? (15.5.7., page 504)
9. Which interface would you use to find the composed width of a run? (15.5.11., page 506)
10. Which interface would you use to find the composed width of a glpyh? (15.5.13., page 506)
11. Which interface would you use to find the composed style of a glyph? (15.5.12., page 506)

15.9. Exercises

15.9.1. Reporting the Widest Line in a Frame

Write a code sample that examines the selection to see if it is a text frame. Then scan the wax lines for the frame and report the width of the widest line.

16.

Text Composition

16.0. Overview

This chapter describes the process by which text gets composed and explains how plug-ins can recompose text.

16.1. Goals

The questions this chapter answers are:

1. What is text composition?
2. What is damage?
3. What is recomposition?
4. What is a paragraph composer?
5. When does composition occur?
6. How is the text composed?
7. How can a plug-in control recomposition?
8. How can a plug-in discover that text has been recomposed?

16.2. Chapter-at-a-glance

"Key concepts" on page 514 explains the architecture involved in the composition of text.

"Interfaces" on page 522 describes the interfaces that control text composition.

"Frequently asked questions (FAQ)" on page 524 answers often asked questions concerning the composition of text.

"Summary" on page 528 provides a summary of the material covered in this chapter.

table 16.1.a. version history

Rev	Date	Author	Notes
2.0	18-Dec-02	Seoras Ashby	Update content for InDesign 2.x API
0.3	14-Jul-00	Seoras Ashby Adrian O'Lenskie	Third Draft

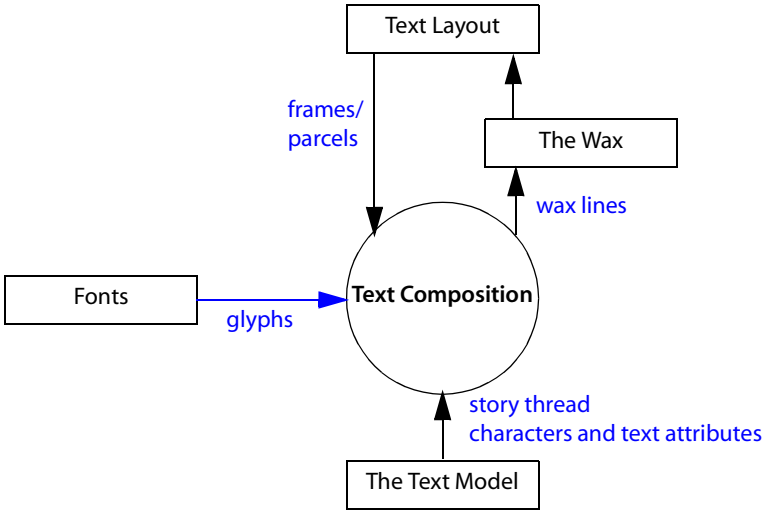
"Review" on page 528 provides questions to test your understanding of the material covered in this chapter.

"Exercises" on page 529 provides suggestions for other tasks you might want to attempt.

16.3. Key concepts

16.3.1. Text composition

figure 16.3.1.a. Text composition



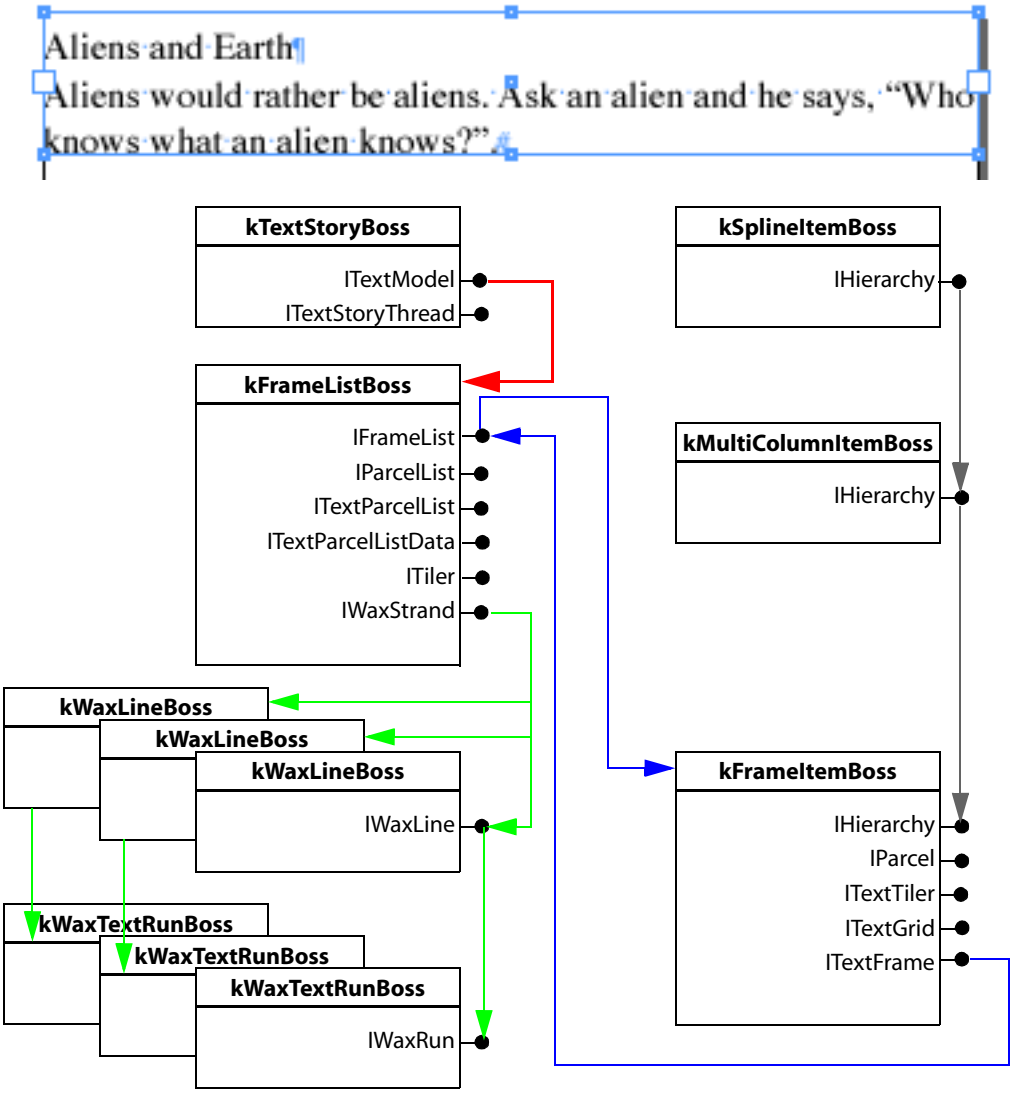
Text composition is the process that converts text content into its composed representation, the wax. It flows text content from a story thread into a layout representated by parcels in a parcel list. Specifically, composition maps the character[1] code data and the attributes that describe the desired appearance of the text into glyphs[2] and arranges them into words, lines and paragraphs. It uses the parcels associated with the story thread's text as containers that define the areas where text can flow. As output composition generates a wax line for each line of text. The process is illustrated in figure 16.3.1.a. Story threads are described in the "Text model" chapter, parcels in the "Text layout" chapter and

1. The term **character** denotes a member of an alphabet or a character code (Unicode, ASCII)
2. The term **glyph** indicates a member of a font.

the wax in "The wax" chapter. Please refer to these chapter for more information on these topics.

An example text frame with no formatting changes is shown in figure 16.3.1.b. Without exposing the details of how the text actually gets composed the objects that represent the story, the frame and the composed text are shown in figure 16.3.1.b. Text composition creates the wax lines (`kWaxLineBoss`) and their associated wax runs (`kWaxRunBoss`) using the primary story thread's content and layout as input. The wax lines are added to the wax strand (`IWaxStrand`). Text composition also maintains the range of characters displayed in each parcel/frame (see the "Span" section in the "Text layout" chapter for more information).

figure 16.3.1.b. Sample text frame with no formatting changes representation



16.3.2. The phases of text composition

There are two distinct phases of text composition, damage and recomposition. The term **damage** refers to changes that invalidate the wax for a range of composed text. Inserting text and modifying frame size are examples of changes that cause damage. The term **recomposition** refers to the process that repairs the damage and updates the wax to reflect the change.

Text composition toggles the wax between the states shown in figure 16.3.2.a. The flow of damage and recomposition is shown in figure 16.3.2.b.

figure 16.3.2.a. The wax state

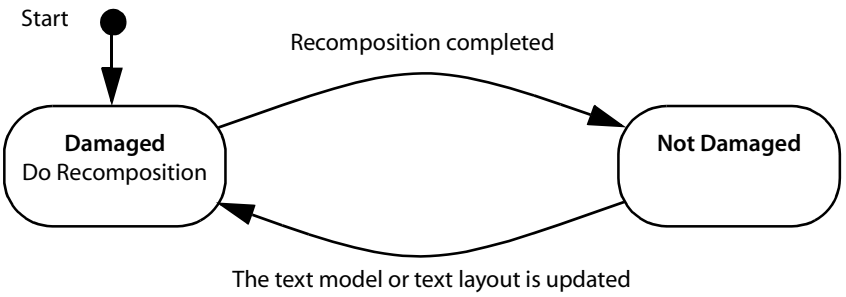


figure 16.3.2.b. Damage and recomposition, the phases of text composition

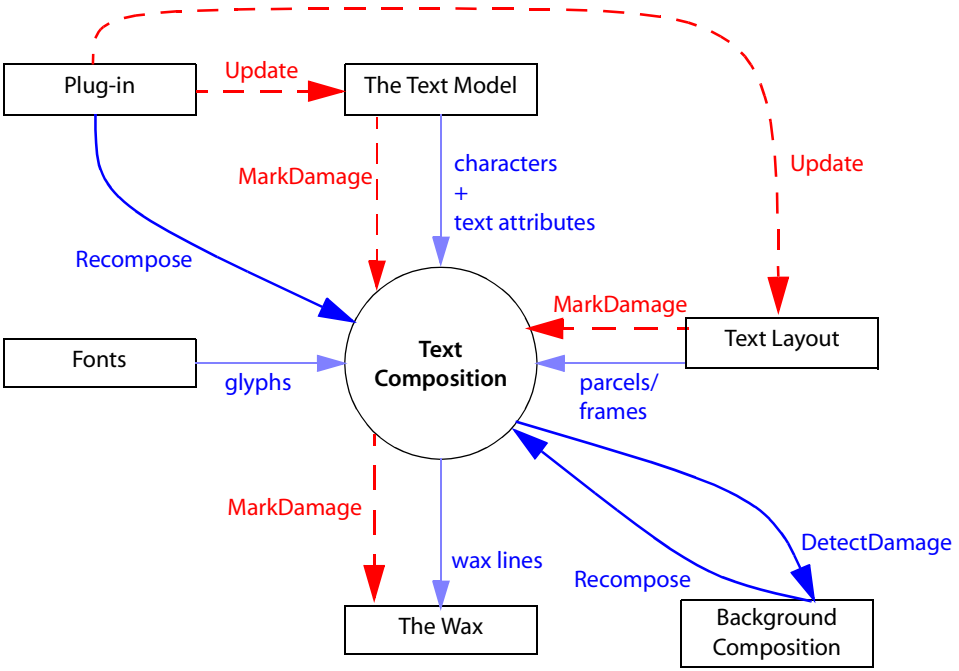


Figure 16.3.2.b shows that a plug-in can update the text model or text layout. These updates cause the wax, the composed representation of the text, to be damaged.

Text composition exposes interfaces that mark the damaged story, frame parcels and wax. The damage recording flow is represented by the dotted lines

in figure 16.3.2.b. Text composition also exposes interfaces that allow text to be recomposed. The recomposition flow is represented by the solid lines.

Background composition (see "Background composition" on page 521) is a separate process that drives text composition. It runs as an idle task when the application has no higher priority tasks.

For example say the plug-in illustrated in figure 16.3.2.b is the text editor. In response to typing the plug-in processes a command to insert the typed characters into the text model. This command calls text composition interfaces that record the damage caused. Background composition detects the damage and recomposes the affected text.

16.3.3. Damage

The term **damage** refers to changes that invalidate the wax for a range of composed text. Damage is recorded by marking the affected stories, parcels, frames and wax. The damage indicates where recomposition is required and the type of damage that has to be repaired.

The **change counter** on the frame list is incremented any time something happens that causes damage. No notification is broadcast when the change counter is incremented, so you can't immediately catch the change. However the method shown in figure 16.3.3.a provides a very useful indication that a change that affects text has occurred.

figure 16.3.3.a. IFrameList::GetChangeCounter

```
//Returns a counter which is incremented (and eventually rollover)
// each time any Parcel in any Frame in the FrameList goes from
// undamaged to damaged. It is thus a useful indication of when some
// Text in the FrameList has been damaged and will be re-composed.
virtual uint32 GetChangeCounter() const = 0;
```

Damage drives and optimises the recomposition process. For example recomposition might be able to shuffle existing wax lines around between frames to repair damage and avoid recomposing the text from scratch. Damage is categorised based on the action that caused it:

- Insert damage occurs when text is inserted.
- Delete damage occurs when a range of text is deleted.

- Change damage occurs when a range of text is replaced or when the text attributes that apply to a range of text are modified.
- Resize damage occurs when a frame is resized.
- Rect damage occurs when text wrap or text inset is applied.
- Move damage occurs when a frame is moved.
- Keeps damage occurs when a line must be pushed to the start of a new frame to eliminate orphans and widows. These are words or single lines of text that become separated from the other lines in a paragraph as depicted in figure 16.3.3.b. An orphan is said to occur when the first line of a paragraph becomes separated from the rest of the paragraph body. A widow is said to occur when the last line of a paragraph becomes separated from the rest of the paragraph body.

figure 16.3.3.b. Orphans(left) and Widows(right)

- Destroyed damage occurs when some combination of the above types of damage occurs. When this happens the existing wax for the affected range must be recomposed.

You should check for damage before relying on the information stored in the wax or the frame spans (see interface `ITextFrame` in the "Text Layout" chapter). If your plug-in detects damage it can either stop with a suitable error or it can recompose the text.

16.3.4. Recomposition

Recomposition is the process by which text is converted from a sequence of characters and attributes into the wax i.e. fully formatted paragraphs ready for display. The control and the functional aspects of recomposition can be separated into:

- Interfaces that control text composition(see "Interfaces" on page 522);

- The wax strand that manages the wax for the story;
- Paragraph composers that create the wax for a line or paragraph.

16.3.5. The wax strand

The wax strand (`IWaxStrand`) manages the wax for a story and is responsible for updating the wax to reflect changes in the text model or text layout. It, rather than a paragraph composer, controls the existing wax and determines when and where a paragraph composer needs to be used to create new wax. It also manages the overall damage recording process.

The main text recomposition methods[1] are `IWaxStrand::RecomposeThisFrame` and `IWaxStrand::RecomposeThisParcel`. The recomposition methods on interfaces like `IFrameList`, `IFrameListComposer` delegate the actual work to these `IWaxStrand` methods. The life cycle of the wax can be described as:

1. The wax strand is informed that a range in the text model has been changed. In response the wax strand locates the wax lines that represent this range and marks them damaged.
2. On the next recomposition pass the wax strand (`IWaxStrand:RecomposeThisParcel`) finds the first damaged wax line in the story and asks a paragraph composer to recompose.
3. The paragraph composer creates new wax lines and applies them to the wax strand (`IWaxStrand::ApplyComposedLine`) thus destroying any existing wax lines that represent the same range in the text model.
4. The wax strand repeats this process till it finds no more damaged wax lines or it reaches the end of the frame.

16.3.6. Paragraph composers

A **paragraph composer** (`IParagraphComposer`) takes up to a paragraph worth of text and arranges it into lines to fit a layout. It creates the wax that represents the composed text. Plug-ins can introduce new paragraph composers. See the "Paragraph composers" chapter for more information.

The text composition architecture is designed for paragraph-based composition. The most significant implication of this design decision is that any change to text or attributes results in at least one paragraph's composition information being re-evaluated. For example, inserting a single character into a

1. These methods are not called directly by third party plug-ins.

paragraph can potentially result in changes to any or all of the line breaks in the paragraph, even those preceeding the inserted character.

16.3.7. Shuffling

The process of avoiding recomposing text and simply moving existing wax lines up or down is called **shuffling**. The performance improvement gained by shuffling is very significant.

The wax strand can determine if a wax line was was damaged because of something that occurred around the wax line and not because the range of text it represents changed. If this is true then the wax strand knows that the net result of recomposing the text would simply move the wax line up or down. The content of the wax line after recomposition would be identical to its current content.

Consider the example of selecting an entire paragraph of text and deleting it. The following paragraph has not changed so it does not need to be recomposed. By pulling the following paragraph up to the position occupied by the deleted paragraph the wax strand is able to avoid the cost of recomposition while still achieving the same outcome.

When shuffling the wax strand has to implement some of the behaviours of a paragraph composer. For example it has to deal with space before and after paragraph attributes.

16.3.8. Vertical justification

Vertical justification moves wax lines up and down within the container that displays them according to some rules. For example the lines can gravitate to the top, the centre, the bottom or be justified to fill the available space. The wax strand is responsible for vertical justification and this mechanism is not extensible by third party plug-ins.

16.3.9. Background composition

Background composition looks for damage and fixes it by calling for recomposition. It runs in the background as an idle task (`IID_ICOMPOSITIONTHREAD` on `kSessionBoss`) and recomposes text. Each time it is called the task the following actions listed in order of priority:

1. recompose visible frames of damaged stories in the frontmost document;
2. recompose other damaged stories in the frontmost document;

3. recompose damaged stories in other open documents.

The actions are performed until the time slice allocated for background text composition expires. Background composition requests recomposition by calling the method shown in figure 16.3.9.a.

figure 16.3.9.a. IFrameListComposer::RecomposeUntil

```
virtual bool16 RecomposeUntil( TextIndex index, UIDRef frame,
IdleTimer *timeCheck);
```

16.3.10. Recomposition transactional model

Plug-ins use commands to update the input data that drives text composition (the text model and text layout). The commands cause damage to occur. Recomposition subsequently recomposes the text and generates the wax to reflect the changes. However, recomposition does not execute within the scope of a command. Instead a database transaction is begun and ended by the wax strand around the recomposition process. This means that recomposition is not directly undoable. However the commands used to update the input data are. Undo causes damage and recomposition repairs it to ensure the wax (i.e. the text displayed) reflects the state of the text model and text layout.

16.3.11. Recomposition notification

Interface `IRecomposedFrames` on the frame list (`kFrameListBoss`) keeps track of which frames have been recomposed so that text frame observers can be notified when recomposition completes. When the `BroadcastRecompositionComplete` method is called each affected column (`kFrameItemBoss`) receives notification that it has been recomposed. Observers need to attach to the `kFrameItemBoss` in which they are interested and watch for the `Update()` method being called with `theChange == kRecomposeBoss and protocol==IID_IFRAMECOMPOSER`.

16.4. Interfaces

16.4.1. Damage

Use the interface methods shown in figure 16.4.1.a to detect damage. The damage bookkeeping methods used to record the damage are not called directly by third party plug-ins. The text subsystem calls these methods as necessary in response to changes that affect text.

figure 16.4.1.a. Damage enquiry interfaces and methods

Interface	Method	Notes
IStoryList	GetLastDamagedStory CountDamagedStories GetNthDamagedTextModelUID	
IFrameList	GetFirstDamagedFrameIndex	
IFrameDamageRecorder	GetCompState	
IWaxLine	IsDamaged IsGeometryDamaged IsKeepsDamaged IsContentDamaged IsDestroyed	
IParcelList	GetFirstDamagedParcelIndex	
ITextParcelListData	GetIsDamaged GetFirstDamagedParcelIndex	
ITextParcelList	GetIsDamaged GetFirstDamagedParcelIndex	

16.4.2. Recomposition

Use the interface methods shown in figure 16.4.2.a to request recomposition.

figure 16.4.2.a. Recomposition interfaces and methods

Interface	Method	Notes
IFrameList	QueryFrameContaining	Helper method that causes recomposition. Set the leanLeftSide parameter to kFalse if you want the frame returned to contain the given text index or range.
IFrameListComposer	RecomposeThruNthFrame RecomposeThruTextIndex	Controls recomposition of frames in the frame list (kFrameListBoss). The methods delegate to the parcel list composer (ITextParcelListComposer).
IFrameComposer	RecomposeThruThisFrame	IFrameComposer controls recomposition of a frames. The methods delegate to the wax strand (IWaxStrand) which does the real work.

Interface	Method	Notes
ITextParcelListComposer	RecomposeThruNthParcel RecomposeThruTextIndex	Controls recomposition of parcels in a parcel list. The methods delegate to the wax strand (IWaxStrand) which does the real work.
IGlobalRecompose		Provides methods that can be used to force all stories to recompose. The interface marks damage that forces recomposition to recompose the damaged elements even though they have not really been changed

The interfaces and methods below are not normally called by third party plug-ins but play a central role in the control of recomposition.

figure 16.4.2.b. Recomposition interfaces and key methods

Interface	Method	Notes
IWaxStrand	RecomposeThisFrame RecomposeThisParcel	See "The wax strand" on page 520.
IRecomposedFrames		See "Recomposition notification" on page 522.
IParagraphComposer		See "Paragraph composers" on page 520.

16.5. Frequently asked questions (FAQ)

If you do not find your question in the list below please check the FAQ in the "Paragraph composers" chapter. It contains more answers to questions relating to the composition of text.

16.5.1. What is text composition?

See "Text composition" on page 514.

16.5.2. What is damage?

See "Damage" on page 518.

16.5.3. What is recomposition?

See "Recomposition" on page 519.

16.5.4. What is the wax strand?

See "The wax strand" on page 520.

16.5.5. What is a paragraph composer?

See “Paragraph composers” on page 520.

16.5.6. What is background composition?

See “Background composition” on page 521.

16.5.7. How do I recompose text?

There are several ways to do this but first you should ask your self “Why should I need to recompose text in a story?”. Damaged text requiring recomposition is normally fixed up by background composition. However your code may find the text it is interested in is damaged and if so it may need to force recomposition to fix up this damage. For example you should always check for damage before scanning the wax or relying on any spans that indicate the range of text stored in a frame or parcel.

You can recompose text within a story either by the index ito the text model (`TextIndex`), or by the visual container used to display the text (a frame or parcel). The most general purpose approach is to use the parcel list composer (`ITextParcelListComposer`) which will work for any text that can be composed. It will work regardless of whether the text is displayed in frame or a table cell for example. Note that you must not assume that all text in the text model can be composed. Some features may store text in the text model that is never composed for display. An example of this might be hidden text.

The figures below show the most common approaches used to force the recompistion of text.

figure 16.5.7.a. Recomposing story text by TextIndex using ITextParcelListComposer

```
// Recompose text up to a given TextIndex. By using the parcel list composer
// you can compose text that is displayed in frames, tables or any
// other feature supports text composition.
static void RecomposeThruTextIndex(ITextModel* textModel,
  TextIndex at)
{
  if (at >= 0 && at < textModel->TotalLength()) {
```

```
    InterfacePtr<ITextParcelList> textParcelList(
      textModel->QueryTextParcelList(at));
    InterfacePtr<ITextParcelListComposer> textParcelListComposer(
      textParcelList, UseDefaultIID());
    if (textParcelListComposer) {
      textParcelListComposer->RecomposeThruTextIndex(at);
    }
  }
}
```

figure 16.5.7.b. Recomposing by parcel using ITextParcelListComposer

```
// Recompose text in the given parcel, and preceeding damaged parcels.
static void RecomposeThruParcel(IParcel* parcel)
{
  InterfacePtr<IParcelList> parcelList(parcel->QueryParcelList());
  InterfacePtr<ITextParcelList> textParcelList(parcelList,
    UseDefaultIID());
  InterfacePtr<ITextParcelListComposer> textParcelListComposer(
    textParcelList, UseDefaultIID());
  if (textParcelListComposer) {
    textParcelListComposer->RecomposeThruNthParcel(
      parcel->GetParcelIndex());
  }
}
```

figure 16.5.7.c. Recomposing story text by TextIndex using IFrameListComposer

```
// Recompose text in the primary story thread up to a given TextIndex.
static void RecomposeThruTextIndexByFrameList(ITextModel* textModel,
  TextIndex at)
{
  if (at >= 0 && at < textModel->GetPrimaryStoryThreadSpan()) {
    InterfacePtr<IFrameList> frameList(
      textModel->QueryFrameList());
    InterfacePtr<IFrameListComposer> frameListComposer(
      frameList, UseDefaultIID());
    if (frameListComposer) {
      frameListComposer->RecomposeThruTextIndex(at);
    }
  }
}
```

figure 16.5.7.d. Recomposing by text frame using IFrameComposer

```
// Recompose text in the given frame, and preceeding damaged frames.
static void RecomposeThruFrame(ITextFrame* textFrame)
{
  InterfacePtr<IFrameComposer> frameComposer(textFrame,
```

```
    UseDefaultIID());
  if (frameComposer != nil) {
    frameComposer->RecomposeThruThisFrame();
  }
}
```

16.5.8. How do I recompose all stories in a document?

`IGlobalRecompose` provides methods that can be used to force all stories to recompose. The interface marks damage that forces recomposition to recompose the damaged elements even though they have not really been changed. The code in figure 16.5.8.a shows `IGlobalRecompose` can be used.

figure 16.5.8.a. Recompose all stories ina document

```
static void RecomposeAllStories(IDocument* document)
{
  InterfacePtr<IGlobalRecompose> globalRecompose(document,
    UseDefaultIID());
  if (globalRecompose != nil) {
    globalRecompose->RecomposeAllStories();
    globalRecompose->ForceRecompositionToComplete();
  }
}
```

16.5.9. Can I be notified when text is recomposed?

The notification involved is described in section "Recomposition notification" on page 522. Observing this is difficult since you'd need to maintain an observer on each frame (`kFrameItemBoss`). Check out "Can I observe changes that affect text?" on page 527for a suggested alternative approach.

16.5.10. Can I observe changes that affect text?

This quickly becomes complex as there are many types of change that affect text. For example changes to the geometry of the text layout (e.g. resize and text inset) could be observed using a document observer. Changes to character and text attributes could be observed by attaching an observer to each text model or interest. Changes to text styles could be observed by attaching observers to the style name tables in the workspace. But you get the idea, it quickly becomes difficult to arrange.

The trick is not to try and observe everything, but instead to be aware that recomposition has occurred. Any change to text, attributes, styles, layout, etc. that may affect lines breaks will cause damage. The change counter on the frame list (`IFrameList::GetChangeCounter`) is incremented any time something

happens that means recomposition is needed. No notification is broadcast when the change counter is incremented, so you can't immediately catch the change, but in general immediate feedback isn't needed. Usually the fact a something has changed in a way that affects text only needs to be determined at fixed points in time.

For example you may wish to export a story from InDesign to a copy editor application. When the story is re-imported you want to tell the user about changes to the layout or text styling that have been made through InDesign. You can arrange this by caching the value of `IFrameList::GetChangeCounter` at the time you export the story and compare this cached value to the actual value when you re-import. If you really have to notify users when layout changes are made that affect text you could check `IFrameList::GetChangeCounter` using an idle task.

16.6. Summary

This chapter described text composition. It showed how it is divided into two distinct phases: damage and recomposition. The overall relationship between stories and the containers that display the wax created by text composition was described. The purpose and function of major interfaces involved in text composition were documented.

16.7. Review

You should be able to answer the following questions:

1. What is text composition? (16.3., page 514)
2. What is the wax? (16.3., page 514)
3. What is a character? (16.3., page 514)
4. What is a glyph? (16.3., page 514)
5. There are two major phases to composition. What are they called and what is the purpose of each phase? (16.3.2., page 516)
6. What does the wax strand do? (16.3.5., page 520)
7. What does a paragraph composer do? (16.3.6., page 520)
8. Which interface would you use to recompose a parcel, a frame, a story, a complete document? (16.5.7., page 525)

16.8. Exercises

16.8.1. Find the text frame that displays a given TextIndex

Use `IFrameList::QueryFrameContaining` to find the text frame that displays the character with a given index (`TextIndex`) in the text model.

17.

Paragraph Composers

17.0. Overview

This chapter describes **paragraph composers,** the components responsible for breaking text into lines and generating its composed representation, the wax**.** The chapter also explains how you can develop your own paragraph composer plug-in. You should have an understanding of the wax before reading this chapter (see "The Wax" chapter). You also need to understand where paragraph composers fit into the overall text composition architecture (see the "Text Composition" chapter).

17.1. Goals

The questions this chapter answers are:

1. What is a paragraph composer?
2. How can I implement a paragraph composer?
3. Can I introduce a new line breaking algorithm?
4. What is the compose scanner (`IComposeScanner`)?
5. What is drawing style (`IDrawingStyle`)?
6. What is composition style (`kComposeStyleBoss/ICompositionStyle`)?
7. How is wax created?

17.2. Chapter-at-a-glance

"Key concepts" on page 532 explains where paragraph composers fit into the text composition architecture and describes the basics involved in typography.

"Interfaces" on page 547 describes interfaces of interest to paragraph composers.

table 17.1.a. version history

Rev	Date	Author	Notes
2.0	18-Dec-2002	Seoras Ashby	New chapter. Content on paragraph composers extracted from InDesign 1.x Text composition chapter and updated for InDesign 2.x API.

"Scenarios" on page 554 describes some basic situations faced when composing text within this application.

"Sample code" on page 561 describes code assets provided on the SDK you should refer to for reference implementations.

"Frequently asked questions (FAQ)" on page 562 provides answers to some often asked questions related to paragraph composers and the composition of text in general.

"Summary" on page 567 provides a summary of the material covered in this chapter.

"Review" on page 567 provides questions to test your understanding of the material covered in this chapter.

"Exercises" on page 567 provides suggestions for other tasks you might want to attempt.

"References" on page 567 provides suggestions for further reading.

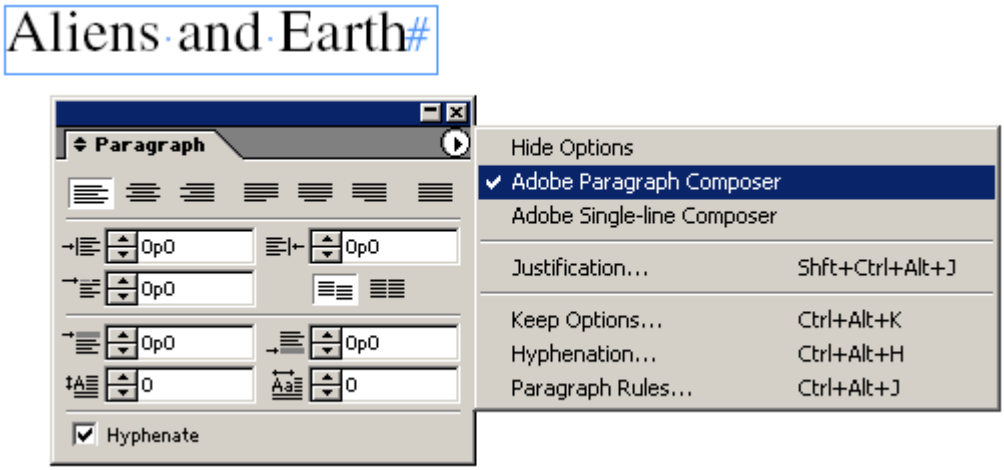
17.3. Key concepts

17.3.1. Paragraph composers

A **paragraph composer** (`IParagraphComposer`) takes up to a paragraph worth of text and arranges it into lines to fit a layout. It creates the wax that represents the text it has composed. Plug-ins can introduce new paragraph composers.

The user selects the composer to be used for a paragraph via the popout menu on the **Paragraph** panel as shown in figure 17.3.1.a or by using the paragraph style dialog (not shown). This sets paragraph attribute `kTextAttrComposerBoss` to indicate the paragraph composer to be used.

figure 17.3.1.a. Setting the paragraph composer



17.3.2. HnJ

The acronym **HnJ** stands for "hyphenation and justification". The term is often used in computer systems to mean the breaking of text into lines and the spacing of text so that it aligns with the margins. You won't find the term HnJ used in this application's API or documentation. However the role performed by HnJ is similar to the role of a paragraph composer. Hyphenation is intimately associated with line breaking. In this application the role is split out and implemented by a hyphenation service (`IHyphenationService`). When a paragraph composer requires to hyphenate a word it will use a hyphenation service.

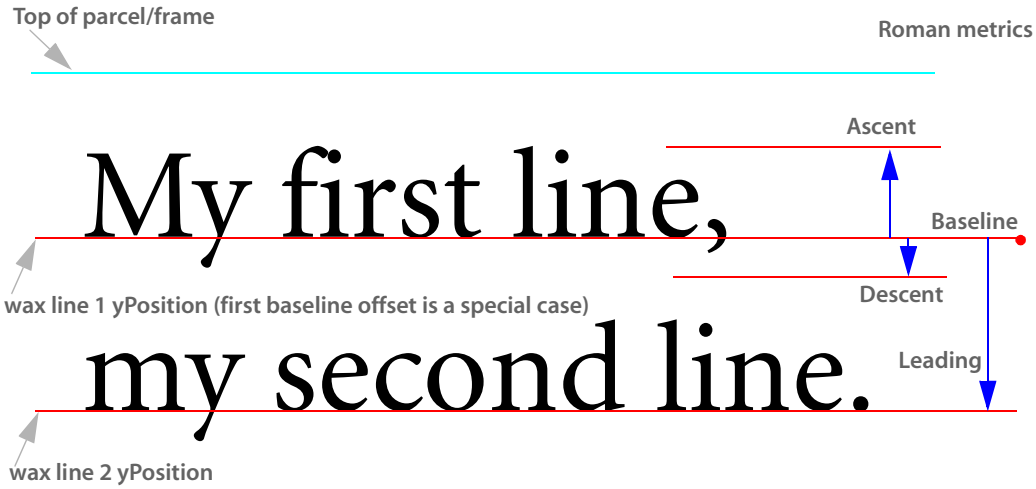
17.3.3. Roman typography basics

You need a good understanding of typography to attempt the task of implementing a paragraph composer. The basics involved are introduced below.

Roman typography uses a baseline on which the base of most glyphs are aligned. Glyphs ascend above the baseline and some glyphs have descenders that pierce through the baseline. The distance between successive baselines is the line leading which is the *largest* leading value of all runs in the line. These metrics are illustrated in figure 17.3.3.a.

Note that in this application the distance between the top of a frame and the baseline of the first line is a special case that is controlled by a property of the parcel called first baseline offset. This is described in more detail in “First baseline offset” on page 542.

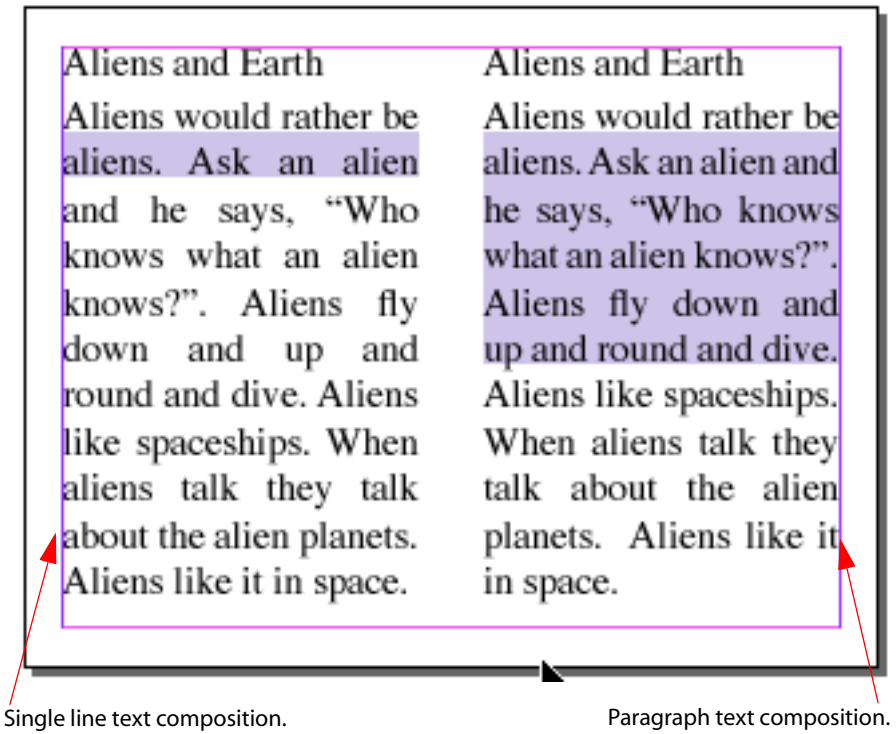
figure 17.3.3.a. Roman typography metrics



Roman text composition involves choosing places to break text into individual lines and justifying these lines to a fixed width. The objective of **line breaking** is to split text into lines so that the space between words is well balanced. The appearance of the text will be disturbed if the text is too loose (too much space) or too tight (too little space). **Line justification** involves tuning various factors to increase or decrease the width of a line to a target width. The key factor is the addition and removal of space between words. There are several other factors, notably kerning, hyphenation and ligatures. Justification is heavily dependent on line breaking. When line breaking is done well justification should not have to adjust inter word spacing significantly.

The evaluation of possible line breaks and the choice of those that give the best looking text can be a sophisticated process. The **line-based** approach composes text one line at a time. The Adobe single-line composer uses this approach. The **paragraph-based** approach considers a network of line breaks for a paragraph and chooses those such that no one line is overly stretched or compressed. The Adobe Multi-line composer uses this approach. Figure 17.3.3.b contrasts the results of the Adobe Single-line composer and the Adobe Multi-line composer.

figure 17.3.3.b. Results of line-based approach(left) versus paragraph based approach(right)



17.3.4. Japanese typography basics

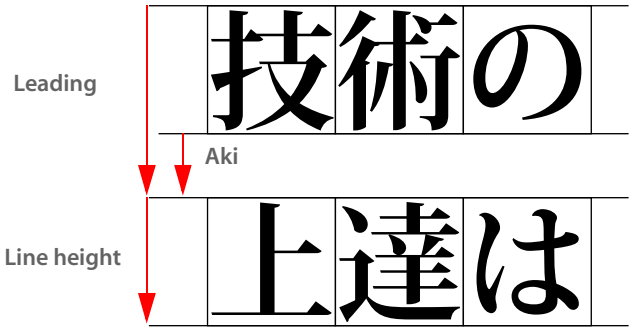
The **em-box** is fundamental to Japanese typography. It is a square that is equal in dimension to the point size of the font as illustrated in figure 17.3.4.a.

figure 17.3.4.a. The em-box

In Japanese typography line leading is the distance between the top of the current line and the top of the next line. The line leading is equal to the line

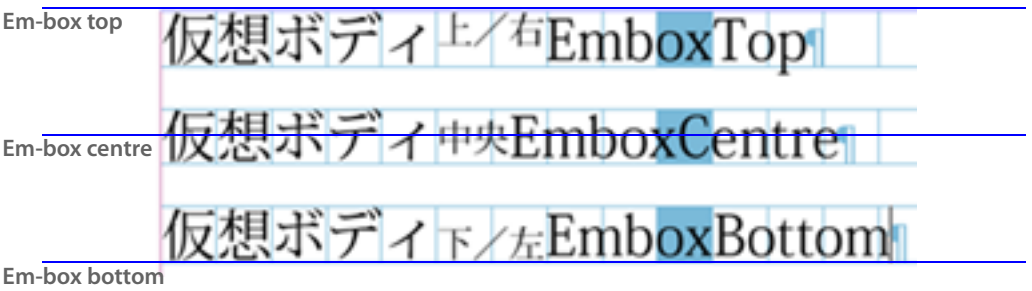
height plus the line aki where the line height is the largest em-box on the line and line aki is the space between lines. Japanese designers work in terms of line leading (gyou-okuri), and line aki (gyou-aki) interchangeably and both ways must be supported.

figure 17.3.4.b. Japanese leading, line height and aki



Traditional Japanese typography is based around three **em-box baselines**, em-box top, em-box centre and em-box bottom as illustrated in figure 17.3.4.c.

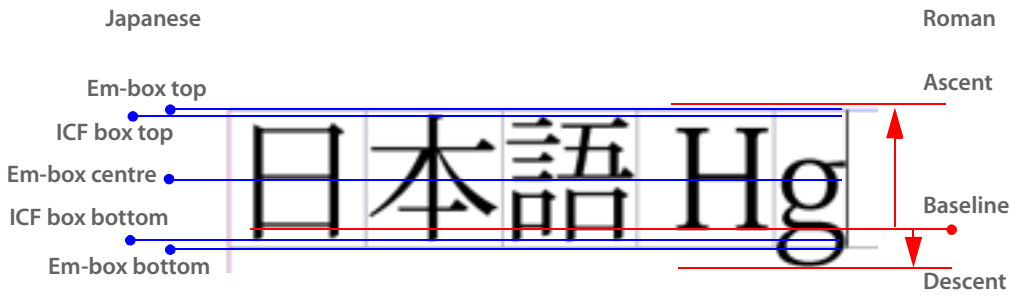
figure 17.3.4.c. Japanese em-box baselines



In addition the **ideographic character face**, introduces two further baselines for text. The ICF box is the bounding box that encloses the largest stroked ideographic glyph in a font. It is closer to the actual glyph bounds than the em-box and the top and the bottom ICF box baselines.

Japanese typography metrics are contrasted with Roman typography metrics in figure 17.3.3.a.

figure 17.3.e. Japanese and Roman typography metrics



The API provides roman, em-box and ICF box font metrics that allow a composer to compose text on one of the six possible baselines (em-box top, em-box centre, em-box bottom, ICF box top, ICF box bottom and roman).

Kinsoku shori, or **kinsoku** for short, is the process of identifying a character in Japanese text where a line may be broken. Some characters are not allowed to start a line, close parenthesis for example. Others are not allowed to end a line, open parentheses for example. The application allows the user to edits sets of such characters. A composer can use these to implement a variety of line break strategies. The simplest approach is **push-out**. Push-out means the character at the end of the line is pushed out to the next line. A more complex approach is **push-in**. Push-in means the line is compressed so that the character is made to fit in the line. In addition some characters are optionally allowed to hang outside the margin while other non-separable characters should not be broken across lines, ellipses for example. Typically all of these characters are some form of Japanese punctuation.

Mojikumi is a set of rules used for Japanese text composition. The rules control the amount of **aki** (space) that appears between characters depending on their JISx4051[1] character classes. The rules also controls how that extra space is expanded or compressed during full justification and push-in kinsoku.

Tsume controls the compression of an individual character, or more exactly, the corresponding glyph in the font from which the character is displayed.

1. A Japanese Industrial Standards committee standard.for line composition.

17.3.6. A paragraph composer's environment

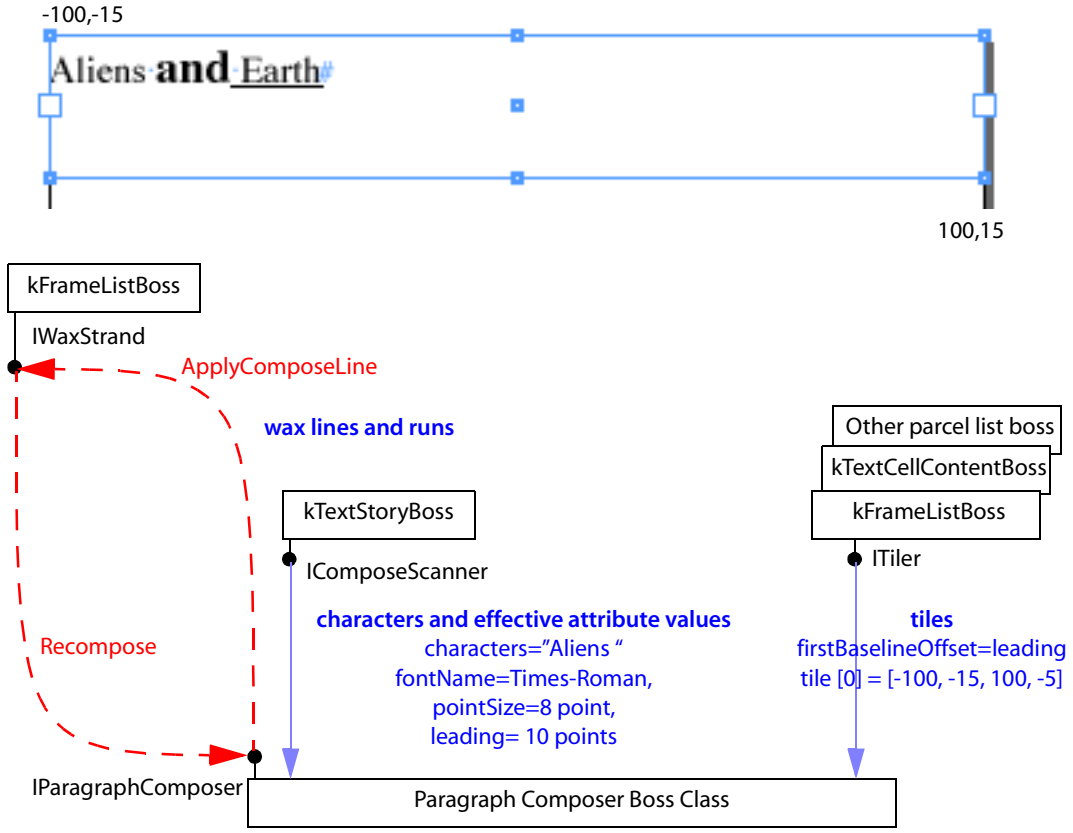
Paragraph composers are called by text composition (see the "Text composition" chapter). When text is to be recomposed the wax strand examines the paragraph attribute `kTextAttrComposerBoss` that specifies the paragraph composer to be used and locates it via the service registry. To recompose text the `IParagraphComposer::Recompose` method shown in figure 17.3.6.a must be called. This call gives the paragraph composer a context in which to work.

figure 17.3.6.a. IParagraphComposer::Recompose

```
/** Determines line position and where text in the line should be broken. As output
   adds a wax line(IWaxLine) to the wax strand which calls the RebuildLineToFit
   method to add wax runs(IWaxRun) for the line.
   @param composeScanner IN for the story being composed.
   @param startingIndex IN index into the text model of first character to compose.
   @param textTiler IN determines areas in the line where text can flow.
   @param parcelIndex IN index into IParcelList of parcel in which yPosition lies.
   @param yPosition IN top of area to flow text into (y position of preceeding line
   or top of parcel if first line in parcel).
   @param waxStrand IN/OUT strand to apply composed wax line (IWaxLine) to.
   @result kTrue if wax line added to wax strand, kFalse otherwise.
*/
virtual bool16 Recompose(IComposeScanner* composeScanner,
  TextIndex startingIndex,
  ITiler* textTiler,
  int32 parcelIndex,
  PMReal yPosition,
  IWaxStrand* waxStrand);
```

For example when a paragraph composer is called to compose the text shown by the frame in figure 17.3.6.b. the context it works in is as shown. The paragraph composer composes the text and create at least one wax line. It accesses the character code and text attribute data for the story using the `IComposeScanner` interface. It determines the areas in a line where glyphs can flow using the `ITiler` interface. Finally the wax lines are applied to the `IWaxStrand` interface by calling `ApplyComposedLine`. Note: both `yPosition` and tiles are specified in the inner bounds (co-ordinate system).

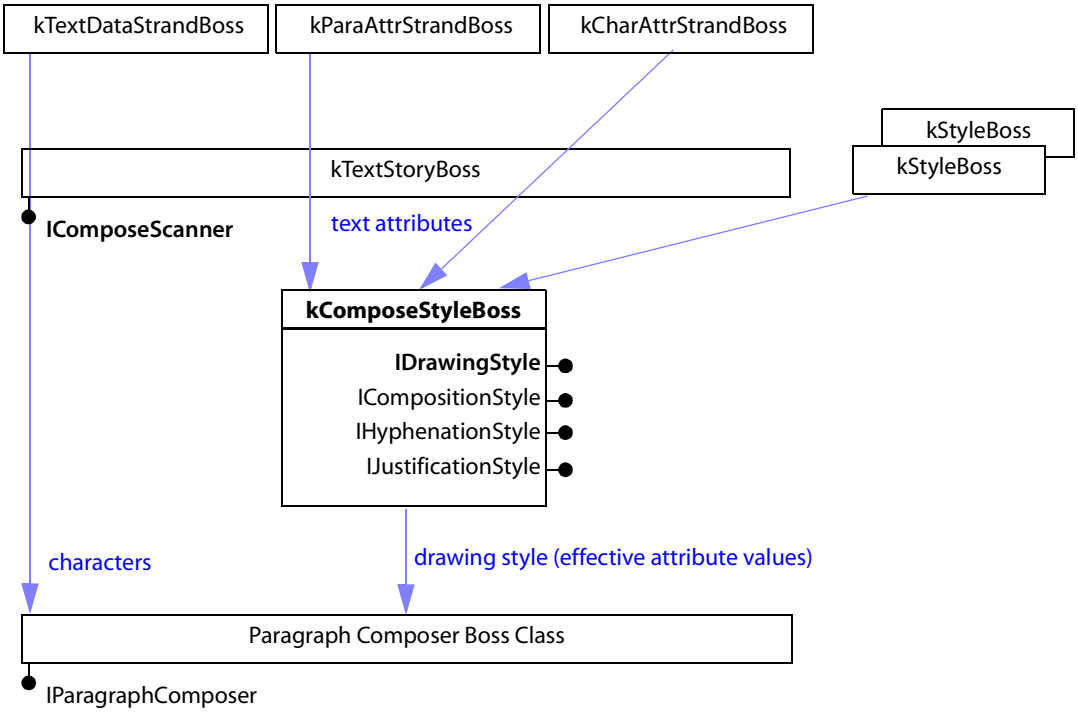
figure 17.3.6.b. Paragraph composer environment



17.3.7. The scanner and drawing style

The scanner (interface `IComposeScanner`) provides access to both the the character and formatting (the text attributes) information from the text model as shown in figure 17.3.7.a. The **drawing style** (interface `IDrawingStyle`) represents the effective value of text attributes at a given index in the text model. The drawing style cached by interfaces on `kComposeStyleBoss` considerably simplifies accessing text attribute values. These interfaces remove the need to resolve text attribute values from their representation in the text model and the text styles it references. A drawing style applies to at least one character. The range of characters it applies to is known as a **run**. For more information on styles and overrides please read "The Text Model" chapter.

figure 17.3.7.a. The scanner and drawing style

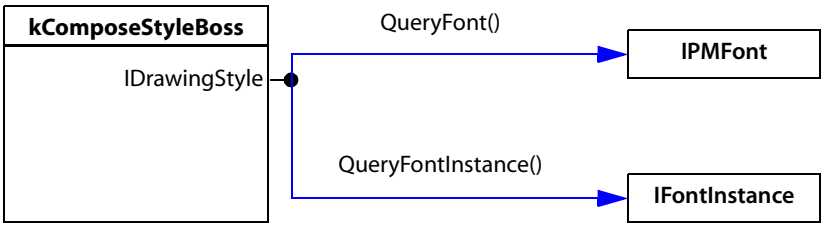


17.3.8. Fonts and glyphs

Fonts contain the glyphs that display characters for a typeface at a particular size. Paragraph composers use the drawing style (`IDrawingStyle`) to find the font to be used as shown in figure 17.3.8.a. The font APIs provide the metrics required to compose the text into lines composed of a run of glyphs for each stylistic run of text.

A font represents a typeface with a given size and style. A typeface is the letters, numbers, and symbols that make up a design of type, Times for example. A glyph is a shape in a font that is used to represent a character code on screen or paper. The most common example of a glyph is a letter, but the symbols and shapes in a font like ITC Zapf Dingbats are also glyphs. For more information on fonts read the “Fonts” chapter.

figure 17.3.8.a. Accessing a font



17.3.9. Tiles

Tiles (see interface `ITiler/ITextTiler`) represent the areas on a line into which text can flow. Normally there .will only be one tile on a line. However text wrap may cause intrusions which breaks up the places in the line text can go. The tiler takes care of this as well as accounting for the effect of irregularly shaped text containers.

Intrusions are the counterparts of tiles. Note they are not their inverse, i.e. they do not specify the areas in the line where text cannot be flowed. From the perspective of `ITiler` an **intrusion** is a horizontal band within a frame in which text flow within the bounding box of the frame may be interrupted. Intrusions can be used to optimise recomposition. They are a flag that indicates text cannot be flowed into the entire width of a line.Intrusions are caused by text wrap and non-rectangular frames.

It is important to recognise that the tiles returned for a line depend on the y position at which they are requested, their depth and minimum width. The intrusions and tiles for some sample text frames are illustrated in figure 17.3.9.a through figure 17.3.9.e.

figure 17.3.9.a. Text frame with no intrusions

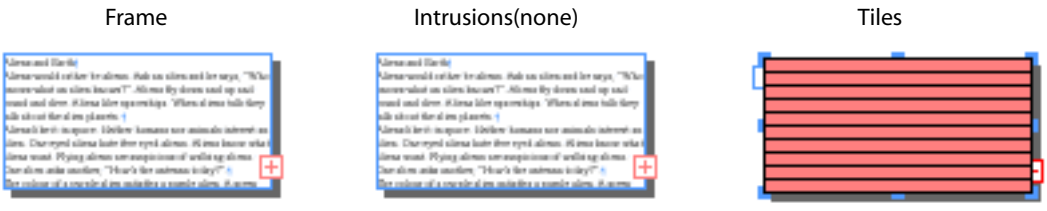


figure 17.3.9.b. Effect of image frame with text wrap

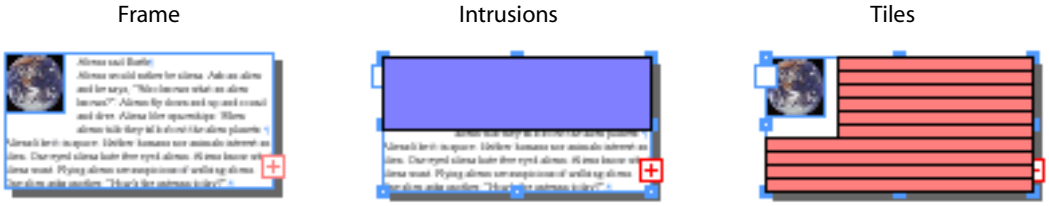


figure 17.3.9.c. Effect of two images with text wrap

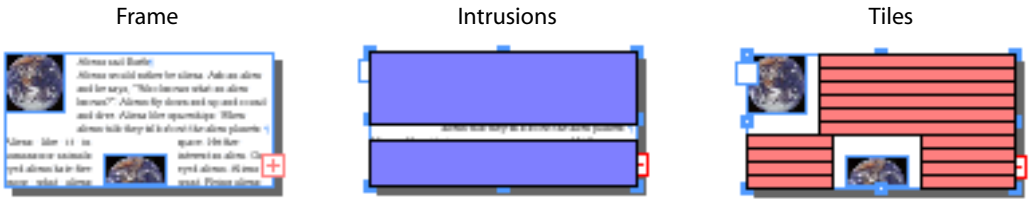


figure 17.3.9.d. Effect of text inset

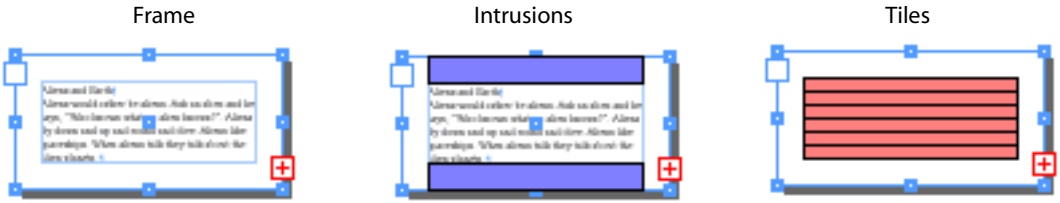
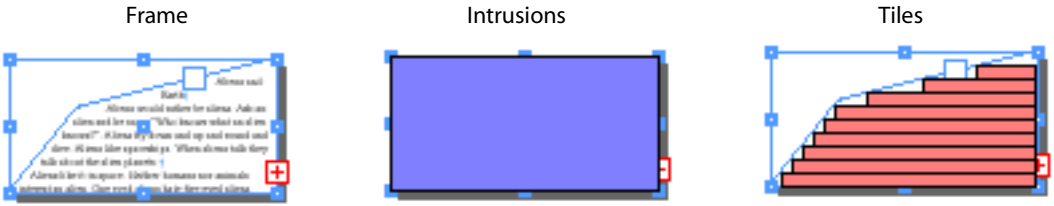


figure 17.3.9.e. Effect of non rectangular frame

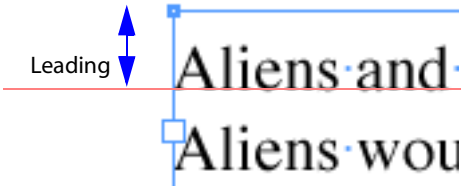


17.3.10. First baseline offset

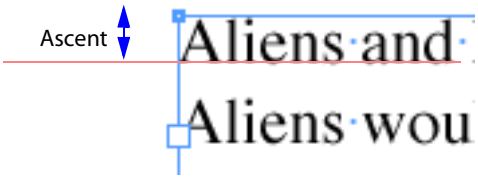
The distance between the top of a parcel/frame and the baseline of the first line of text it displays is controlled by the **first baseline offset** setting. Some example settings are illustrated in figure 17.3.10.a.

figure 17.3.10.a. First baseline offset examples

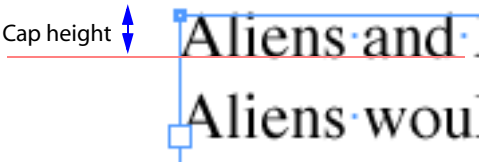
The setting controls the distance between the top inset of the frame and the baseline of the first line.



Use the largest leading on the line.



Use the largest ascent on the line. This makes the top of the tallest glyph fall below the top inset of the frame.



Use the largest Cap Height on the line. This makes the top of upper case letters touch the top inset of the frame.

17.3.11. Control characters

There are many control characters to which a paragraph composer can apply an appropriate behaviour to correctly implement the character's semantic intent. Some major control characters are tabulated in figure 17.3.11.a.

figure 17.3.11.a. Control characters

Character code[a]	Meaning
kTextChar_CR	End of paragraph
kTextChar_SoftCR	Soft end of line
kTextChar_Space	Space.
kTextChar_Tab	
kTextChar_HyphenMinus kTextChar_DiscretionaryHyphen kTextChar_UnicodeHyphen	Different kinds of hyphens.

figure 17.3.11.a. Control characters

Character code[a]	Meaning
kTextChar_EnSpace kTextChar_EmSpace kTextChar_FigureSpace kTextChar_PunctuationSpace kTextChar_ThinSpace kTextChar_HairSpace kTextChar_ZeroSpaceBreak kTextChar_ZeroSpaceNoBreak kTextChar_FlushSpace	Special space characters.
kTextChar_ReplacementCharacter kTextChar_Substitute	Describes a glyph that has no corresponding Unicode character code. The GlyphID for such a character is obtained from the drawing style (IDrawingStyle).
kTextChar_Table kTextChar_TableContinued	Embed table. Paragraph composers shoud return control to their caller which will handle these characters.
kTextChar_ObjectReplacementCharacter	Compose an in-line frame.

a. See TextChar.h for a full listing of control character codes.

17.3.12. In-line frames

In-line frames (`kInlineBoss`) allow frames to be embedded in the text flow. An in-line frame behaves as if it were a single character of text and moves along with the text flow when the text is recomposed. The character `kTextChar_ObjectReplacementCharacter` in inserted into the text data strand to mark the position of the in-line in the text. The in-line frames are owned by the owned item strand (`kOwnedItemStrandBoss`) in the text model. Paragraph composers use `ITextModel` to access this strand directly to obtain the geometry of the frame associated with the `kInlineBoss`. In-line frames are represented in the wax by their own type of wax run, `kWaxILGRunBoss`.

17.3.13. Table frames

Table frames (`kTableFrameBoss`) are owned items that are anchored on a `kTextChar_Table` character embedded in the text flow. Paragraph composers can and do compose text displayed in table cells. However they never compose (i.e. never create wax for) the character codes related to tables, `kTextChar_Table` and `kTextChar_TableContinued`. When a paragraph composer encounters either of these characters it should create wax for any buffered text and return control to its caller.

17.3.14. Creating Wax

During the process of building lines a paragraph composer would normally use some intermediate representation of the glyphs so it can evaluate potential line break points and adjust glyph widths. The specific arrangement used will depend on the overall feature set of the paragraph composer and is beyond the scope of this chapter. However once the line break decisions have been made the paragraph composer will want to create wax lines and runs.

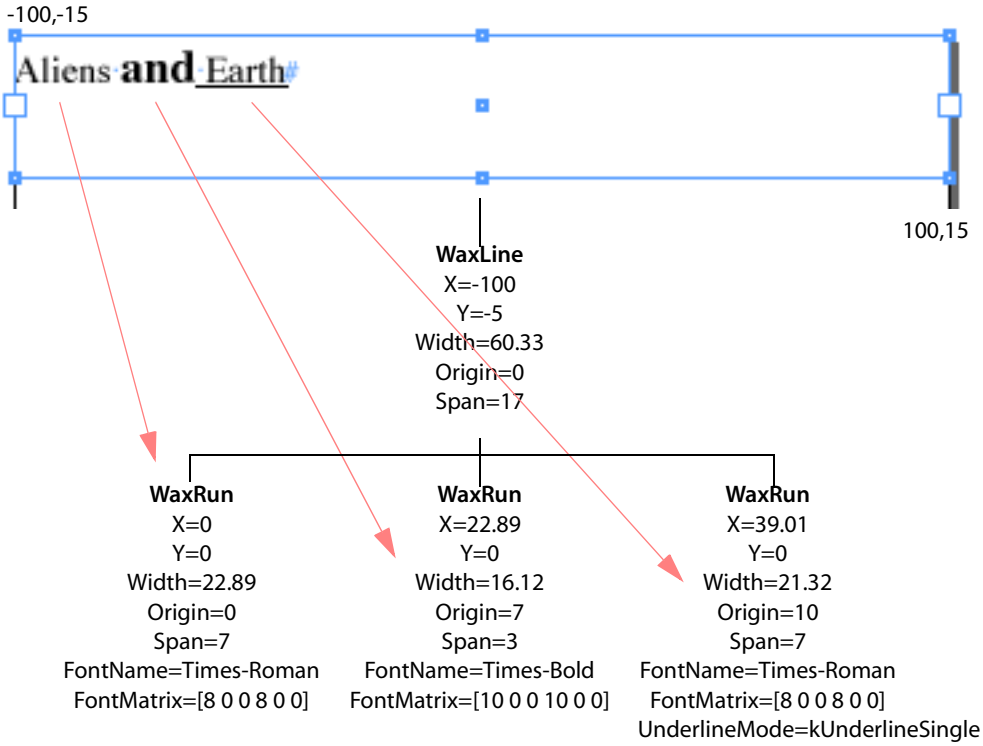
Details on the mechanics of the creation of wax lines and runs can be found in "The Wax" chapter. Once created the new wax lines are added to the wax strand by calling the method shown in figure 17.3.14.a.

figure 17.3.14.a. IWaxStrand::ApplyComposedLine

```
virtual void ApplyComposedLine(TextIndex at, IWaxLine * newLine) = 0;
// Called by paragraph composers to add a new wax line to the wax for a story
```

The wax generated by a paragraph composer for the text shown in figure 17.3.6.b is depicted in figure 17.3.14.b.

figure 17.3.14.b. Wax for single line with formatting changes



17.3.15. Adobe paragraph composers

The composers provided by the application under the Roman feature set are shown in figure 17.3.15.a and under the Japanese feature set in figure 17.3.15.b. Paragraph composers are implemented as service providers (`IK2ServiceProvider`) and can be located via the service registry. The `ServiceID` used to identify paragraph composers is `kTextEngineService`.

figure 17.3.15.a. Roman paragraph composers

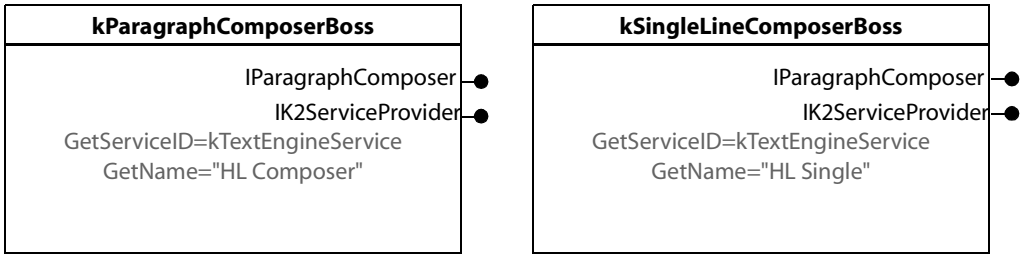
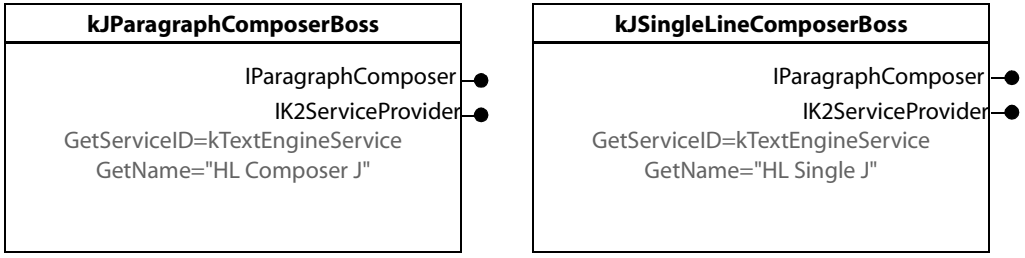


figure 17.3.15.b. Japanese paragraph composers

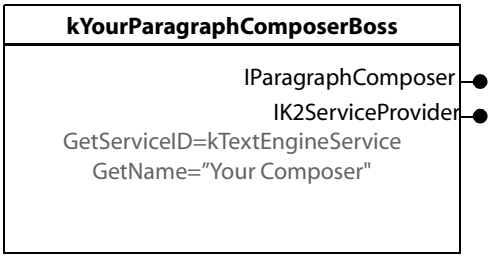


17.4. Interfaces

17.4.1. Class diagram

Paragraph composers are boss classes that implement `IParagraphComposer`, the interface called by the application to compose text. To be recognised as a text composer the boss class must also implement a text engine service (`IK2ServiceProvider`) with a `ServiceID` of `kTextEngineService`. The service must also provide a name, a translatable string, for the paragraph composer that will be displayed in the user interface. As output composers generate wax lines (`IWaxLine`) and associated wax runs (`IWaxRun`) for up to one paragraph of text at a time. The class diagram of a custom paragraph composer is shown in figure 17.4.1.a.

figure 17.4.1.a. Custom paragraph composers class diagram



17.4.2. IParagraphComposer

There are two distinct phases to text composition and `IParagraphComposer` reflects these roles:

1. Positioning the line and, if necessary, deciding where text in the line should break. This information is represented persistently in the wax line. Features that affect line break decisions belong here. This is the role of the `Recompose` method.
2. Positioning glyphs that represent the characters in the line and, if necessary, adjusting their width. This information is represented by a set of wax runs associated with the wax line. Wax runs are not persistent and must be rebuilt for display when a wax line is read from disc. Features that affect glyph position (paragraph alignment, justification, letter spacing, word spacing and kerning) belong here. This is the role of the `RebuildLineToFit` method.

`Recompose` is called when text needs to be fully recomposed. Each time this method is called it should compose at least one line and, at most, one paragraph of text. `Recompose` creates wax starting from the character in the story indicated by `startingIndex`. The top of the area into which text should be flowed is given by `yPosition` and composition is done using the supplied scanner and tiler. The wax lines generated as a result are applied to the given wax strand. Note that you are expected to create at least one wax line each time this method is called. This holds even when it turns out that you are composing overset text.

figure 17.4.2.0.a. IParagraphComposer::Recompose

```
/** Determines line position and where text in the line should be broken. As output
    adds a wax line(IWaxLine) to the wax strand which calls the RebuildLineToFit
```

```
    method to add wax runs(IWaxRun) for the line.
    @param composeScanner IN for the story being composed.
    @param startingIndex IN index into the text model of first character to compose.
    @param textTiler IN determines areas in the line where text can flow.
    @param parcelIndex IN index into IParcelList of parcel in which yPosition lies.
    @param yPosition IN top of area to flow text into (y position of preceeding line
    or top of parcel if first line in parcel).
    @param waxStrand IN/OUT strand to apply composed wax line (IWaxLine) to.
    @result kTrue if wax line added to wax strand, kFalse otherwise.
  */
  virtual bool16 Recompose(IComposeScanner* composeScanner,
    TextIndex startingIndex,
    ITiler* textTiler,
    int32 parcelIndex,
    PMReal yPosition,
    IWaxStrand* waxStrand);
```

`RebuildLineToFit` is called to regenerate the wax runs for a wax line.No line breaking or line positioning need be done here.

figure 17.4.2.0.b. IParagraphComposer::RebuildLineToFit

```
/** Positions glyphs in the line and adds wax runs(IWaxRun) to the line.
Called when a wax line is added to the wax strand by Recompose and
when a wax line is restored from disc and must be rebuilt for
display.
@param rebuildMe line to be rebuilt.
@param startingIndex index into the text model of first character in this line.
@param composeScanner for story being composed.
@param textTiler not used in this implementation, the wax line gives the tiles.
@result kTrue if wax runs successfully rebuilt for this line, kFalse otherwise.
*/
virtual bool16 RebuildLineToFit(IWaxLine* rebuildMe,
  TextIndex startingIndex,
  IComposeScanner* composeScanner,
  ITiler* textTiler);
```

17.4.3. IComposeScanner

`kTextStoryBoss . . . . . IComposeScanner`

`IComposeScanner` provides methods that help access character and text attribute information from the text model.

Figure 17.4.3.a shows `QueryDataAt` which gets a chunk of data from the text model starting from a given `TextIndex`. It returns a pointer to the raw character data (`textchar*`) and, optionally, to the drawing style and the length of the chunk of data returned.It is recommended practice always to ask for the length of the chunk. It is the only way you can safely know how to use the `textchar*` the call returns. Sample code showing how to use `QueryDataAt` is given in "Frequently asked questions (FAQ)" on page 562.

figure 17.4.3.a. IComposeScanner::QueryDataAt

```
virtual const textchar* QueryDataAt
(
TextIndex position,
// TextIndex you want the run to start
IDrawingStyle **newstyle,
// output: drawing style at the given position. The caller must
// release the returned interface pointer. nil if not required.
int32 *length
// output: length of the chunk of text returned. Should only be nil if the
// caller is only interested in the character or drawing style at the given position
) = 0;
// Returns a pointer to the first character in the chunk of data , nil otherwise.
```

The drawing style can also be acquired by one of the methods listed in figure 17.4.3.b.

figure 17.4.3.b. Acquiring IDrawingStyle from IComposeScanner

```
virtual IDrawingStyle* GetCompleteStyleAt
(
  TextIndex position,
  int32 *lenleft = nil
) = 0;

virtual IDrawingStyle* GetParagraphStyleAt
(
  TextIndex position,
  int32 *lenleft = nil,
  TextIndex *paragraphStart = nil
) = 0;
// Returns the drawing style at a given TextIndex.
// lenleft can be used to find how many more characters the
// drawing style applies to.
```

Figure 17.4.3.c shows QueryAttributeAt which allows callers to query the effective value of a particular text attribute at a given TextIndex. It checks if a text attribute applies at the given position and returns its IAttrReport interface. Optionally it calculates the combined run length of the attribute over the range of text between startPosition and endPosition and passes it back to the caller in argument length. So if startPosition is 5 and endPosition is 20 and the attribute you query for applies to a run of 3 characters and a further run of 4 characters within the given range the combined run length would be 7.

figure 17.4.3.c. IComposeScanner::QueryAttributeAt

```
virtual IAttrReport* QueryAttributeAt
(
  int32 startPosition,
  // TextIndex at which you want to look for the text attribute
  int32 endPosition,
  // = startPosition if you don't want to find combined run length
  // of the attribute over the  range startPosition:endPosition
  ClassID typeAttribute,
  // attribute to look for e.g. kTextAttrPointSizeBoss
  int32 *length
  // output: combined run length of the attribute over range
  // startPosition:endPosition. nil if not required
) = 0;
```

17.4.4. IDrawingStyle

kComposeStyleBoss . . . . . IDrawingStyle

IDrawingStyle provides access to the effective values of major text attributes such as font, point size and leading. If the text property you are interested in is not in IDrawingStyle you will find it in one of the other style interfaces on kComposeStyleBoss.

figure 17.4.4.a. Some IDrawingStyle methods

```
virtual IPMFont* QueryFont() = 0;
virtual IFontInstance* QueryFontInstance(bool16 vertical) = 0;
virtual PMReal GetPointSize() const = 0;
virtual PMReal GetLeading() = 0;
virtual void FillOutRenderData(IWaxRenderData* data, bool16 vertical)
const = 0;
```

17.4.5. ICompositionStyle

kComposeStyleBoss . . . . . ICompositionStyle

`ICompositionStyle` provides access to indent, space before/after, keep with next, paragraph rule and the effective value of othet text attributes.

figure 17.4.5.a. Some ICompositionStyle methods

```
virtual PMReal IndentLeftBody() const = 0;
virtual PMReal IndentRightBody() const = 0;
virtual PMReal IndentLeftFirst() const = 0;
virtual PMReal SpaceBefore() const = 0;
virtual PMReal SpaceAfter() const = 0;
```

17.4.6. IHyphenationStyle

`kComposeStyleBoss . . . . . IHyphenationStyle`

`IHyphenationStyle` provides access to the language and other effective attributes values related to hyphenation.

17.4.7. IJustificationStyle

`kComposeStyleBoss . . . . . IJustificationStyle`

`IJustificationStyle` provides access to letter and word spacing and the effective values of other text attributes related to justification.

17.4.8. IPMFont

`. . . . . IPMFont`

`IPMFont` encapsulates the CoolType font API. It represents a typeface and can generate instances (IFontInstance) of it at various point sizes. Note `IPMFont` is not an `IPMUnknown` but it is reference counted and can be used with InterfacePtr.

17.4.9. IFontInstance

`. . . . . IFontInstance`

`IFontInstance` encapsulates the CoolType font instance API. It represents an instance of a typeface at a given size. Note `IPMFontInstance` is not an `IPMUnknown`. but it is reference counted and can be used with InterfacePtr.

`IFontInstance` controls the mapping from a character code (`textchar`) into the identifier of its corresponding glyph (`GlyphID`). The methods available are shown in figure 17.4.9.a.

figure 17.4.9.a. Some IFontInstance methods

```
virtual GlyphID GetGlyphID(textchar charCode) = 0;
virtual void GetGlyphWidth(Text::GlyphID glyphID, Fixed *xWidth,
  Fixed *yWidth, Fixed *bbox = nil) const = 0;
virtual PMReal GetAscent() = 0;
virtual PMReal GetDescent() = 0;
virtual PMReal GetCapHeight() = 0;
virtual PMReal GetXHeight() = 0;
virtual PMReal GetEmBoxHeight() const = 0;
```

17.4.10. ITiler

```
kFrameListBoss . . . . . . . . . . . . . . . . . . . . . . . . ITiler
kTextCellContentBoss . . . . . . . . . . . . . . . . . . . . . ITiler
```

`ITiler` manages the tiles for a parcel list and is used by paragraph composers to determine the areas on a line into which text can flow (see "Tiles" on page 541). It controls the width of each line.

The `GetTiles` method shown in figure 17.4.10.a. is used to get the tiles . Note that if `GetTiles` cannot find large enough tiles in the current parcel it will return kFalse and should be called again to see if the next parcel in the list can meet the request. If no parcel can meet the request the tiler will return tiles into which to flow overset text.

figure 17.4.10.a. ITextTiler::GetTiles

```
virtual bool16 GetTiles(PMReal minWidth,
  PMReal height, PMReal TOPHeight,
  Text::GridAlignmentMetric gridAlignment,
  PMReal gridAlignmentAdj,
  TextIndex nCurrentPosition,
  int32*pParcelIndex,
  PMReal *pYOffset,
  Text::FirstLineOffsetMetric *pTOPHeightMetric,
  PMRectCollection& tiles,
  bool16 *pAtTOP,
  bool16 *pVisible,
  bool16 *pParcelPositionDependent,
  PMReal *pLeftMargin,
  PMReal *pRightMargin) = 0;
```

`GetTiles` is a complex call to set up and you should study the API documentation and the text composer samples provided on the SDK to understand fully how to use it. The "TOP" abbreviation used in many of the parameter names is short for "top of parcel" since when a line falls at the top of

a parcel special rules apply that govern its height (see “First baseline offset” on page 542).

The essential parameters are the minimum tile width (minWidth), the minimum tile height (height) and the y position (pYOffset).

For Roman composers a tile must be wide enough to receive one glyph plus any left and right line indents that are active. A heuristic is often used that approximates the minimum glyph width to be the same as the leading. The minimum tile height depends on the metric being used to compose the line. This will normally be leading but the first line in a parcel is a special case where the metric used may vary dependent on the first baseline offset (ascent, cap height, leading) associated with the parcel. The `yOffset` indicates the top of the area into which text is to be flowed. It is actually a position rather than an offset from the top of the parcel. It will initially be the `yPosition` passed when the `IParagraphComposer::Recompose` method is called.

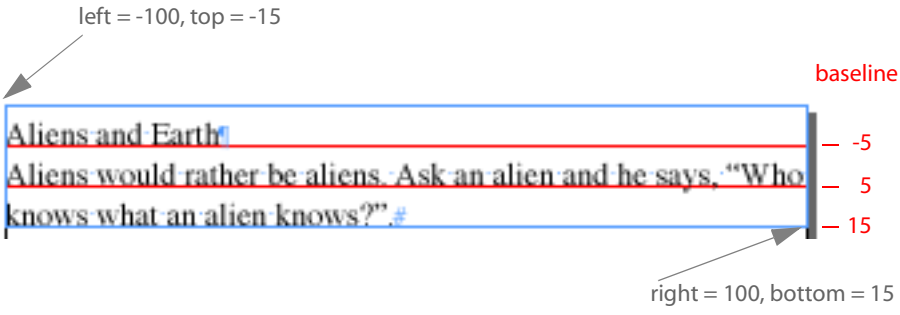
17.5. Scenarios

This section describes scenarios that illustrate how text gets recomposed. These will be of interest if you are considering implementing your own paragraph composer since they show some basic situations you’ll need to cope with. To reduce complexity it is assumed the paragraph composer being called just generates one line each call i.e. we are looking at a single line composer.

17.5.1. Simple text composition

Figure 17.5.1.a shows a composed text frame 200 points wide and 30 points deep with its baseline grid shown. The text is 8 point Times-Regular with 10 point leading and the first baseline offset for the frame is set to leading.

figure 17.5.1.a. Simple text composition



When text of the same appearance is flowed into the frame the distance between the baselines of succeeding lines of text is set to the leading as illustrated in figure 17.5.1.a.

The wax strand examines the paragraph attribute that specifies the paragraph composer to be used, locates it via the service registry. The paragraph composer is then asked to recompose the story from the beginning and to flow text into the frame starting from the top as shown in figure 17.5.1.b.

figure 17.5.1.b. IParagraphComposer::Recompose() Call

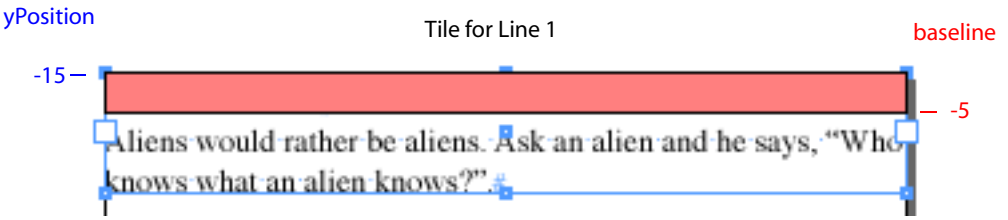
```
bool16 waxCreated = paragraphComposer->Recompose
(
  composeScanner, // scanner for story being composed
  startingIndex,  // =0, TextIndex of first character to be composed
  tiler,  // interface to determine areas to compose into
  parcelIndex  // =0, index into IParcelList of parcel in which yPosition lies
  yPosition,  // = -15, top of area to compose into
  waxStrand  // strand to apply composed lines to
);
```

The `yPosition` passed indicates the top of the area into which glyphs can be flowed. This will be the baseline of the preceeding line or the top of the parcel.

The paragraph composer acquires the drawing style from the compose scanner. and extracts the effective values of the text attributes it can handle. Please refer to SDK sample code to see how this is done.

The composer examines the drawing style and its associated font and calculates the depth and width of the tiles it needs. The example uses 8 point Times-Regular text with 10 point leading and no line indents so the minimum height and width would be 10 points.The tiler is then requested for tiles of the required depth and minimum width at the given yPosition and returns the tile shown in figure 17.5.1.c.

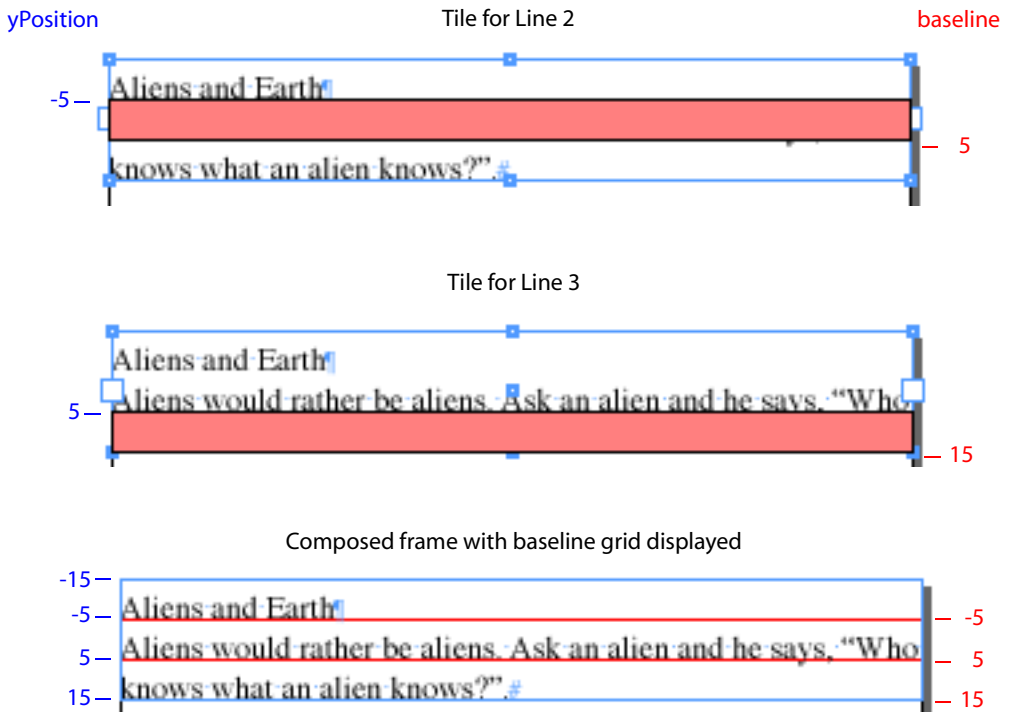
figure 17.5.1.c. Tiles for the first line



The paragraph composer then scans the text using IComposeScanner and flows text into the tile until the tile is full or an end of line character is encoutered. It chooses where the line should be broken and creates a wax line for the range of text the line will display. The wax line is applied to the `IWaxStrand` and as a side effect the composer's `IParagraphComposer::RebuildLineToFit` method gets called to generate wax runs for the line. Following this the `IParagraphComposer::Recompose` method is finished its work and returns control to its caller.

The wax strand then successively asks the paragraph composer to recompose the second and third lines with `yPositions` of -5 and 5 respectively until the text is fully composed as shown in figure 17.5.1.d.

figure 17.5.1.d. Tiles for the second and third lines



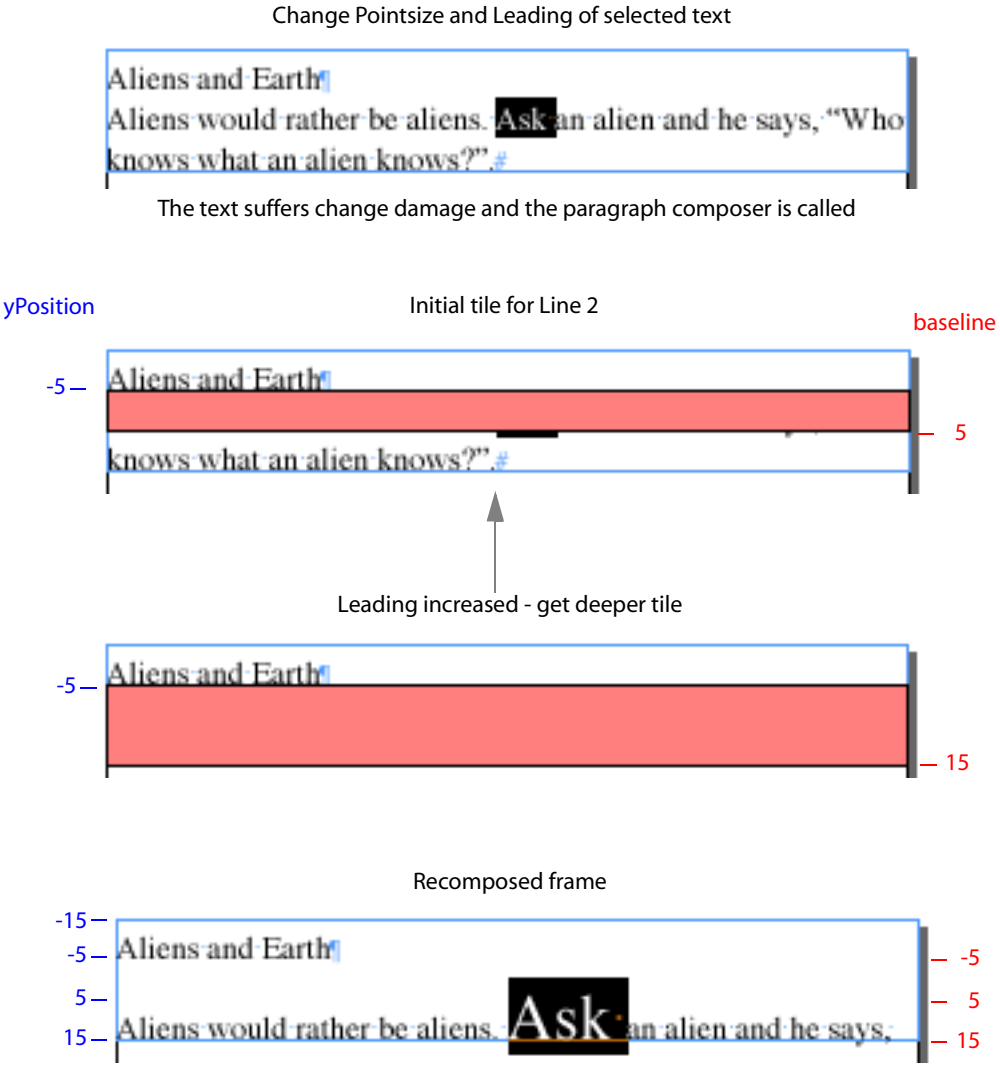
17.5.2. Change in text height on line

As a line is composed attributes that control the height of the line, point size and leading for example, may change. The baseline of the text must be set to reflect the largest value of the metric (leading, ascent etc.) that is being used to compose the text.

To achieve this the tiler is asked for tiles deep enough to take text of a given height. If an increase in text height is encountered as composition proceeds along a line the tiler needs to be asked for deeper tiles to accommodate the text i.e. the composer must ensure the parcel can receive the deeper text.

For example if the point size for the word "Ask" is changed to 16 points and its leading to 20 points the text suffers change damage. The resulting sequence of recomposition is illustrated in figure 17.5.2.a.

figure 17.5.2.a. Change point size and leading



Initially the composer encounters 8 point text on 10 point leading so it requests tiles of an appropriate depth. Then it hits the style change to 16 point text and 20 point leading. It goes back to the tiler and gets a deeper tile. Then the style changes back to the smaller point size. The composer already has a tile deep enough to take this text so it fills the tile with glyphs and breaks the line. Note how the baseline is set to reflect the largest leading value encountered in the line.

17.5.3. Text wrap

The text wrap settings on other page items or a change to the shape of the frame may become significant during recomposition depending on the `yPosition` and depth of the tiles needed. To illustrate this a graphic with text wrap as shown in figure 17.5.3.a. is added to the simple text frame arrangement.

figure 17.5.3.a. Simple text wrap

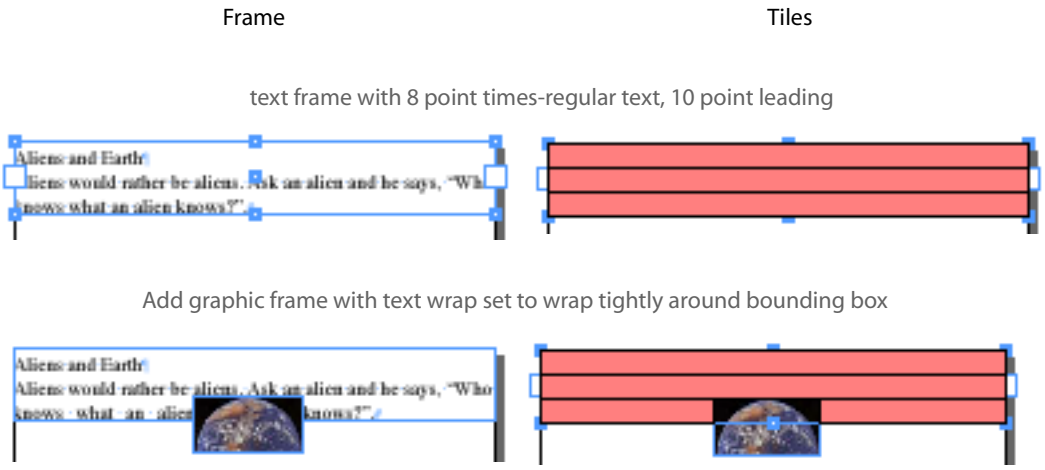


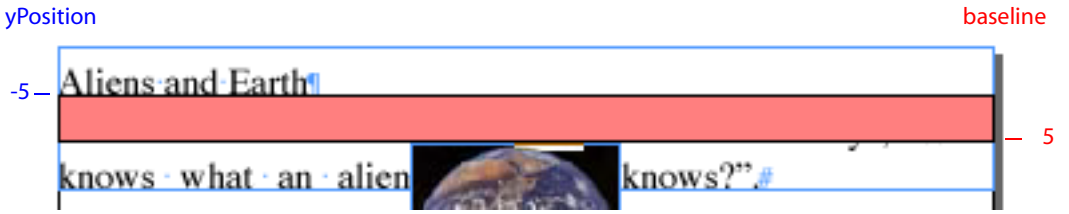
Figure 17.5.3.a shows the text frame and the tiles into which the 8 point text is flowed with 10 point leading. Note that the third line in the frame is affected by the text wrap and flows around the bounding box of the graphic.

The sequence below illustrates what happens when the point size for the word "Ask" is changed to 12 points and its leading to 14 points. The initial situation is shown in figure 17.5.3.b.

figure 17.5.3.b. Change the selection to 12 point text, 14 point leading

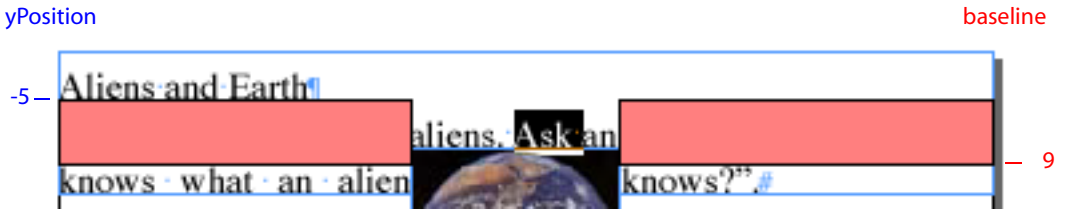
The wax strand picks up the change damage and asks the paragraph composer to recompose the first line of the second paragraph. The baseline of the first line of text in the frame, -5 points, is passed in as the `yPosition`.

figure 17.5.3.c. Composer begins to recompose



The paragraph composer gets tiles deep enough to take the initial leading value (10 points) it encounters on the line as shown in figure 17.5.3.c. Then it comes across the run of text with the changed point size and leading. Since the text is deeper than the tiles it has obtained the composer goes back to the tiler and asks for a new set of tiles to receive the deeper text as shown in figure 17.5.3.d.

figure 17.5.3.d. Composer asks for deeper tiles

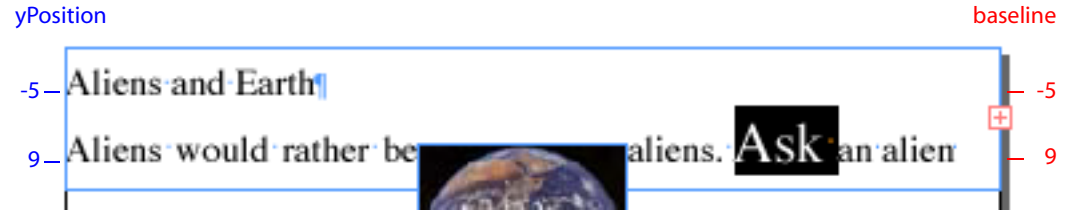


In this example the request for deeper tiles brings the text wrap setting on the graphic into play. The tiler returns the two tiles shown in figure 17.5.3.e so that text tightly wraps to the bounding box of the graphic.

figure 17.5.3.e. Deeper tiles

The paragraph composer now flows glyphs into the deeper tiles generating a wax line with four wax runs, one for the tile to the left of the graphic and three in the tile to the right of the graphic. In this case the change means that all of the text for the story cannot be displayed in the frame so the story is overset as shown in figure 17.5.3.f.

figure 17.5.3.f. Fully recomposed frame



An important lesson this scenario reinforces is that the tiles that are returned by the tiler depend on the `yPosition` within the frame for which they are requested and the depth asked for by the caller.

17.5.4. Frame too narrow or not deep enough

It is entirely possible that a frame is too narrow to accomodate any text when the indent settings for a paragraph are large or the text has a large point size. However the `IParagraphComposer::Recompose` method must return a wax line each time it is called. When this happens you are going to get overset text. The tiler (ITiler) should be called repeatedly until it turns a result kTrue. It will iterate over all the parcels and if none of them can accommodate the text it will return a tile overset text can be flowed into.

17.6. Sample code

17.6.1. SingleLineComposer

The SingleLineComposer plug-in shows how to add a new paragraph composer that composes Roman text one line at a time.

17.6.2. ComposerJ

The ComposerJ plug-in shows how to add a new paragraph composer that composes Japanese text one line at a time.

17.6.3. Hyphenator

The Hyphenator plug-in shows how integrate a custom hyphenation package into the application as a hyphenation service (IHyphenationService).

17.6.4. Other samples

The TextExportFilter plug-in shows how to scan characters using IComposeScanner.

17.7. Frequently asked questions (FAQ)

17.7.1. What is a paragraph composer?

See “Paragraph composers” on page 532.

17.7.2. What is typography?

See “Roman typography basics” on page 533, “Japanese typography basics” on page 535and “References” on page 567.

17.7.3. What is text composition?

See the “Text composition” chapter.

17.7.4. Where does a paragraph composer fit into the text architecture?

See “A paragraph composer’s environment” on page 538 and the “Text composition” chapter.

17.7.5. What is the compose scanner?

“The scanner and drawing style” on page 539.

17.7.6. What is drawing style?

“The scanner and drawing style” on page 539.

17.7.7. What is a font and what is a glyph?

See “Fonts and glyphs” on page 540.

17.7.8. What is a tile?

See “Tiles” on page 541.

17.7.9. What is an intrusion?

See “Tiles” on page 541.

17.7.10. What is HnJ?

See “HnJ” on page 533.

17.7.11. Can I do my own HnJ?

Yes, implement your line breaking breaking algorithm and justification in a paragraph composer. Integrate your hyphenation algorithm by making it available as a hyphenation service to and use it from your paragraph composer.

17.7.12. How do I implement a paragraph composer?

Study this chapter and use the referenced sample code as a starting point.

17.7.13. How do I control the paragraph composer used to compose text?

See “Paragraph composers” on page 532 for how this is controlled using the user interface. Programatically you need to set the paragraph attribute `kTextAttrComposerBoss` to reference the paragraph composer to be used.

17.7.14. How do I scan text?

If you only require access to character code data of a story the simplest API to use is the TextIterator class. There are many code snippets that show how it is used (e.g. SnipInspectStoryCharacters). If you don’t like processing character by character you can use `IComposeScanner` to access the characters in a story in larger chunks. Check out the SDK plug-in TextExportFilter for a fully worked example.

If you requireto access styled runs of text you should use IComposeScanner. See “How do I estimate the width of text?” on page 563 for an example.

17.7.15. How do I estimate the width of text?

You can estimate of the width of a character string in a given horizontal font using IFontInstance::MeasureWText. The code in figure 17.7.15.a shows how this is done.

figure 17.7.15.a. EstimateStringWidth

```
/** Return width of the string in the given horizontal font. To measure the width of
a character string in a vertical font you use IFontInstance::GetGlyphWidth.
@param text string to be measured.
@param fontInstance horizontal font
@return width of the string in the given font.
*/
```

```
static PMReal EstimateStringWidth(const WideString& text,
  IFontInstance* fontInstance)
{
  Fixed width;
  Fixed height;
  fontInstance->MeasureWText((textchar *)text.GrabX16String(),
    text.Length(),
    &width,
    &height);
  return ::ToPMReal(width);
} // EstimateStringWidth
```

To apply this estimate to a range of text in a story you can use `IComposeScanner` to access runs of characters that have the same drawing style. The code in figure 17.7.15.b illustrates this.

figure 17.7.15.b. EstimateTextWidth

```
/** Returns estimated width of a given text range by scanning the text using
IComposeScanner and estimating width using IFontInstance.
@param textModel text model to be scanned.
@param startingIndex of the first character to be measured.
@param span the number of characters to be measured.
@return total estimated width of a given text range.
*/
static PMReal EstimateTextWidth(ITextModel* textModel,
  const TextIndex& startingIndex,
  const int32& span
)
{
  // Use the story's compose scanner to access the text.
  InterfacePtr<IComposeScanner> composeScanner(textModel,
    UseDefaultIID());
  ASSERT(composeScanner);
  if (!composeScanner){
    return PMReal(0.0);
  }
  // Width of the given text range.
  PMReal totalWidth = ::ToPMReal(0.0);
  // Drawing style for the current run.
  InterfacePtr<IDrawingStyle> drawingStyle(nil);
  // Font for the current run.
  InterfacePtr<IFontInstance> fontInstance(nil);
  // Current index into the text model.
  TextIndex index = startingIndex;
```

```
// Number of characters still to be processed
int32 length = span;
// Number of characters returned by the compose scanner.
int32 chunkLength = 0;
// Character buffer.
WideString run;

// The compose scanner may not return all the text
// in one call. So call it in a loop.
while (length > 0) {
  // Drawing style for the next run.
  IDrawingStyle* nextDrawingStyle = nil;
  // Get a chunk of text.
  const textchar* text = composeScanner->QueryDataAt(index,
    &nextDrawingStyle,
    &chunkLength);
  if (text == nil || chunkLength == 0){
    break; // no more text.
  }
  ASSERT(nextDrawingStyle);
  if (!nextDrawingStyle) {
    break;
  }

  // If the drawing style changes measure the width of
  // buffered text and switch to the new style and font.
  if (nextDrawingStyle != drawingStyle) {
  if (run.Length() > 0) {
    totalWidth += EstimateStringWidth(run, fontInstance);
    run.Clear();
  }
  drawingStyle.reset(nextDrawingStyle);
  fontInstance.reset(drawingStyle->QueryFontInstance(
    kFalse)); // assume horizontal text.
  ASSERT(fontInstance);
  if (!fontInstance) {
    break;
  }
  } // end drawing style change
  else {
    // No change to drawing style but we still need to release.
    nextDrawingStyle->Release();
    nextDrawingStyle = nil;
  }

  // Buffer the characters returned by the compose scanner.
```

```
    if (chunkLength < length) {
      // Add all the characters to the run
      run.Append(text, chunkLength);
    }
    else {
      // Add only the characters we want to the run.
      // The compose scanner may more data than we need.
      run.Append(text, length);
    }

    // Prepare for next interation
    index += chunkLength;
    length -= chunkLength;
  } // end while

  // Process any buffered text.
  if (run.Length() > 0 && fontInstance != nil) {
    totalWidth += EstimateStringWidth(run, fontInstance);
  }
  return totalWidth;
} // EstimateTextWidth
```

17.7.16. How do I measure composed width or depth more accurately?

To measure the composed width and depth of text more accurately you can flow the text into a story that has a layout (text frames) and compose it with whatever paragraph composer you want. You can then scan the wax generated to find the width and depth measurement you are interested in. This is the only way you can account for the many properties that affect the composed text (the paragraph composer's line breaking agorithm, hyphenation, text style changes such as font, point size and leading etc.) and the effect of layout properties such as text wrap and first baseline offset. An example of the wax scanning part of this is given by the SnipTextEstimateDepth code snippet on the SDK.

Estimating the width or depth of text without flowing the text of a story into a layout is much more difficult. But in principle you can use the scanner and drawing style (`IComposeScanner` and `IDrawingStyle`) to scan the text and apply your own line breaking rules. This will quickly become a sort of mini paragraph composer and you'll need some of the code you will find in sample plug-in's like SingleLineComposer. Check out this sample's SLCTileComposer class for the kind of code you might use.

17.8. Summary

This chapter described paragraph composers, the component that creates the wax lines that represent the composed text of a line or paragraph. The environment in which a paragraph composer works was described in detail. The concepts and interfaces you need to know to write a new paragraph composer were explained and sample code available for further reference was introduced. The mechanisms used to create the wax were described. Finally some frequently asked questions were answered.

17.9. Review

You should be able to answer the following questions:

1. What is a paragraph composer? (17.3.1., page 532)
2. What is drawing style? (17.3.7., page 539)
3. What is the scanner? (17.3.7., page 539)
4. What is a tile? (17.3.9., page 541)

17.10. Exercises

17.10.1. Vertical Scale

Investigate the various scale methods on `IDrawingStyle` and enhance the SingleLineComposer plug-in on the SDK to apply the character attribute that controls vertical scale.

17.10.2. Paragraph Alignment

Investigate the various paragraph alignment methods in ICompositionStyle and enhance the SingleLineComposer plug-in on the SDK to be able to align left, right and centre.

17.10.3. Justification

Following on from the previous exercise enhance the SingleLineComposer plug-in so it can justify lines using whatever mixture of letter and word spacing you want.

17.11. References

- Modern digital typography topics
  http://www.adobe.com/type/topics/main.html
- A glossary of typographic terms
  http://www.adobe.com/type/topics/glossary.html

18.

Text Attributes and Adornments

18.0. Introduction

This chapter describes how your plug-ins can add custom text attributes to store custom properties you want to associate with a range of text. It also shows how your plug-in can adorn composed text by drawing when the wax is being drawn.

18.1. Goals

The questions this chapter answers are:

1. When would you want a custom text attribute?
2. How do you add a custom text attribute?
3. What is a text adornment?
4. How do you add a text adornment?

You should know what a text attribute is and have a working knowledge of the text model before trying to add new text attributes and text adorments. If you need more information on these topics you should read "The Text Model" chapter.

18.2. Chapter-at-a-glance

"Text Attributes" on page 570 describes why you might want to add a new text attribute.

"Text Adornments" on page 571 introduces adornments and how they work.

table 18.1.a. version history

Rev	Date	Author	Notes
0.1	15-May-00	Seoras Ashby	First Draft
0.2	9-Sep-02	Jane Zhou	Update to InDesign 2.0.x content

"Text Attribute and Text Adornment Interfaces" on page 575 describes the interfaces involved in adding text attributes and adornments.

"Working with Text Attributes and Text Adornments" on page 579 describes some practical examples of adding text attributes and adornments.

"Summary" on page 579 provides a summary of the material covered in this chapter.

"Review" on page 579 provides questions to test your understanding of the material covered in this chapter.

18.3. Text Attributes

Text attributes were introduced in "The Text Model" chapter as follows:

> A text attribute describes a single text property. It can apply either to a range of characters (such as the color or point size of characters) or to a paragraph (such as paragraph alignment or the drop-cap being applied).

You can add a custom **text attribute** to store a property you wish to associate with a range of characters or paragraphs.

Your text attribute could store a property that affects how text is formatted. The majority of the text attributes provided by the application are used for this purpose. For example, `kTextAttrFontUIDBoss` and `kTextAttrPointSizeBoss` are text attributes used to store the font and point size of characters. Such attributes need to be processed by the text composer. So in this situation you would need to add a new paragraph composer to apply your properties (please read the "Text Composition" chapter for more information on implementing a new paragraph composer). You could also choose to extend the application's **New Style...**, **Style Options...** and **Find/Change...** selectable dialogues to add new dialogues that manipulate your text attributes.

Alternatively you might want to associate some data with a range of characters, and you don't want the text in your attribute styled. To achieve this you would add a new custom text attribute to store the text. See our SDK samples CHDataMerger and BasicTextAdornment for implementation details.

Text attribute boss usually inherits from kAttrBossReferencingBoss, which is only for debug purpose to hold the number of attribute boss lists that a particular attribute boss is part of it.

If you want to know a specific text attribute that InDesign supports, please check out the appendix that lists all text attributes provided by the application.

18.4. TextAttributeRunIterator

TextAttributeRunIterator can iterate over multiple ranges of text and access a specified set of text attributes. It can also apply attributes to the current text range.

This is a special iterator. To access the results, you don't need to dereference the iterator. Instead, you could use the overloaded -> operator to query the result you are looking for. For example, you want to search for the point size within a range of text. Here is what you would do:

```
// textRanges is the range of text to be searched, ItÕs
K2Vector<InDesign::TextRange>
// attributeClasses is the text attributes to be looked for, ItÕs
K2Vector<ClassID>

TextAttributeRunIterator runIter(textRanges->begin(), textRanges-
>end(),
  attributeClasses.begin(), attributeClasses.end());
while (runIter)
{
  InterfacePtr<const ITextAttrRealNumber> pointSizeAttr
  (
    static_cast<const ITextAttrRealNumber *>
    (
      runIter->QueryByClassID(kTextAttrPointSizeBoss,
      ITextAttrRealNumber::kDefaultIID)
    )
  );
  PMReal pointSize = pointSizeAttr->Get();
  ++runIter;
}
```

18.5. Text Adornments

Text adornments provide a way for plug-ins to adorn the wax, i.e. composed text. They give a plug-in the opportunity to do additional drawing when the wax in a frame is drawn. The wax draws the text and also calls the text

adornments that it is aware of to draw. You need to arrange for your text adornment to be attached to the wax in order for this to happen.

Text Adornments are bosses that are "attached" by ClassID to individual wax run. When the run is drawn, they are given control via interface ITextAdornment.

Adornment Draw() method gets called by the priority value it returns via its GetDrawPriority() method. Higher priorities (smaller numbers) are called before lower priorities (larger numbers).

Text adornments do not have the ability to influence how text is composed (i.e. how characters are built into wax lines and wax runs by text composition). Instead text adornments can augment the appearance of the text. A text adornment can control whether it is drawn in front of or behind the text.

There are two types of text adornments, normal text adornments and global text adornments.

18.5.1. Normal Text Adornments

A normal text adornment is controlled by one or more text attributes. It can provide visual feedback of the text to which the text attributes apply. For example, an adornment could highlight the background on which the text is drawn or strike out text by drawing a line in the foreground.

The text attribute controls the process by interacting with text composition and associating the adornment with a drawing style (see interface `IDrawingStyle` in the “Text Composition” chapter). This causes the text composer to attach the adornment to a wax run(see interface `IWaxRenderData` in “The Wax” chapter).

Figure 18.5.1.a shows the main text adornments used by the application and the text attributes that control them.

figure 18.5.1.a. Application Text Adornment Descriptions

Adornment ClassID	Attribute ClassID	Description
kTextAdornmentStrikeoutBoss	kTextAttrStrikeoutBoss	Strikes out text
kTextAdornmentStrikethruBoss	kTextAttrStrikethruBoss	Strikes through text
kTextAdornmentUnderlineBoss	kTextAttrUnderlineBoss	Underlines text

figure 18.5.1.a. Application Text Adornment Descriptions

Adornment ClassID	Attribute ClassID	Description
kTextHyperlinkAdornmentBoss	kHyperlinkAttributeBoss	Hyper link mark
kTextAdornmentIndexMarkBoss	kTAIndexMarkBoss	Index mark
kTextAdornmentKentenBoss	kTAKentenSizeBoss, etc.	Adorns text for the purpose of emphasis
kTextAdornmentRubyBoss	kTARubyPointSizeBoss, etc.	Annotates base text

To add a normal text adornment, you first need to add a new text attribute. In more complex situations you might use more than one text attribute to control a single text adornment. For example, kTAKentenSizeBoss, kTAKentenRelatedSizeBoss, kTAKentenFontFamilyBoss, and kTAKentenFontStyleBoss, etc. control collectively the kenten adornment implemented by the kTextAdornmentKentenBoss.

Normal text adornments are attached to a drawing style and subsequently to an individual wax run. These adornments are always called to draw. However, they may choose whether or not to draw anything.

18.5.2. Global Text Adornments

Global text adornments are considered to be attached to all wax runs, with the exception that they never have run specific adornment data. They provide the ability to draw something without requiring the text to be recomposed. Unlike the normal text adornments described above, they do not need to be attached to individual wax runs in order to draw. They will, however, be asked if they are active before they are called to draw.

For example the **Show Hidden Characters** feature is implemented using a global text adornment named `kTextAdornmentShowInvisiblesBoss`. The adornment can have the behavior as if was attached to all the runs, but only get called when it says so by having its GetIsActive() method query the state of the menu pick.

The global text adornments used by the application are listed in figure 18.5.2.a.

figure 18.5.2.a. Application Global Text Adornment Descriptions

Adornment Boss	Description
kTextAdornmentHJKeepsVBoss	Highlight keeps violations

figure 18.5.2.a. Application Global Text Adornment Descriptions

Adornment Boss	Description
kTextAdornmentMissingFontBoss	Highlight missing fonts
kTextAdornmentMissingGlyphsBoss	Highlight missing glyphs
kTextAdornmentShowInvisiblesBoss	Show hidden characters
kDynamicSpellCheckAdornmentBoss	Squiggle line to mark the spell checks
kTextAdornmentShowKinsokuBoss	Show Japanese character line break
kTextAdornmentShowCustomCharWidthsBoss	Mark character width as a filled rectangle
kXMLMarkerAdornmentBoss	XML marker

Global text adornments are service providers. The ServiceID is kGlobalTextAdornmentService. They aggregate the `IK2ServiceProvider` interface and use the default implementation `kGlobalTextAdornmentServiceImpl`.

18.6. Text Attribute and Text Adornment Interfaces

18.6.1. Interface Diagram

figure 18.6.1.a. Text Attribute and Normal Text Adornment Interface Diagram

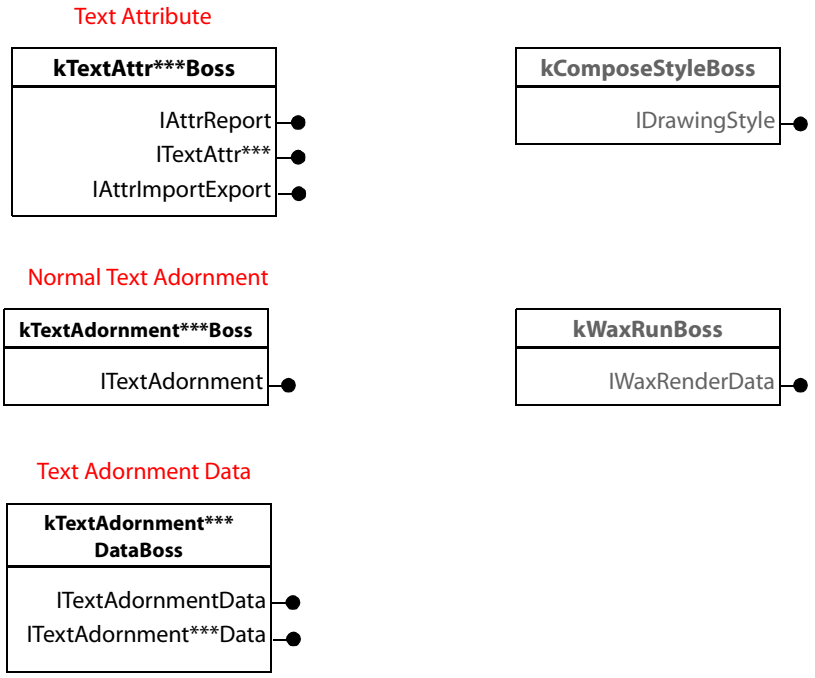


figure 18.6.1.b. Global Text Adornment Interface Diagram

18.6.2. IAttrReport

`kTextAttr***Boss . . . . . IAttrReport`

All text attributes provide an implementation of interface `IAttrReport`. Bosses that support this interface are recognized by the application as text attributes.

`IAttrReport` describes the attribute to the application and provides the mechanism for controlling a text adornment.

18.6.3. ITextAttr***

`kTextAttr***Boss . . . . . ITextAttr***`

`ITextAttr***` represents the interface where you store the value of your text attribute. The interface must have a persistent implementation with a `ReadWrite()` method (see the "Persistence" chapter).

There are a number of existing interfaces that may be suitable for storing the value you want to maintain in your text attribute. These are shown in figure 18.6.3.a. For their persistent implementation IDs, please see TextAttrImplID.h.

figure 18.6.3.a. Text Attribute Value Interfaces

Interface	PMIID	Description
ITextAttrRealNumber	IID_ITEXTATTRREALNUMBER	real number value
ITextAttrBoolean	IID_ITEXTATTRBOOLEAN	boolean flag value
ITextAttrInt16	IID_ITEXTATTRINT16	int16 value
ITextAttrUID	IID_ITEXTATTRUID	UID value to reference another object
ITextAttrWideString	IID_ITEXTATTRWIDESTRING	double byte string value

Alternatively you can create a new interface that stores the data you need. You need to provide your own persistent implementation for it though.

18.6.4. IAttrImportExport

`kTextAttr***Boss . . . . . IAttrImportExport`

`IAttrImportExport` allows your text attribute to interact with the Adobe InDesign Tagged Text filter. Implementation of this interface is optional.

If you choose to implement this interface, it will be called when Adobe InDesign Tagged Text files are exported and imported, which will give the opportunity to write tags on export and to apply tags on import, respectively.

18.6.5. ITextAdornment

`kTextAdornment***Boss . . . . . ITextAdornment`

Normal text adornments are bosses that are attached by `ClassID` to individual wax runs. This happens in two stages:

1. the text adornment must be controlled by a text attribute. When the text attribute's `TellComposition()` method is called it attaches the adornment to the drawing style it is given (see method `AddTextAdornment()` on interface `IDrawingStyle` in the "Text Composition" chapter).
2. text composition will subsequently attach the adornment to the wax run it creates (see interface `IWaxRenderData` in "The Wax" chapter).

When a wax run is drawn, each attached text adornment is called via the `ITextAdornment` interface.

The wax in a frame is drawn in a number of passes. A text adornment tells the application whether it should be drawn behind the glyphs (i.e. in the background), in front of the glyphs (i.e. the foreground) or somewhere in between. The draw priority returned by their `GetDrawPriority()` method controls when the adornment is called to draw. Higher draw priorities (smaller numbers) are called to draw before lower draw priorities (larger numbers).

Furthermore, draw priority is a real number that breaks down into two pieces:

- **pass** (the whole part of the draw priority value).
- **run** (the fractional part of the draw priority value).

For each unique pass value across all the active adornments in a frame, a full iteration of the wax runs will be made calling all the adornments which share that pass value. Then, within each wax run, the adornments will be called based on their run priority. Some predefined pass priorities are listed in TextDrawPriority.h.

For performance reasons, it is important to minimize the number of passes that are made over the wax. Try to piggyback your drawing on an existing pass, such as `kTAPassPriBackground`, `kTAPassPriText` or `kTAPassPriForeground`. If drawing your adornment on a particular run will be negatively affected by some other adornment drawn on another run within the same pass, you may need to define its own pass. This is usually the case with fill type operations. These types of adornments usually require their own pass.

`GetInkBounds()` gives you the opportunity to adjust the **ink bounds** of the wax. The ink bounds passed into the method are empty. If the adornment

draws within the ink bounds of the wax line, then it doesn't have to modify the ink bounds (see interface IWaxShape in "The Wax" chapter). The text composer will set the ink bounds when it creates the wax. You only need to set the inkBounds argument if your adornment needs to draw outside of the ink bounds of the wax line.

If you want to know the bounds of the wax line that owns the wax run you can navigate to it using the methods found in IWaxRun. You can find the ink bounds of the wax line in interface IWaxShape.

18.6.6. IGlobalTextAdornment

kTextAdornment***GlobalBoss . . . . . IGlobalTextAdornment

Global text adornments are special kinds of text adornments in that they are treated as if they were attached to every wax run, with the exception that they never have run specific adornment data.

GetIsActive() is invoked at the start of each draw pass and allows a global text adornment indicate that its Draw() method should or should not be called. A typical implementation would check a flag stored in the plug-in's preferences to see whether or not the adornment is active. The purpose of this method is to give the parcel a chance to avoid passes and calling adornments that aren't needed. For example, if a particular adornment was the only one needing to be called on a particular pass and the adornment wouldn't be drawing because of some global state, the pass could be avoided by returning kFalse.

Some known Adobe global adornments draw priorities are predefined in IGlobalTextAdornment.h.

EndOfParcelDraw() is called at the end of each pass through the elements in a parcel. The parcelShape passed into this method may not be a UID based object.

18.6.7. ITextAdornmentData

kTextAdornment***DataBoss . . . . . ITextAdornmentData

Your text adornment can optionally have a text adornment data boss associated with it. All text adornment data bosses must support the `ITextAdornmentData` interface.

The key concept here is that even though the drawing style has the adornment attached to it, it won't actually get attached to the wax run unless the adornment data says it is active.

18.6.8. ITextAdornment***Data

`kTextAdornment***DataBoss . . . . . ITextAdornment***Data`

Your text adornment data boss can support whatever interface, or interfaces you need, to maintain the properties needed to control what your text adornment draws.

18.6.9. IK2ServiceProvider

`kTextAdornment***Boss . . . . . IK2ServiceProvider`

Global text adornments must support the `IK2ServiceProvider` interface. You should use the default implementation `kGlobalTextAdornmentServiceImpl` provided by the application for this interface.

18.7. Working with Text Attributes and Text Adornments

See our sample plug-ins BasicTextAdornment and CHDataMerger in the SDK for how to add custom text attributes and adornments.

18.8. Summary

This chapter described how to add custom text attributes and text adornments.

18.9. Review

You should be able to answer the following questions:

1. When would you want to add a custom text attribute?
2. What is a text adornment?
3. Name different types of text adornments InDesign supports?

18.10. Appendix

Below is a table of text attributes supported by InDesign 2.0.x.

19.

Working with Text Styles

19.0. Overview

This chapter describes how to program with text styles. The theory behind text styles is explained and sample code showing how a plug-in can manipulate text styles is presented.

19.1. Goals

The goals for the section:

1. To introduce the practical aspects of styles, specifically:
   - What is a text style.
   - How to get information about text styles.
   - How to expose the values of a particular text style.
2. How to gain access to the styles through the `StyleNameTables`.
3. How to get information about the value of a particular text attribute.
4. The relationships between styles.
5. Using styles
   - Creating styles.
   - Editing styles.
   - Applying styles to ranges of text.
   - Deleting styles.

19.2. Chapter-at-a-glance

"Text Styles" on page 583 discusses the definition of paragraph and character styles.

"Style Name Tables" on page 584 discusses how styles are accessed through name tables in the workspace.

"Text Attribute Descriptions" on page 585 shows how attributes can be asked to describe themselves.

"Style Relationships" on page 585 provides code that allows the natural parent - child relationships between styles to be investigated.

"Creating Styles" on page 590 shows the steps necessary to create a style.

"Applying Styles" on page 590 details how to apply a style to text.

"Editing styles" on page 590 provides an example of how to edit an existing style.

"Default Styles" on page 591 discusses the concept of the *default style*, and how to programmatically set it.

"Deleting Styles" on page 591 shows how a style can be deleted, and discusses some associated issues.

table 19.2.a. version history

Rev	Date	Author	Notes
2.0	23-Oct-02	Lee Huang	Update content for InDesgn 2.x API
0.3	14-Jul-00	Adrian O'Lenskie Seoras Ashby	Third Draft
0.2	15-May-00	Adrian O'Lenskie Seoras Ashby	Second Draft
0.1	01-May-00	Adrian O'Lenskie Seoras Ashby	First Draft

"Review" on page 592 provides questions to test your understanding of the material covered in this chapter.

"Exercises" on page 593 provides suggestions for other tasks you might want to attempt.

19.3. Text Styles

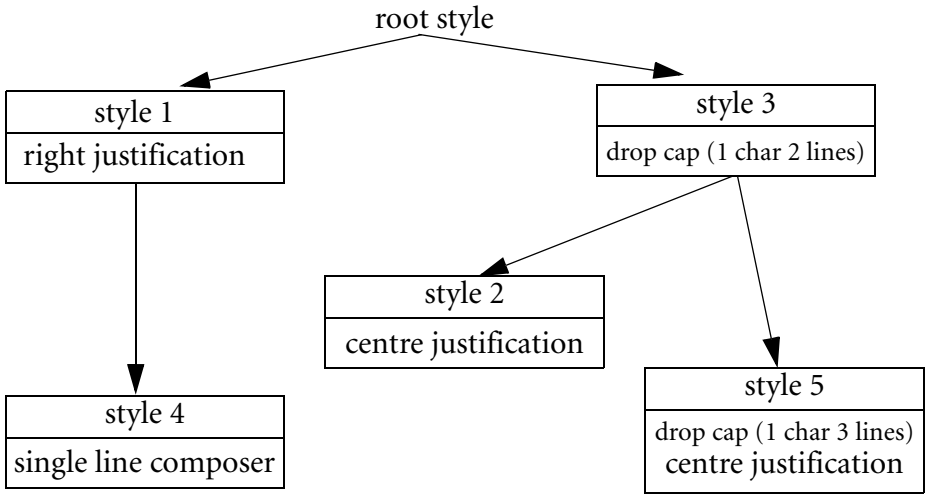
A **text style** can be considered as a container that holds a set of text attributes. There are two types, one for paragraphs and the other for ranges of characters.

Paragraph styles hold both paragraph and character attributes, allowing total control of the formatting of paragraphs. For example, the paragraph style "quote" might be used to represent inline quotes. We might want this text to be centre justified, have a certain left and right offset, and a particular set of rules to govern hyphenation. All these are determined by paragraph level attributes. It is also likely that we want to define character level attributes to be associated with the style, for example the type face being italic, leading or even the colour.

Character styles hold only character attributes. They are used to control ranges of characters and provide a subset of the functionality of paragraph attributes (albeit at a per character granularity rather than per paragraph).

We will consider paragraph styles in the first instance, as they contain a superset of attributes allowed. Imagine we have the styles set up as described in figure 19.3.a. As is shown, all styles derive from the root style. The styles record *deltas* from their parent's style. So, style 1 is identical to the root style, except justification is right. Style 4 is the same as style 1, except it uses the single line composer rather than the multi-line composer. Of course, style 4 has two differences from the root style, the composer and its justification (which it inherits from style 1 to be right justified). We are going to use this example to demonstrate how styles information can be extracted and manipulated with InDesign.

figure 19.3.a. Set of Paragraph styles within a document.



19.4. Style Name Tables

Styles are maintained within workspaces (`kWorkspaceBoss` and `kDocWorkspaceBoss`). Specifically they are accessed through the `IStyleNameTable` interface (one exists for both the paragraph styles and character styles in each workspace). The prototype for this interface is given in `IStyleNameTable.h`

The snippet `SnipInspectTextStyles.cpp` dumps the names of all the paragraph styles supported by the front-most document to the `SnippetRunner`'s Log window. The snippet uses `IWorkspace` to get to the paragraph or characther's `IStyleNameTable`, then calls the `IStyleNameTable`::GetRootStyleUID() method to get to the root of the style name table, from there, we can recursively get to all the children of the root style.

One thing worth special attention is how we get to either paragraph or character style name table by querying the interface (`IStyleNameTable`) with a different interface IID (`IID_ICHARSTYLENAMETABLE` or `IID_IPARASTYLENAMETABLE`).

For paragraph style name table:

```
InterfacePtr<IStyleNameTable>
iParaStyleNameTable(iWorkspace,IID_IPARASTYLENAMETABLE);
```

and for character style name table:

```
InterfacePtr<IStyleNameTable>
iCharStyleNameTable(iWorkspace,IID_ICHARSTYLENAMETABLE);
```

By examing `kDocWorkspaceBoss` in the InterfaceList.txt, we can see both IIDs are part of the `kDocWorkspaceBoss`, both implementation are based on `IStyleNameTable`, this is so we can use different IID to get to different implementation of the same interface, namely, `IStyleNameTable`.

Executing the snippet with the styles as set in figure 19.3.a yields similiar output as shown in figure 19.4.a.

figure 19.4.a. Extracting style names from the stylenametables

```
[No paragraph style] has parent:Root
Paragraph Style 1has parent: [No paragraph style]
Paragraph Style 4 has parent: Paragraph Style 1
Paragraph Style 3 has parent: [No paragraph style]
Paragraph Style 2 has parent: Paragraph Style 3
Paragraph Style 5 has parent: Paragraph Style 3
```

19.5. Text Attribute Descriptions

Before we continue much further into examining styles, we should look at the basic building block -the text attribute and how we can get diagnostic information from it. The code in `SnipInspectTextStyles:reportAttribute()` in `SnipInspectTextStyles.cpp` will return in the parameter Description a string representing the current value of the text attribute (if the text attribute boss supports this feature).

This code asks the attribute to describe itself (the `AppendDescription()` method of `IAttrReport` allows the attribute to indicate what it is set to, for example the `kTextAttrPointSize` boss might indicate it is set to "+size: 6pt"). Not all attributes report their status, so in this case we attempt to get the attribute name from the object model. Not all boss objects register a name with the object model, so in this case we display the `ClassID` of the boss. Attributes that do not report their "current" value are designed for internal use, and can be ignored by developers.

19.6. Style Relationships

The relationships between styles can be investigated programmatically. What we will do now is dissecting the `SnipInspectTextStyles` class of the `SnipInspectTextStyles.cpp` in more details to show how you can interrogate the application to determine the relationships the styles have with each other,

and the text model in general. The code snippet illustrated in this section were extracted from the `SnipInspectTextStyles.cpp`, for simplicity, some error checkings were omitted.

We are attempting to display information regarding the relationships between all styles in a workspace. The first thing to do would be to decide the workspace we were concerned with. As shown in figure 19.6.a. `ILayoutUtils::QueryActiveWorkspace()` can be used to get the current active workspace. When there is a document opened, the active workspace will be the front most document's workspace, represented by the `IWorkspace` of the `kDocWorkspaceBoss`. If there is no opened document, the active workspace would be the the `IWorkspace` of the `kWorkspaceBoss`.

figure 19.6.a. Getting the active workspace

```
InterfacePtr<IWorkspace> iWorkspace(Utils<ILayoutUtils>()-
>QueryActiveWorkspace());
```

Now we have identified the workspace we wish to examine, assuming we are concerned with the paragraph styles. This being so, we need to get the root style for the paragraph style table, and dump information regarding that. This is shown in figure 19.6.b.

figure 19.6.b. Getting the root paragraph style

```
// dumps paragraph style information for the active workspace
InterfacePtr<IStyleNameTable>
iParaStyleNameTable(iWorkspace,IID_IPARASTYLENAMETABLE);
UID rootStyleUID = iParaStyleNameTable->GetRootStyleUID();
status = helperInspectStylesRecurse(iParaStyleNameTable, rootStyleUID,
0, stream);
```

The `helperInspectStylesRecurse` method is recursive, it takes a name table, a node within that name table, an indication of the level in the hierarchy it exists in (for text formatting purposes) and a file stream that we will output the result to. From this, it recurses down the table until it has displayed all nodes in order (i.e. children are displayed within the scope of their parent rather than the ordering of the table). For details, please refer to the `helperInspectStylesRecurse` method in the `SnipInspectTextStyles.cpp`.

`helperInspectStylesRecurse` displays the information about the current style before iterating through the style name table. Whenever it finds a node that has

a parent that is the current style (i.e. a child of the current style), it dumps the node (and its children).

The next task to perform is the display of the diagnostic information, the code that does this is shown in `SnipInspectTextStyles::helperDisplayStyleInformation()`.

The `helperDisplayStyleInformation()` method gets information regarding this style's parent before determining how it differs from that parent. For every attribute that is different, it calls the method (described above) to generate the diagnostic information. The output of the style information is streamed to an external file called `style.log` because the information is too much to fit into the SnippetRunner window.

If we iterate through all styles in the document displaying this diagnostic information with the set of styles as described in figure 19.3.a, we would see output looking like that shown in figure 19.6.c.

figure 19.6.c. Example trace when tracing through all styles in a document

```
-----------------[No paragraph style] -- Based on Root------------------
Number of bosses is 196
-:Description:-
 + color: [Black] + Roman + size: 12 pt + last: flush left + body: flush left
 + char width: 100% + pair kern method: Metrics + ligaturescurrent + stroke: 1 pt
 + tracking: 0 + composer:  Adobe Paragraph Composer + drop cap characters:  0 + drop
cap lines:  0 + not shifted
 - caps + stroke color: [None] + pair kern: auto + consecutive hyphens: 3 + char
height: 100%
 + left indent:  0p0 + right indent:  0p0 + first indent:  0p0 + autoleading: 120% +
leading: auto
 + language: English: USA + hyphenation + min before: 2 + min after: 2 + hyphenate
capitalized
 + shortest word: 5 - no break + hyphenation zone:  3p0 + space before: 0p0 + space
after: 0p0
 + tabs: none - underline + Times + default figure style + desired wordspace: 100%
 + max. wordspace: 133% + min. wordspace: 80% + desired letterspace: 0% + max.
letterspace: 0% + min. letterspace: 0%
 + desired glyph scaling:  100% + max. glyph scaling:  100% + min. glyph scaling:
100%~ Boss 0x1b36(6966)  - start anywhere
 + keep at start/end of paragraph + keep next:  0 + keep first:  2 + keep last:  2 +
position: normal
 - strikethrough + em center hang + alt: 0% - keep lines + stroke tint: 100%
 + tint: 100% - stroke overprint - overprint + stroke gradient angle: 0Á + gradient
angle: 0Á
 + stroke gradient length: -1 pt + gradient length: -1 pt~ Boss 0x1b49(6985) ~ Boss
0x1b4a(6986)  + skew angle: 0Á
 + rule above color: (Text Color) + rule above stroke: 1 pt + rule above tint: -1% +
rule above offset: 0p0 + rule above left indent: 0p0
 + rule above right indent: 0p0 + column width rule above + rule below color: (Text
Color) + rule below stroke: 1 pt + rule below tint: -1%
 + rule below offset: 0p0 + rule below left indent: 0p0 + rule below right indent:
0p0 + column width rule below - rule above overprint
 - rule below overprint - rule above - rule below~ Boss 0x1b5e(7006)  + highlight
angle: 0Á
 + highlight length: 1 pt + stroke highlight angle: 0Á + stroke highlight length: 1
pt~ Boss 0x1b63(7011)  + strikeout
~ Boss 0x1b6a(7018)  + single: force-justified - OT ordinal - OT fractions - OT
discretionary ligatures
 - OT titling~ Boss 0x1b7a(7034)  + hyphen weight: 5 + OT contextual alternates - OT
swash
 + Tsume:  0% + Mojikumi:   + Aki before char:  automatic + Aki after char:
automatic + Kinsoku:  No Kinsoku
 + Kinsoku Type:  KinsokuPushInFirst + Hang Type:  KinsokuNoHang + Bunri-Kinshi~
Boss 0x4228(16936)  - Ruby Open Type Pro
~ Boss 0x422d(16941) ~ Boss 0x422e(16942)  + Ruby Point Size:  Str_Auto~ Boss
0x4230(16944)  + Ruby Alignment:  1-2-1 (JIS) rule
 + Ruby Type:  Per-Character Ruby + Ruby Font:   + Roman + Spacing:1-2-1 aki + Ruby
X Scale:  100%
 + Ruby Y Scale:  100% + Ruby X Offset:  0 pt + Ruby Y Offset:  0 pt + Ruby Position:
Above/Right - Ruby Auto Align
 + Ruby Overhang:  Up to 1 Ruby Character - Ruby Overhang - Ruby Auto Scaling + Ruby
AutoScale Min:  66% + Ruby Color:  Str_Auto
 + Ruby Tint:  Str_Auto + Ruby Fill OverprintAuto + Ruby Stroke Color:  Str_Auto +
Ruby Stroke Tint:  Str_Auto + Ruby Stroke OverprintAuto
 + Ruby Outline:  Str_Auto + Kenten Kind:  None + Kenten Size:  Str_Auto + Kenten
Related Size:  1 pt + Kenten Font:
~ Boss 0x424b(16971)  + Kenten X Scale:  100% + Kenten Y Scale:  100% + Kenten
Placement:  0 pt + Kenten Alignment:  Center
 + Kenten Position:  Above/Right + Kenten Character:   ~ Boss 0x4253(16979)  + Kenten
Color:  Str_Auto + Kenten Tint:  Str_Auto
Kenten OverprintAuto + Kenten Stroke Color:  Str_Auto + Kenten Stroke Tint:
Str_AutoKenten Stroke OverprintAuto + Kenten Outline:  Str_Auto
 - Tatechuyoko + Tatechuyoko X Offset:  0 pt + Tatechuyoko Y Offset:  0 pt + Kumi
Number:  0 - Kumi Number with Roman
 + Jidori:  0 + Grid Gyoudori:  0 - Grid Align First Line + Grid Alignment:  None +
Character Rotation:  0Á
 - Rotate Roman~ Boss 0x4269(17001) ~ Boss 0x426a(17002) ~ Boss 0x426b(17003)  +
```

```
Rensuuji
 + Shatai Percentage:  Ø% + Shatai Angle:  45Á + Shatai Adjust Tsume - Shatai Adjust
Rotation - Warichu
 + Warichu lines: 2 + Warichu size: 5Ø% + Warichu line gap: Ø pt + Warichu:AlignLeft
+ Alternate Glyph:  Default form
 + Warichu minimum characters before: 2 + Warichu minimum characters after: 2 +  -
OTF Use H or V Kana - OTF Use Proportional Metrics
 - OTF Use Roman Italics + Leading Model:  Aki Below~ Boss Øx429f(17Ø55)  - Index
Marker~ Boss Øx13516(79126)
~ Boss Øx13549(79177)
-----------------Paragraph Style 1 -- Based on [No paragraph style]----------------
--
Number of bosses is 2
-:Description:-
 + last: flush right + body: justified
-----------------Paragraph Style 4 -- Based on Paragraph Style 1------------------
Number of bosses is 1
-:Description:-
 + composer:  Adobe Single-line Composer
-----------------Paragraph Style 3 -- Based on [No paragraph style]----------------
--
Number of bosses is 2
-:Description:-
 + drop cap characters:  1 + drop cap lines:  2
-----------------Paragraph Style 2 -- Based on Paragraph Style 3------------------
Number of bosses is 2
-:Description:-
 + last: centered + body: justified
-----------------Paragraph Style 5 -- Based on Paragraph Style 3------------------
Number of bosses is 3
-:Description:-
 + last: centered + body: justified + drop cap lines:  3
```

The above code shows all the information maintained within the styles of the frontmost document. It also shows the relationships between styles. A style that is based on another style is shown below that style. The description of the style overrides that given for the particular attribute in the parent style.

As you can see, the output shows all the default values of the attributes supported within the application. The root style (named "[No Paragraph Style]") maintains the whole list of attributes (along with attributes never seen in the UI). The styles derived from this root style record only the differences.

So, Style 3 is based on this default style, but rather than having 0 drop characters over 0 lines as defined in the root style, it defines a single drop character to be dropped two lines.

Style 2 is based on Style 3, so as well as defining the text to be center justified (the body of the text and the last line of the text to be centered) as opposed to left justified as set in the root style, it inherits the attributes the changes made to the root style by Style 3 (i.e. the single drop char spread over two lines).

Style 5 is also based on Style 3, and like Style 2 it also defines the text to be center justified. This style also defines a drop cap of a single character over three lines, this attribute replaces that defined in Style 3.

19.7. Creating Styles

Before we can create a style (we chose to create a paragraph style here), we need to have a set of attributes we wish the style to have (attributes that are different from the style it will be based on). We need to set the style's name and indicate which style this new style is to be based on (i.e. where it fits in to the style hierarchy). The `CreateStyle()` method in the snippet `SnipCreateParaStyle.cpp` shows how to create a new paragraph style, based on the text attributes of a text selection.

In this case, we apply two lists of attributes, one representing the local overrides on the character attribute strand, and the other representing the local overrides on the paragraph attribute strand. The style that is created is represented by the string name it is assigned. This will be the name that it is known as in the paragraph styles panel and more generally, the paragraph style name table for this workspace. The sample goes on to apply the style to the paragraphs touched by the text selection.

19.8. Applying Styles

The snippet `SnipApplyParaStyle.cpp` shows how we can retrieve and apply a style from its name. `paraStyleNameTable` is the paragraph style name table for the workspace. We first retrieve the style we want to apply from the front document's workspace, we must also know the range of text we want the style to apply to. We use the command generation mechanisms of the text story boss to return us a command that will perform this task for us. We strongly suggest developers make use of these mechanisms rather than create the command directly. The command generation mechanisms handle a lot of the grungy, error-prone details in the initialisation of the command.

19.9. Editing styles

You can edit a current style, effectively changing the attributes that are associated with it. The code snippet `SnipUpdateCurrentParaStyle.cpp` in SDK gives an example of how to do this.Basically, the effect is to add the local overrides defined in the attribute boss list of an `IAttributeStrand` associated with an `ITextModel` to the attribute boss list within the style. We duplicate the attribute boss list because we anticipate that we will want to clear the list of

overrides that are currently being applied. As part of this operation the current `AttributeBossList` is deleted. To see this function in action: create a style, then create some text with this style, then override some of the attributes from the Paragraph panel, you should see a plus sign next to the style name. then run the snippet, the + sign disappeared, then examine the style, the override should now be part of the style (thus no +).

19.10. Default Styles

There is the concept of default styles. These are the paragraph and character styles that are used by default when creating a new story. If you always want stories to begin with a certain style you can set this programmatically. The snippet `SnipSetDefaultParaStyle.cpp` sets the default style to the one that the current text selection is based on. The command used to set the default is `kDefaultTextStyleCmdBoss`. The command's target (its item list) should be pointed to the current workspace.

19.11. Deleting Styles

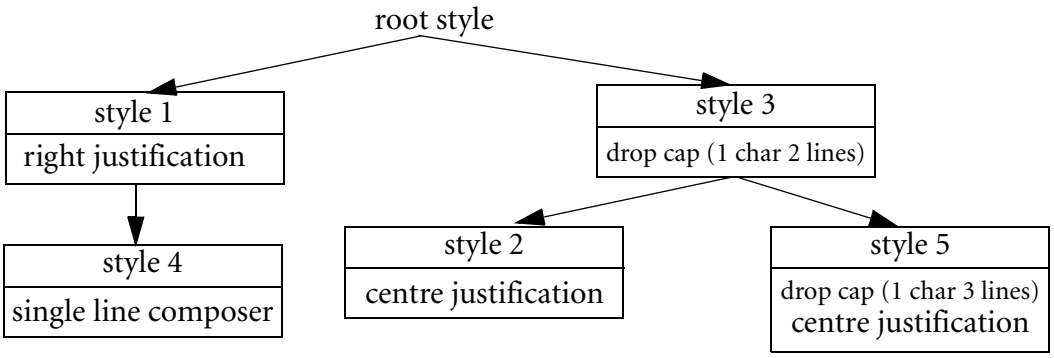
A named style can be deleted from the application. The snippet `SnipDeleteParaStyle.cpp` in SDK deletes the style whose name matches the one supplied by the user from the front most workspace. `kDeleteParaStyleCmdBoss` is used to delete a style from the active workspace.

There is an obvious question regarding what happens to text that is formatted with a style that is being deleted. The formatting of that text, i.e. how it appears must not change. The `AttributeBossList` that applies to the style that is about to be deleted is copied directly to the attribute strand as a local override.

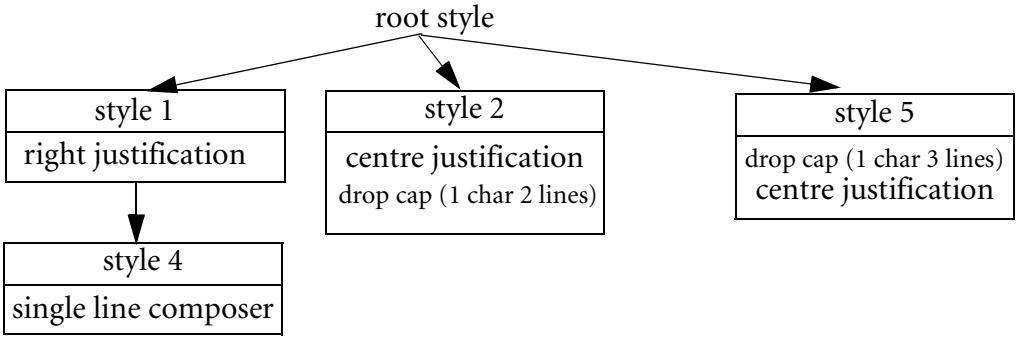
In the case that the style that is about to be deleted is not a leaf in the styles hierarchy (i.e. there exists styles that are based on it), all styles based on the candidate for deletion, become based on the style's parent, and the attributes within the style's `attributeBossList` are added to the `attributeBossLists` of the "child" styles. This is shown in figure 19.11.a. When we delete "style 3", both "style 2" and "style 5" are based on the root style. "style 2" has the attribute that defines the drop cap added to its `AttributeBossList`. As "style 5" was overriding the setting of this attribute in "style 3", it does not need the attribute.

figure 19.11.a. Deletion of a style

before deletion



after deletion



19.12. Summary

This chapter described the practical elements of programming with text styles. It showed the natural hierarchical relationships that styles possess with each other and gave examples showing how to create, edit and delete styles.

19.13. Review

You should be able to answer the following questions:

1. Which interface on an attribute describes its current setting? (19.5., page 585)
2. What style holds the default formatting information for text? (19.10., page 591)
3. What formatting information does the root character style hold? (19.3., page 583)
4. What is an override? (19.6., page 585)

5. If you delete a style, what happens to its children? (19.11., page 591)
6. What happens to text that is formatted using a style when that style is deleted? (19.11., page 591)

19.14. Exercises

19.14.1. Creating styles

Starting with the root style, programmatically create 6 new styles, each new style 2 points greater in size than the previous one.

19.14.2. Deleting styles

Write a method that deletes every style apart from the root style from a document

19.14.3. Style Tree Walker

Write a method that will create a new style based on every other style in a document. Where a particular "leaf" attribute overlaps, the override should be based on the rightmost, lowest style in the style hierarchy.

20.

Fonts

20.0. Overview

This chapter describes the **fonts API** and how it relates to the text sub-system.

20.1. Goals

The questions this chapter answers are:

1. What is a font?
2. What is the font manager?
3. What is a font group?
4. What is a font family?
5. How can I find the font used to display text from a story?

20.2. Chapter-at-a-glance

"Key concepts" on page 596 explains the architecture involved in fonts.

"Interfaces" on page 598 describes the interfaces that control fonts.

"Frequently asked questions (FAQ)" on page 600 answers often asked questions concerning fonts.

"Summary" on page 602 provides a summary of the material covered in this chapter.

table 20.1.a. version history

Rev	Date	Author	Notes
2.0	17-Dec-02	Seoras Ashby	New chapter initial release.

"Review" on page 602 provides questions to test your understanding of the material covered in this chapter.

"Exercises" on page 602 provides suggestions for other tasks you might want to attempt.

20.3. Key concepts

20.3.1. Terminology and definitions

This section introduces the terms needed to understand this document.

- **glyph;** a shape used to represent a character code on screen or in print.
- **font**; a collection of glyphs that were designed together and intended to be used together. See interface `IPMFont`.
- **font group**; a collection of fonts that were designed together and intended to be used together. Within a group there may be a number of different stylistic variants. See interface `IFontGroup`.
- **font family**; a font group used within a document. See interface `IFontFamily`.
- **group name**; name of a font group e.g. "Times", "Courier", "Times New Roman".
- **family name**; the name of a font family e.g. "Times", "Courier", "Times New Roman". *The group name and the family name are always the same.*
- **stylistic variant**; a variant of a font in a font group.
- **style name**; the name of a stylistic variant. Typically, the "Roman" or "Plain" or "Regular" member of a font group is the base font, the actual name varies from group to group. The group may include variants such as "Bold", "Semibold", "Italic", and "Bold Italic".

The terms font group and font family are used interchangeably in the API and in this document. *From the perspective of the API* a key distinction between font group and font family is this.

- font groups describe all the fonts available to the application.
- font families describe the fonts used by a document.

20.3.2. The font manager

The font manager (`IFontMgr`) on the session (`kSessionBoss`) provides access to all the font groups (`IFontGroup`) available to the application. The font group will allow you to access each font (`IPMFont`) in the group.

20.3.3. Cooltype

Cooltype is the core technology through which fonts are accessed. The API provides interfaces `IFontGroup`, `IPMFont` and `IFontInstance` as shells through which Cooltype is called. These are not standard interfaces, i.e. they do not derive from `IPMUnknown`. So you cannot create them using `CreateObject` or query them for other interfaces because they are not aggregated on a boss class. However these interfaces are reference counted and their lifetime can be managed using `InterfacePtr`.

In addition to the fonts made available by your operating system Cooltype can load fonts directly from the common Adobe fonts folder and from the Fonts folder inside the application's folder.

20.3.4. Documents and fonts

When a font is used by a document an object is created within the document to refer to it. The abstraction used is the **font family** (interface `IFontFamily`) on boss class `kFontGroupBoss`.

The document font manager (`IDocFontMgr`) manages the font families within a document. When a font is used for the first time in a document this interface is used to create the boss object.

The text attributes that refer to the font in which text appears are:

- `kTextAttrFontUIDBoss`; interface `ITextAttrUID` gives the `UID` of the font family (`IFontFamily`).
- `kTextAttrFontStyleBoss`; interface `ITextAttrFont` gives the name of the stylistic variant.

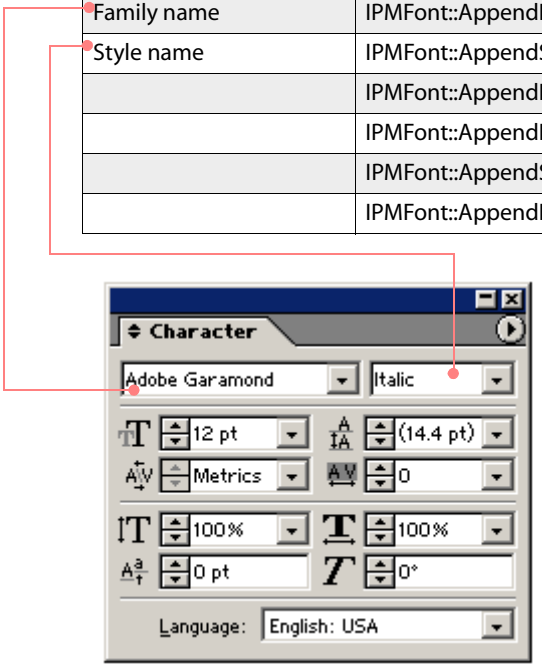
Text attributes are introduced and described fully in the "Text model" chapter.

20.3.5. Font names

Internally the application uses Postscript font names. The name returned by `IPMFont::AppendFontName` is the Postscript font name. If you know the Postscript name of the font you want you can get the `IPMFont` for it using `IFontMgr::QueryFont`. Several other names are made available on `IPMFont` and `IFontFamily`. For example if you use `IFontMgr::QueryFont` to instantiate the Postscript font "AGaramond-Italic" interface `IPMFont` can give you the names shown in figure 20.3.5.a.

figure 20.3.5.a. Font names

Name	Method	Example
Postscript font name	IPMFont::AppendFontName	AGaramond-Italic
Family name	IPMFont::AppendFamilyName	Adobe Garamond
Style name	IPMFont::AppendStyleName	Italic
	IPMFont::AppendFullName	Adobe Garamond Italic
	IPMFont::AppendFamilyNameNative	Adobe Garamond
	IPMFont::AppendStyleNameNative	Italic
	IPMFont::AppendFullNameNative	Adobe Garamond Italic



If you do not have the Postscript font name but you know the name of the typeface on a given platform, i.e. the typeface name on Windows or a family name on Mac, you can use `IFontMgr::QueryFontPlatform` to get the corresponding `IPMFont`.

20.4. Interfaces

figure 20.4.a. Font interfaces

Interface	Notes	Navigation
IFontMgr	Provides access to all fonts available to the application. Aggregated on kSessionBoss.	Via session InterfacePtr<IFontMgr> fontMgr(gSession, UseDefaultIID());

Interface	Notes	Navigation
IFontGroup	Shell above the CoolType API that represents a font group. Not aggregated onto any boss class i.e. not an IPMUnkown. Does not have a UID. Ref counted for convenience so you can manage scope using InterfacePtr.	Via IFontMgr::QueryFontGroup Via FontGroupIteratorCallBack.
IPMFont	Shell above the CoolType API that represents a font. Provides font name mapping calls. and access to font metrics at a given point size. Not aggregated onto any boss class i.e. not an IPMUnkown. Does not have a UID. Ref counted for convenience so you can manage scope using InterfacePtr.	Via IFontMgr::QueryFont. Via IFontMgr::QueryPlatformFont. Via IFontFamily. Via text attributes kTextAttrFontUIDBoss and kTextAttrFontStyleBoss Via IDrawingStyle.
IFontInstance	Shell above the CoolType API that represents an instance of a font of a given point size. Not generally of interest unless you need to write a paragraph composer or need to map character codes to GlyphIDs. Not aggregated onto any boss class i.e. not an IPMUnkown. Does not have a UID. Ref counted for convenience so you can manage scope using InterfacePtr.	Via IFontMgr. Via IDrawingStyle.
IFontFamily	Represents a font group within a document. Each font group used by a document has a kFontGroupBoss object. Managed by IDocFontMgr. Is an IPMUnknown. Has a UID.	Via IDocFontMgr Via text attribute kTextAttrFontUIDBoss (gives UID of IFontFamily boss object).

Interface	Notes	Navigation
IDocFontMgr	Manages font families (IFontFamily) within a document. When a font is used for the first time in a document this interface is used to create the font family. Processes underlying commands to create/delete font families. If you are changing the font used by text you should be calling IDocFontMgr::GetFontGroupUID to get the UID to put in your kTextAttrFontUIDBoss.	Via document workspace. InterfacePtr<IDocFontMgr> docFontMgr(document->GetDocWorkSpace(), UseDefaultIID());
IDocumentFontUsage	Manages used and missing font information for a document.	Via IDocument. InterfacePtr<IDocumentFontUsage> docFonts(document, UseDefaultIID());

20.5. Frequently asked questions (FAQ)

20.5.1. How do I iterate available fonts?

Code snippet SnipFontMgr shows how to iterate all fonts available to the application by calling `IFontMgr` directly.

Code snippet SnipFontGroupIterator shows how to implement a `FontGroupIteratorCallBack` (see IFontMgr.h) to iterate all fonts.

20.5.2. How do I find a given font?

This depends on what information you have that identifies the font. Read "Font names" on page 597 and check out code snippet SnipFontMgr for a variety of approaches.

Code snippet SnipFontFindIterator implements a `FontGroupIteratorCallBack` that finds the name of the postscript font given the full name of the font as returned by `IPMFont::AppendFullName`. For example if you search for "Courier Bold" it will give you back the name of the Postscript font "Courier-Bold".

20.5.3. How do I find the font used to display a story's text?

One way is to use the values of text attributes `kTextAttrFontUIDBoss` and `kTextAttrFontStyleBoss`. The UID in `kTextAttrFontUIDBoss`'s `ITextAttrUID` interface gives you can be used to instantiate an `IFontFamily` object.The `PMString` in `kTextAttrFontStyleBoss`'s `ITextAttrFont` interface will give you

the stylistic variant (e.g. regular or bold). From these you can find the name of the font as shown in figure 20.5.3.a.

figure 20.5.3.a. Finding the font name from text attributes.

```
static PMString FindFontName
(
  IDataBase* db,
  ITextAttrUID* fontUID,
  ITextAttrFont* fontStyle
)
{
  InterfacePtr<IFontFamily> family(db, fontUID->GetUIDData(),
    UseDefaultIID());
  InterfacePtr<IPMFont> font(family->QueryFace(
    fontStyle->GetFontName());
  PMString fontName = font->AppendFontName(fontName);
  return fontName;
}
```

The second way is to use `IComposeScanner` to get the drawing style (`IDrawingStyle`) at a particular index in the text model as shown in figure 20.5.3.b.

figure 20.5.3.b. Finding the font from the drawing style

```
InterfacePtr<IComposeScanner> scanner(textModel, UseDefaultIID());
IDrawingStyle* style = scanner->GetCompleteStyleAt(textIndex);
InterfacePtr<IPMFont> font(style->QueryFont());
```

20.5.4. How do I change the font used to display a story's text?

To set the font used to display a range of text in a story override text attributes `kTextAttrFontUIDBoss` and `kTextAttrFontStyleBoss` in the text model. See the "Text model" chapter for information on overriding text attributes.

The set the font for a text style add or change the value of text attributes `kTextAttrFontUIDBoss` and `kTextAttrFontStyleBoss` in the style. See the "Working with text styles" chapter for more information.

20.5.5. How do I get the name of a font from the UID of that font.

Use the UID to instantiate an `IFontFamily` interface and get the name from there. The UID of a font is typically obtained from text attribute `kTextAttrFontUIDBoss`, from `IDocFontMgr` or from `IDocumentFontUsage`.

20.6. Summary

This chapter described the fonts API and answered some often asked questions about how to use it.

20.7. Review

You should be able to answer the following questions:

1. What is a font group? (20.3.1., page 596)
2. What is a font family? (20.3.1., page 596)
3. What is a font? (20.3.1., page 596)

20.8. Exercises

20.8.1. Find the name of the font that displays text at a given TextIndex

Use one of the approaches described in "How do I find the font used to display a story's text?" on page 600 to find the font used to display the text of a story at a given text index.

20.9. References

- Modern digital typography topics
  http://www.adobe.com/type/topics/main.html
- A glossary of typographic terms
  http://www.adobe.com/type/topics/glossary.html
- Adobe type technology overview
  http://partners.adobe.com/asn/developer/type/main.html

21.

Printing

21.0. Overview

In this document, you will become familiar with the InDesign commands, interfaces, structures, services and event-handling mechanisms used to print.

You will learn how to interject your own code into the printing process using the `IPrintSetupProvider` interface. The **PrintSelection** sample plug-in found in the SDK demonstrates how to do this and you will be directed to look at that example later in this document.

Note that it is this interjection into the printing process that makes for a valuable third-party plug-in, rather than modifying the application's printing plug-in. The printing process is described here to explain the environment into which a third-party plug-in based on `IPrintSetupProvider` enters.

To demonstrate details of the printing process, this document makes extensive references to the **BasicPrint** sample plug-in found in the SDK. If it is available, locate that plug-in now -- you will be directed to portions of it shortly.

21.1. Goals

The goals of this chapter are to:

1. Acquaint the reader with the major concepts and components of printing.
2. Demonstrate the use of those components for the reader who wants a deeper understanding of the extensibility of the print subsystem.

table 21.0.a. version history

Rev	Date	Author	Notes
0.3	7-Nov-2002	Rodney Cook	Update for 2.x.
0.2	9-Jun-1999	Andrew Coven	Edits for Beta 3.5.
0.1	24-Apr-1999	Rodney Cook	First draft.

3. Describe how third-party developers are expected to participate in the printing process.
4. Familiarize the reader with other printing-related SDK documentation for further understanding.

21.2. Chapter-at-a-glance

"21.3.The Major Concepts of Printing" on page 604 discusses how printing is achieved and controlled.

"21.4.The Major Components of Printing" on page 605 discusses the commands, interfaces, and structures used to print.

"21.5.PrintSetup Service Provider" on page 608 describes the mechanisms used to participate in the printing process as a PrintSetup service.

"21.6.Print Event Handling" on page 609 discusses the mechanisms used to register and unregister for handling draw events.

"21.7.Summary" on page 612 recaps the highlights of the chapter.

"21.8.Review" on page 612 hits you with some questions to determine if you have assimilated the information adequately to progress.

"21.9.References" on page 612 provides sources for additional information related to the topics in this chapter.

21.3. The Major Concepts of Printing

Adobe InDesign prints similarly to Adobe Photoshop and Adobe Illustrator. The look and feel of its user interface is also similar.

21.3.1. Printing is Simply Drawing to the Printer

With the exception of EPS, images, and PDF, printing from the application entails drawing part or all of a publication to a printer rather than the screen. The application uses a concept called Display Postscript, thanks to the Adobe Graphics Manager (AGM) to draw graphics primitives to both the screen and printer.

Because each object can delegate the drawing of children down the document hierarchy, the entire document can be drawn with a single call to the `IDrawMgr::Draw()` method of the topmost object.

Throughout the traversal of this hierarchy, draw events are generated. A draw event handler can register for and receive these events, providing access to every level of the object hierarchy and every application object as it is drawn to either the screen or printer.

21.3.2. Control is Provided by the Application API

The tasks of printing from the InDesign application are shared between:

- AGM, which is responsible for PostScript generation.
- The InDesign Print plug-in, which is responsible for user interface, initialization of print settings and drawing the pages.
- Plug-ins that register with the application as print setup providers, which are invited to assume control of the print process at regular intervals.

As a developer, you don't have direct access to AGM; InDesign provides the user interface, commands, interfaces, and data structures you need and provides all available external control over printing. Orderly opportunities are provided along the way for print setup provider plug-ins to break into the printing process -- either momentarily or for the balance of the printing process.

21.4. The Major Components of Printing

This section discusses the public commands, interfaces, and structures used by the application's own print plug-in and provided to external developers to help create their own printing solutions.

21.4.1. Highlights of the SDK BasicPrint Plug-in

The **BasicPrint** plug-in supplied with the InDesign SDK demonstrates all the major printing components and, unlike the application code, is available to the reader for inspection.

This section examines highlights of the BasicPrint plug-in to put these printing components in a context that makes them easier to understand. A more complete description of each component is provided later in this chapter.

If you are following along in the BasicPrint plug-in project, look now at `BscPrnActionComponent.cpp` for Step 1 and and then at `BscPrnPrintActionCmd.cpp` for the remainder of the print process.

Hint: Look for instances of `kPrintSetupService` inthe Steps below for opportunities for third-party developers to participate in the printing process.

The highlights of the application-supplied print plug-in are as follows:

1. Client code, usually in the form of either a menu action or script event, gets two pieces of information: an `IDocument` pointer for the document to be printed and a flag indicating whether the print UI should be displayed. The client code then creates and executes a `kBscPrnPrintActionCmdBoss`.
2. Inside the `BscPrnPrintActionCmd::Do()` method, a series of supporting print commands are started. (Note: All subsequent steps originate from inside this command.)
3. A print command data interface (`IPrintCmdData`) used by all the print commands gets the `IDocument` interface pointer supplied by the client code. The `IDocument` pointer is then used to get pointers for the ink list and trap style manager, as well as UIDRefs for the document and print style.
4. Now, the service registry polls `kPrintSetupService` providers to determine whether any plug-in wants to break into the print process at `StartPrintPub()`. A provider that has registered for this entry point can either take over the process at this point or perform some action and return control to the application's print plug-in.
5. If control returns to the print plug-in, a duplicate copy of print data (`IPrintData`) is made.
6. Now, the service registry polls `kPrintSetupService` providers to determine whether any plug-in wants to break into the print process at `BeforePrintUI()`. A provider that has registered for this entry point can vote on whether to show the print UI before returning control to the application's print plug-in. If the print UI is to be shown, a `kPrintDialogCmdBoss` is created and processed.
7. Now, the service registry polls `kPrintSetupService` providers to determine whether any plug-in wants to break into the print process at `AfterPrintUI()`. A provider that has registered for this entry point can vote on whether to show the Save dialog and whether to return control to the application's print plug-in. If the Save dialog is to be shown, a `kSaveFileDialogBoss` is created and processed.

8. If control returns to the print plug-in, the print data (`IPrintData`) is saved to the document.
9. Next, data is gathered for the print job -- a `kPrintGatherDataCmdBoss` is created but not yet processed.
10. Now, the service registry polls `kPrintSetupService` providers to determine whether any plug-in wants to break into the print process at `BeforePrintGather()`. A provider that has registered for this entry point can vote on whether to process the `kPrintGatherDataCmdBoss` created earlier and whether to return control to the application's print plug-in.
11. If control returns to the print plug-in, the service registry polls `kPrintSetupService` providers to determine whether any plug-in wants to break into the print process at `AfterPrintGather()`. A provider that has registered for this entry point can vote on whether to quit here or return control to the application's print plug-in.
12. If control returns to the print plug-in, a `kNewPrintCmdBoss` is created and processed. It is here that printing occurs.
13. After saving the print data again (in case it changed during printing) the print process ends.

In the following sections, each of the major components mentioned in the sequence above are described in greater detail.

21.4.2. Commonly-used Print Structures

The main structure for getting and setting printing information is contained within a class based on `IPrintData`. For additional information, see `IPrintData.h`.

21.4.3. Commonly-used Print Interfaces

The main interfaces used in the print process are:

- IPrintCmdData -- command data interface for InDesign printing commands.
- IOutputPages -- used with export commands to output multiple pages from multiple open publications -- basically a UIDRef list for outputing pages from multiple open pubs (probably from a book).
- IPrintSetupProvider -- used for setting up or changing the print parameters, prior to and during the printing process.
- IPrintData -- used to get and set print data.
- IPrintJobData -- used for managing list of inks.

21.4.4. Commonly-used Print Command Bosses

The main command bosses used in the print process are:

- kPrintDialogCmdBoss -- used to put up the print dialog.
- kPrintSavePrintDataCmdBoss -- used to save the print data.
- kPrintGatherDataCmdBoss -- used to gather print data.
- kNewPrintCmdBoss -- used to control the print process.

21.5. PrintSetup Service Provider

A plug-in can register as a print setup service (`kPrintSetupService`) by providing an implementation for `IK2ServiceProvider`. It will then be called at strategic points during the execution of application print commands. The implementation for `IPrintSetupProvider` interface provides methods to setup or change print parameters prior to and during the printing process.

Open the **PrintSelection** SDK sample plug-in now and follow along.

21.5.1. Registering as a PrintSetup Service provider

Look now in `PrnSel.fr` at `kPrnSelPrintSetupProviderBoss`. Notice that this boss aggregates `IK2ServiceProvider` and provides an implementation represented by `kPrnSelSetupServiceImpl`.

Now, look at `PrnSelSetupService.cpp`, which registers this plug-in with the application as providing a `kPrintSetupService`.

21.5.2. Participating in the print process

Look again in `PrnSel.fr` at `kPrnSelPrintSetupProviderBoss`. Notice that this boss aggregates `IPrintSetupProvider` and provides an implementation represented by `kPrnSelSetupProviderImpl`.

Now, look at `PrnSelSetupProvider.cpp`, which contains methods to participate in the printing process at various places. For example, `StartPrintPub()` is called from `BscPrnPrintActionCmd::Do()` before printing a single publication and sets the value for bReturn, which specifies to the `Do()` method whether to continue printing.

Additional methods, such as `BeforePrintUI()` and `AfterPrintUI()`, provide control over the print process during the print process.

21.6. Print Event Handling

The application uses AGM to draw graphics primitives to both the screen and printer. Since each application object draws its own children, the entire document can be drawn with a single call to the `IPrintMgr::Draw()` method of the topmost object in the hierarchy.

Throughout the traversal of this hierarchy, draw messages are generated. There are several types of draw messages generated: Draw, FilterCheck, AbortCheck, HitTest, and Inval. They are defined in `DocumentContextID.h`. Printing is only concerned with the Draw message. A draw event handler can register for and receive these events, providing access to every level of the object hierarchy, and every application object as it is drawn to either the screen or printer.

Now, look at `PrnSelDrawHandler.cpp`, which contains methods to: install/uninstall themselves into the draw event dispatcher, get called when the event they've register for happens, and define the event data passed to `HandleEvent()`.

21.6.1. Draw Events

Draw events are defined in `DocumentContextID.h`. In general, three draw events are generated for each `Draw()` method in the hierarchy: kBeginXXXMessage, kEndXXXMessage, and kDrawXXXMessage.

The kBeginXXXMessage is generated just before the call to the next level of the hierarchy (after any transformation is applied to the object). The kEndXXXMessage is generated just after execution returned from the hierarchy. Important Note: The kDrawXXXMessage is considered superflous and should no longer be used; it is scheduled to be eliminated.

21.6.2. Registering and Unregistering

There are two ways to register/unregister for draw events: as a service provider, or direct registration through the `IDrwEvtDispatcher` interface. The call to `RegisterHandler()` takes three parameters: the event being registered for, a pointer to the handler, and the priority of the event handler. For more information about the events and priorities, see the sections below.

21.6.2.1. Registering/Unregistering Using a Service Provider

A boss can register as a service provider, using the `IK2ServiceProvider` interface, and the `kDrawEventService` service ID. It must provide an implementation of the `IDrwEvtHandler` interface. When the application starts,

the Register() method in the draw event handler is called. The handler registers itself for the draw events it wishes to receive.

Unregistering is similar to the registering comments above, except the Unregister() method is called in the IDrwEvtHandler interface.

21.6.2.2. Direct Registration/Unregistration

A second method of registering for events is to instantiate the IDrwEvtDispatcher interface and call the RegisterHandler() method directly.

Look now at kPrnSelDrawServicesBoss in PrnSel.fr. Notice that this boss does not provide an implementation for IK2ServiceProvider. This is because this sample uses the direct registration method. Look now at the Update() method in PrnSelDialogObserver.cpp.

Unregistration is similar to the registering comments above, except use the UnRegisterHandler() method in the IDrwEvtDispatcher interface.

21.6.2.3. Draw Event Handling Priorities

Priorities are defined in IDrwEvtDispatcher.h. When a handler registers for an event, it must pass a priority to the RegisterHandler() method. Currently, there are five defined priorities: kDEHLowestPriority, kDEHLowPriority, kDEHMediumPriority, kDEHHighPriority, and kDEHInitialization.

As each event is processed, the handlers are called from the kDEHInitialization priority down to kDEHLowestPriority, in order. If two handlers have the same priority for the same event, the handler registered first will be called first. The return code for handlers registered using the kDEHInitialization priority is ignored. For additional information about return codes for the other priorities, see the section below.

21.6.3. Handling Draw Events

21.6.3.1. Parameters

The draw event handler's HandleEvent() method takes two parameters: a ClassID which is the eventID (defined in DocumentContextID.h), and a void pointer to a class containing the event data. For Draw events, this pointer should be cast to the DrawEventData class (defined in IDrwEvtHandler.h) to access the data.

21.6.3.2. Return Code

Look now at the `HandleEvent()` method in `PrnSelDrawHandler.cpp`. If the event handler returns `kTrue` to the `kBeginXXXMessage`, it is assumed the event was properly handled, and no other event handlers are called for the event. Also, the default code in the application will not be executed. The normal return code from draw events is kFalse. The `kEndXXXMessage` does not look at the return code from the event handler. (It would not make sense to, since the draw operation has already occurred.)

21.6.4. Print Events

Since InDesign uses the AGM drawing commands to print (it just sets up a different graphics port to draw to), print events are the same as draw events. One important distinction should be mentioned here. Draw events are normally registered when the application starts and unregistered when the application ends. Print events are registered just before printing starts and unregistered when printing finishes.

21.6.4.1. Service Provider

To aid in registering only for print events, a Service Provider mechanism is used. A boss can register as a service provider, using the `IK2ServiceProvider` interface, and the `kPrintEventService` service ID. It must implement the `IDrwEvtHandler` interface.

When the application sets up to start printing, the `Register()` method in the draw event handler is called. The handler registers itself for the draw (print) events it wishes to receive.

When printing is finished, the `Unregister()` method is called in the `IDrwEvtHandler` interface, giving the handler the opportunity to unregister for each draw event it previously registered for.

21.6.4.2. Keeping an Instance of the Draw Event Handler Notes

Since the registering of an event handler involves saving off a pointer to the handler into a table, it is very important the handler remains instantiated for as long as the handler is registered. When the handler is registered, an `AddRef()` is performed on it in an attempt to ensure this.

Similarly, a corresponding `Release()` is called when the handler is unregistered from the dispatcher.

21.6.4.3. Events Generated

Draw events are defined in `DocumentContextID.h`.

21.7. Summary

In this chapter, you learned printing from the application is drawing part or all of a publication to a printer rather than the screen. You became familiar with the InDesign commands, interfaces, structures, and event-handling mechanisms used to print, and also learned to distinguish between the tasks performed by AGM and those performed by InDesign APIs.

You were led through 2 plug-ins: **BasicPrint**, which behaves much like the application's own Print plug-in, to show you the flow of print operations and **PrintSelection**, which shows you how you can participate in the print process as a print setup provider. Detailed study of these two plug-in will help you write your own print setup provider.

Finally, you were directed to additional sources of information on the topics discussed in this chapter.

21.8. Review

You should be able to answer these questions:

1. What role does object hierarchy play in printing?
2. How are the tasks of printing divided between the application API and AGM?
3. What are the major structures used in printing?
4. What are the major interfaces used in printing?
5. In which two printing commands does registration for draw events occur?
6. Why is it a bad idea to use the kDrawXXXMessage?
7. Name two ways to register/unregister for draw events.

21.9. References

- Adobe. *Postscript Language Reference Manual*, 1990.
- Stroustrup. *The C++ Programming Language*, 1997.
- Adobe InDesign SDK. *Command Reference*, 2002. See `Adobe InDesign SDK/Documentation/CommandReference.pdf`.

22.

Scripting Architecture

22.0. Overview

Scripting support in Adobe InDesign allows users to exert virtually the same control of Adobe InDesign from a script as is available from the user interface. This functionality may be used for purposes as simple as automating repetitive tasks or as involved as controlling the application from a remote database.

The extensibility of the Adobe InDesign scripting architecture allows you to provide scripting support for either new functionality added by your application plug-ins or for Adobe InDesign functionality not yet exposed to scripting. The architecture largely provides a platform-independent and scripting language-independent foundation upon which you can build. It abstracts and provides implementations for the common elements of scripting. You only have the comparatively small task of adding implementations for the functionality you are exposing.

Note: Adobe InDesign currently supports scripts written in Visual Basic for Object Linking and Embedding (OLE) Automation (Windows NT/2000/XP) or AppleScript (Macintosh OS9.x/OS10.x).

The pieces of the Adobe InDesign scripting architecture your plug-in needs to implement are:

- A script provider - `IScriptProvider`.
- A script library for each scripting language. Note: A script library under Windows is the OLE Type Library and under the Macintosh is the Apple Event Terminology Extension (AETE) Resource Library.
- If you are exposing a new script object - `IScript` and (Windows only) `IAutomationRefCount`.

This document describes how the scripting architecture of Adobe InDesign works and directs you to documents that show you how you can expose your functionality to scripting.

Note: For a detailed explanation of adding scripting support to an InDesign plug-in, see *Scripting Your InDesign Plug-in* described in **References**.

22.1. Goals

The questions this chapter answers are:

1. What are the major components of the scripting architecture?
2. What are script properties and events?
3. What's involved in adding an event/property to an existing script provider?
4. What is involved in providing scripting support for a new object?
5. What platform-specific and scripting language-specific issues are there?

22.2. Document-at-a-glance

"22.3.Architecture" on page 615 introduces the scripting architecture. It gives a high-level overview and describes the architectural elements. You should understand this material before attempting your own script provider.

"22.4.Summary" on page 619 recaps everything presented in this chapter.

"22.5.Review" on page 619 presents some questions to determine whether you have assimilated the information adequately to progress.

"22.6.Exercises" on page 620 gives suggestions for other areas to explore related to these topics.

"22.7.References" on page 620 cites sources of additional information.

table 22.1.a. version history

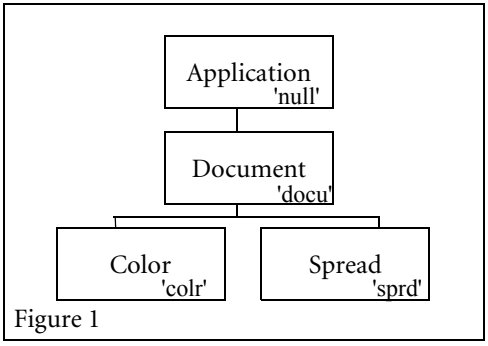
Rev	Date	Author	Notes
0.3	8/21/02	Rodney Cook	Update for InDesign 2.x
0.2	1/3/00	Peter Boctor	Second draft.
0.1	6/21/99	Rodney Cook	First draft.

22.3. Architecture

22.3.1. The document object model

The Adobe InDesign scripting architecture supports scripting languages through a Document Object Model (DOM) -- an object-oriented model where objects contain properties and methods and an object hierarchy determines the relationship between objects.

figure 22.3.b. document object model



For example, the figure above shows a simple DOM in which an application contains a document, which in turn contains a color and a spread.

Scripts are basically limited to two actions on objects: getting or setting a property and executing an event. A script wanting to do either of these actions first needs to find the right object to operate on and then execute the action.

For example, if the Color object exposed a “mode” property, a script wanting to set the mode to CMYK would first need to find the right color object. It does this by starting with the application object, finding the right document, and then finding the right color. Once the right color is found, then the script can tell the object to change its mode property to CMYK. For a more detailed explanation of getting or setting a property and executing an event, see the *Scripting Your InDesign Plug-in* technote described in **References**.

22.3.3. Script libraries and script IDs

The way in which a DOM is presented to the scripting user is up to the environment of the scripting language. AppleScript provides the user the ability to open a dictionary which displays an `AETE` resource. Visual Basic provides the

user with an Object Browser displaying an Object Document Language (ODL) type library resource.

In these environments, objects, properties, methods and enumerations are associated by name. Additionally, these resources contain a mapping between these names and an integer which is composed of 4 characters, such as 'docu'.

A script might use the string "document" to use the document object, the string "delete" to execute the delete method and the string "name" to access the name property, but what is sent to Adobe InDesign is the appropriate 4-character value defined in the AETE resource and the ODL type library.

You need to create a unique four-character IDs for each new object, property, method and enumeration you expose. A list of currently-used InDesign IDs can be found in the file "**ScriptingDefs.h**". Note that if you create your own four-character ID, it is your responsibility to determine that it is unique.

22.3.4. One script object, one InDesign boss

Each of the objects in the DOM figure above is an object available to a script. A script writer can utilize these objects to control Adobe InDesign. Each of these objects has one and only one corresponding boss in Adobe InDesign.

For example, to expose a document script object, the Adobe InDesign scripting architecture needs an equivalent Adobe InDesign document boss. This association is done using the `IScript` and (Windows only) `IAutomationRefCount` interfaces.

If you are exposing a property or method on an already-exposed object, then a boss has already been associated with this scripting object. If, however, you are exposing a new object, then you need to create new implementations of both the `IScript` and `IAutomationRefCount` (Windows only) interfaces and add them to the boss you are exposing. If this boss is one you created in your plug-in, then you can edit your .fr file directly. If this boss exists within Adobe InDesign, then you will need to create an add-in to the boss.

Any new objects you expose need to fit somewhere in the DOM -- specifically, they need to have a container. Just as a spread is below the document in the DOM figure above (a document contains a spread), you need to determine where your objects fit in the hierarchy.

22.3.5. The script provider

The three basic functionalities your plug-in can expose to scripting are: objects, properties and events. The actual code implementing this functionality lives in a script provider, `IScriptProvider`. A script provider is an Adobe InDesign service provider -- it provides the service of scripting for one or more objects.

22.3.5.1. Key Methods

The key methods on `IScriptProvider` are: GetObject(), AccessProperties() and HandleEvent(). These map to the three functionalities your plug-in can expose: objects, properties and events. More than one provider can provide property and method functionality to a script object. This means you can create a script provider handling your own property on the document object even though Adobe InDesign already exposes a document object. GetObject() however can only be implemented by the original script provider exposing the object to scripting. This provider is said to represent the object.

GetObject() is called when a script is finding the object it needs to operate on. For example, if a script wants to delete a color stop, it first finds the right color (which Adobe InDesign handles). But then it needs to find the right color stop in that color. So it calls your script provider, passes in the color and asks you to find a specific color stop (by index or by name are the most common ways of finding an object).

AccessProperty() and HandleEvent() are called when a script is trying to get/set a property or execute an event, respectively, on an object. For example, if a script is trying to get the property "location" on your color stop object, it calls your provider's AccessProperty() and passes the color stop you provide, whether it is a get or set operation and expects you to do the right thing. Or, if a script is trying to delete one of the color stop objects you provided, it calls your provider's HandleEvent(), passes you the color stop, and expects you to do the right thing.

22.3.5.2. What you need to do in the key methods

The code in your provider's GetObject(), AccessProperty() and HandleEvent() are largely specific to what you are exposing. However, there are three common tasks you will need to do:

- extract data from a script
- return data to a script
- return an error to a script.

For errors, you can create an error string in your plug-in's string table, associate an error number with the string in you plug-in's ID.h file, and return the error number. The error string is then returned to the script.

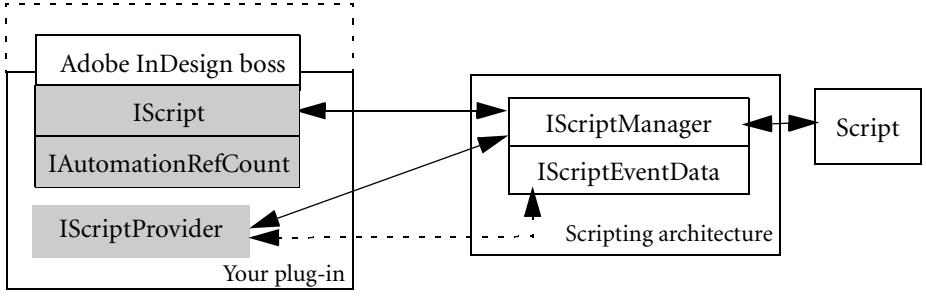
For extracting/returning data, all three methods pass in an `IScriptEventData` interface abstracting this functionality from the scripting language. This means your code can extract data, return data and return an error without having to know the scripting language of the script controlling Adobe InDesign. The two main methods of `IScriptEventData` handling these tasks are ExtractEventData() and SetReturnData(). These methods accept and return a `ScriptData` object -- a C++ class holding any data type supported by the Adobe InDesign scripting architecture.

22.3.6. Tying it all together

The figure below shows all the pieces necessary for exposing objects, properties and methods to scripting, as well as the basic flow of control:

- A script requests either finding an object, getting/setting a property or executing a method.
- If the object in question is an object you expose, then the scripting architecture responds by calling your script provider, passing in an `IScriptEventData`.
- Your code handles the request using `IScriptEventData` to extract/return data from/to the script.

figure 22.3.g. necessary pieces and flow-of-control



The gray boxes are the pieces you need to implement. An IScriptProvider is always needed. An IScript and IAutomationRefCount (Windows only) are needed if you expose a new scripting object.

Adobe InDesign scripting uses four main interfaces to provide scripting support:

IScript	A marker to distinguish an object from other kinds of objects.
IScriptManager	Creates a scripting language-specific script manager for the user script. Enables communication between the script editor (OLE Automation or AppleScript) and an IScriptProvider implementation. Functional details of this interface are provided in IScriptManager.h.
IScriptProvider	Responds to events, method calls, or property requests routed from the user script by the applicable script manager. Functional details of this interface are provided in the helpers document in Adobe InDesign SDK/Documentation/CommandReference/.
IScriptEventData	Manages language-specific script event data (and possibly error information) passed between the script and the corresponding script provider. Functional details of this interface are provided in the helpers document in Adobe InDesign SDK/Documentation/CommandReference/.

22.3.8. Examples in the SDK and test scripts

Test scripts for both Windows and Macintosh platforms are provided with the SDK CustomPrefsScript plug-in.

For a discussion of how to create your own script using either AppleScript or Visual Basic, see the "Scripting Basics" chapter of the *Adobe InDesign Scripting Guide* described in "22.7.References" on page 620.

For a discussion of system requirements for either AppleScript or Visual Basic, see the "Introduction" chapter of the *Adobe InDesign Scripting Guide*.

22.4. Summary

This chapter describes the Adobe InDesign scripting architecture. The basics of providing scripting support for your plug-ins is also covered. For more detailed explanations, see *Scripting Your InDesign Plug-in* described in **References**.

22.5. Review

You should be able to answer these questions:

1. What is a script object?
2. What is a script provider? What does a provider do with a script object?
3. How is scripting data handled?
4. What script provider methods are necessary to add events and properties to an application object?

5. What do you need to implement if introducing a new application object to the scripting architecture?

22.6. Exercises

22.6.1. Adding a property

How would you add a property to a script provider?
Hint: see the CustomPrefsScript sample plug-in in the SDK.

22.6.2. Implementing a new script object

What is involved in creating a script object?
Hint: see the CustomPrefsScript sample plug-in in the SDK.

22.6.3. Extracting data

How does a script provider obtain data from a script?
Hint: see the CustomPrefsScript sample plug-in in the SDK.

22.6.4. Returning data

How does a script provider return data to a script?
Hint: see the CustomPrefsScript sample plug-in in the SDK.

22.7. References

- Adobe InDesign SDK. *Scripting Your InDesign Plug-in*, 2002. See **ScriptingYourPlug-in.pdf** on your installation disk.
- Adobe User Education. *Adobe InDesign User Guide*, 1999.
- Adobe InDesign SDK. *Adobe InDesign Scripting Guide*, 1999. See **InDesignScriptingGuide.pdf** on your installation disk.

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